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Research Article

# EFFECT OF COWPEA AND CARROT INCLUSION ON THE PHYSICOCHEMICAL, PROXIMATE, AND SENSORY PROPERTIES OF GERMINATED/PRE-GELATINIZED MAIZE COMPLEMENTARY FOOD

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**ABSTRACT**

**Objectives:** Effect of addition of cowpea and carrot flour on the physicochemical, proximate, and sensory properties of germinated/pre-gelatinized maize complementary food was evaluated.

**Methods:** Germinated and pre-gelatinized maize grains, soaked and roasted cowpea, and cleaned carrot were processed individually into flour. Maize, cowpea, and carrot flour were blended at the ratios of 95:5:0, 90:5:5, 85:10:5, 80:15:5, 75:20:5, 70:25:5, and 60:30:5 represented by letters A – G. Maize flour (100%) served as control. Analysis was by standard analytical methods.

**Results:** pH and total titratable acidity ranged, respectively, from 6.09 to 6.33 and 0.77 to 1.13% lactic acid. Moisture, protein, fat, ash, crude fiber, and carbohydrate content varied significantly ($p \leq 0.05$) from 8.23 to 11.48, 7.63 to 10.59, 2.72 to 6.39, 1.25 to 2.05, 2.86 to 6.63, and 66.43 to 73.59%, respectively. Energy differed significantly ($p \leq 0.05$) from 345.44 to 374.11 Kcal/100 g. Addition of cowpea and carrot flour increased the nutrient content except for carbohydrate and energy. Assessors' degree of likeness of the gruel was from like moderately to dislike moderately with increase in cowpea addition for aroma (2.35–7.55), taste (2.70–8.10), mouth feel (3.25–7.55), thickness and consistence (2.80–7.45), and overall acceptability (2.57–7.75) except for color (3.50–7.60), with no significant ($p \geq 0.05$) difference in texture (3.05–4.50). Sample G with 30% cowpea addition had significantly ($p \leq 0.05$) the highest protein content but the least degree of likeness for all sensory attributes except color.

**Conclusion:** An addition of up to 10% cowpea with 5% of carrot flour for improved protein and acceptable sensory attributes is recommended.

**Keywords:** Maize, Germination, Pre-gelatinization, Cowpea, Carrot, Complementary food, Acidity, Proximate, Sensory properties.

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## INTRODUCTION

Complementary foods according to the WHO are foods other than breast milk introduced to infants when breast milk alone is no longer sufficient to meet their nutritional requirements [1]. After 6 months, the infants need for energy and nutrients exceed that of the breast milk and the infant is developmentally ready for other foods. Inadequate nutrition at this stage will falter growth and development hence the introduction of complementary foods while continuing with breast feeding [2]. In Nigeria, traditional complementary foods are mostly made from fermented cereals, such as maize, millet, and sorghum, and introduced to the infants between 3 and 5 months depending on the locality and types of cereal grain or root crop available [3].

Maize (*Zea mays*) is one of the cereals that are grown worldwide due to its ability to adapt in diverse environments and it has multiple end uses as a human food and livestock feed and serves as an important component for varied industrial products. In Nigeria, maize is one of the main ingredients for complementary foods, a major component of many dishes, and also serves some medicinal purposes. Chemically, maize is composed of 70–73% of carbohydrates mainly starch, 8–11% of protein, % of lipid, and varying amounts of other nutrients, vitamins, and minerals [4]. The lipid content is mostly found in the maize germ and is a good source of energy and fatty acids. Maize like other cereals is relatively low in lysine and tryptophan, but fair in sulfur-containing amino acids such as methionine and cysteine [5]. Legumes form a good basis for complementing cereals as they are good in the amino acids that are limiting in cereals, but they are rarely used for weaning and are introduced much later (after 6 months of age) because of the problems of indigestibility, flatulence, and diarrhea associated with their use.

Cowpea (*Vigna unguiculata* [L] Walp.) is an annual herbaceous legume grown predominantly in Africa and is an important staple crop providing an affordable source of protein [6]. According to Khalid *et al*. [7], whole and dehulled defatted cowpea flour contains protein, fat, fiber, ash, and carbohydrate contents of 22.30–26.73, 2.10–2.30, 4.10–1.02, 3.77–3.87, and 60.07–59.78%, respectively. The dietary protein of cowpea nutritionally complements staples such as cereals and tuber crops that are low in protein and limiting in some essential amino acid [8]. In Nigeria, it is popularly called beans and comes in different varieties: The brown, black-eyed, and brown-eyed varieties. It is processed in utilized in several forms: Boiled alone or with rice and consumed with stew, cooked together with ripe plantain or sweet potatoes and consumed as pottage, dehulled ground and used in akara or moimoi production. The flour has been used as composite flour for bakery products [9,10] and formulation of infant complementary foods [11].

The carrot (*Daucus carota* subsp. *sativus*) is a root vegetable, typically orange in color, though purple, black, red, white, and yellow cultivars exist [12]. The colors of carrot flesh may be white, yellow, orange, red, purple, or very dark purple [13]. They are an excellent source of antioxidant compounds (flavonoids: Kaempferol, quercetin and luteolin, and other phenols) [14,15]. They are rich source of the pro-Vitamin A carotene. Carrots can be eaten in a variety of ways: Boiling and eating as part of main meal, salads, and production of flour for incorporation into other products. Recently, there is the addition of carrot flour to infant formula to improve the Vitamin A content [16,17].

Pre-processing and processing operations of cereals grains such as soaking, germination, and fermentation are known for their benefits on the nutrient and sensory properties of the food. Germination process involves the soaking of cereals grains and holding at ambient temperatures to sprout, during which endogenous enzymes are activated and new ones synthesized to modify the constituent of the seed [18]. The activities of these enzymes result in improvement in carbohydrate and protein digestibility, increase in bioavailability of vitamins and minerals, degradation of anti-nutrient factors and release of many bound nutrients, and increase in palatability and acceptability of the products [19,20]. According to Dewey and Brown [21], the use of flour from germinated cereals can increase the concentration of gruel to 3–5 times while maintaining the same viscosity as that of gruel of ungerminated flour. Pre-gelatinization is a hydrothermal process that consists of heating and drying [22]. Its application on cereals has been reported to improve the physicochemical, composition, and functional properties of the products [23,24]. A complementary food developed from blends of germinated/pre-gelatinized maize flour with cowpea and carrot flours would be expected to provide sufficient nutrient and energy dense food to meet the infant requirements. This study was, therefore, aimed at evaluation of the effect of cowpea and carrot inclusion on the physicochemical, proximate, and sensory properties of germinated/pre-gelatinized maize complementary food.

## METHODS

### Maize, cowpea, and carrot samples

The yellow variety of maize (*Z. mays*) and cowpea (V. unguiculata [L] Walp.) was purchased from Mile 3 Market in Port Harcourt, Rivers State. Carrot tubers (*D. carota subsp. Sativus*) work was purchased from fruit garden in Port Harcourt, Rivers State, Nigeria.

### Preparation of germinated/pre-gelatinized maize flour

The steps for the preparation of the germinated and pre-gelatinized maize flours were according to the methods described by Traoré *et al*. [25] and [23], respectively. Briefly, the maize grains after sorting and cleaning were soaked in distilled water at room temperature overnight and then spread out on a humidified thick towel for 3 days to sprout. The germinated grain was heated at 70˚C for 15 min, oven dried in hot air oven (Gallenkamp, UK) overnight at 70°C, milled, sieved with 0.2 mm sieve, and packaged in a well-labeled transparent polyethylene bag.

### Preparation of cowpea flour

Cowpea flour was prepared according to the method described by Ngoma *et al*. [26] with slight modifications. Briefly, cowpea seeds were cleaned, sorted, and about 4 kg was soaked in excess distilled water for 10–15 min for the manual removal of the seed coats. Dehulled seeds were washed in water, drained and roasted in hot air oven at 150˚C for 30 min, cooled at room temperature, milled using hammer mill, and sieved with 0.2 mm sieve to obtain the flour that was packaged in a dry airtight plastic container.

### Preparation of carrot flour

Fresh carrots were washed and the outer layers scraped using a hand scrapper. About 3 kg of the carrot were grated, dried at 70°C overnight and blended with hammer mill, and sieved with 0.2 mm sieve to obtain carrot flour that was packaged in a well-labeled plastic container. The prepared flours were preserved in a deep freezer until required for use. Formulation of the germinated/pre-gelatinized maize flour complementary food with cowpea and carrot flour.

Table 1 shows the supplementation of the germinated and pre-gelatinized maize flour with different proportions of the cowpea and carrot flours.

### Determination of pH and total titratable acidity (TTA)

The pH and TTA of the germinated/pre-gelatinized maize flour blended with cowpea and carrot flours were determined using standard AOAC [27] methods. pH of 10 g of the sample suspended in 100 ml of distilled water left to stand for about 10 min was measured using a pH meter (Umcan 9450 model) after initial standardization with buffers of pH 4.0 and 7.0.

**Table 1: Formulation ratios for the complementary food blend**

| Sample | Germinated/pre-gelatinized maize flour | Cowpea flour | Carrot flour |
|---|---|---|---|
| Control | 100 | 0 | 0 |
| A | 95 | 5 | 0 |
| B | 90 | 5 | 5 |
| C | 85 | 10 | 5 |
| D | 80 | 15 | 5 |
| E | 75 | 20 | 5 |
| F | 70 | 25 | 5 |
| G | 65 | 30 | 5 |

Thereafter, 10 ml of the filtrate from the pH determination was titrated against 0.1 M NaOH until a light pink color was observed using three drops of phenolphthalein as the indicator. The acidity was calculated as % lactic acid. Proximate analysis of the germinated/pre-gelatinized maize flour blended with cowpea/carrot flour.

The proximate composition of the formulated germinated/pre-gelatinized maize food with cowpea and carrot flours was determined according to the standard AOAC [27] methods. Moisture was determined gravimetrically after drying to a constant with in an air over at 60°C. The micro-Kjeldahl method was used for protein determination. Fat was obtained after exhaustive Soxhlet extraction. Carbohydrate content was determined by difference: 100%– (% MC+% Ash+% Crude protein+% Fat+% Crude fiber). Energy (Kcal/g) was calculated using the Atwater factor of 4.0 Kcal/g for protein and carbohydrate and 9 Kcal/g for fat. Sensory analysis of complementary food from blends of germinate/pre-gelatinize maize flour with cowpea and carrot flours.

The gruel from the blends of germinated/pre-gelatinized maize flour with cowpea and carrot flours for the sensory analysis was prepared as described by Obinna-Echem *et al*. [28] and the sensory attributes were analyzed using a 9-point hedonic scale, with the degree of likeness of the product attribute expressed as: 1 – dislike extremely, 2 – dislike very much, 3 – dislike moderately, 4 – dislike slightly, 5 – neither like nor dislike, 6 – like slightly, 7 – like moderately, 8 – like very much, and 9 – like extremely. Sensory properties: Aroma, color, appearance (smoothness), mouth feel, taste, texture, and overall acceptability of the coded gruel were carried out using a panel of 20 assessors consisting of nursing mothers, staff, and students of the Department of Food Science and Technology, River State University, Port Harcourt.

### Statistical analysis

Statistical analysis was carried out using Minitab (Release 18.1) Statistical Software English (Minitab Ltd. Coventry, UK). Statistical differences and relationship among variables were evaluated by analysis of variance under general linear model and Tukey pairwise comparisons at 95% confidence level. The non-parametric Friedman test and 2-sample t-test were employed in determining the statistical differences among the product sensory attributes.

## RESULTS AND DISCUSSION

pH and TTA as % lactic acid of complementary food from blends of germinated/pre-gelatinized maize with cowpea and carrot flours Fig. 1 presents the pH and TTA of complementary food from blends of germinated/pre-gelatinized maize with cowpea and carrot flours. There was no significant ($p \leq 0.05$) difference in the pH and TTA of the samples. The values ranged from 6.09 to 6.33 and 0.77 to 1.13% lactic acid, respectively, for the pH and TTA. The new neutral pH is an indication that there was no fermentation which would have led to the production of organic acid and subsequent reduction in pH. The flour samples were not acidic and, therefore, they are adequate for use in production of complementary food for children.

Proximate composition (%) and energy content (Kcal/100 g) of complementary food from blends of germinated/pre-gelatinized maize with cowpea and carrot flours.

The proximate composition (%) of complementary food from germinated/pre-gelatinized maize flour blended with cowpea and carrot flours is shown in Table 2. There was significant (p≤0.05) variation in the proximate composition of the samples with increase in addition of cowpea flour. The moisture content of the samples varied significantly (p≤0.5) from 8.28 to 11.48%. The control had significantly (p≤0.05) the least moisture content while sample G with 30% cowpea and 5% carrot flours had the highest. The moisture contents of the samples were higher than what was reported for complementary food from blends of maize, barley, and roasted peas by Fikiru *et al*. [29]. Low moisture content indicates higher dry solids content which is expected of flour. Low moisture is also associated with low water activity which is good for inactivation of enzymatic and microbial activates and hence prolongs the shelf-life of the product.

Protein content of the samples ranged from 7.63 to 10.59%. The protein content of the samples with cowpea and carrot flour addition was significantly (p≤0.05) higher than the control sample. This protein result is similar to the report by Shakpo and Osundahunsi [30], for germinated maize and cowpea blends. This was expected as cereals are mostly starchy while the legumes are rich in proteins containing the essential amino acids (lysine and tryptophan) that are limiting in cereals. Proteins are essential for normal growth and development of children since they help the body to synthesis new tissues and repair worn out tissues and are also components of hormones, enzymes, and other vital processes in the body [31]. According to the WHO [32], the protein requirement for an infant of 6 months–2.5 years old is 1.12 g/kg/day for both male and female. This implies that for infant male and female of average weight of 7.8 and 7.2 kg, respectively, the protein content of 100 g of the complementary gruel from germinated/pre-gelatinized maize blended with cowpea and carrot flours will meet 87–121% and 94–131% of the daily protein requirement of infants, which is sufficient to check protein deficiency.

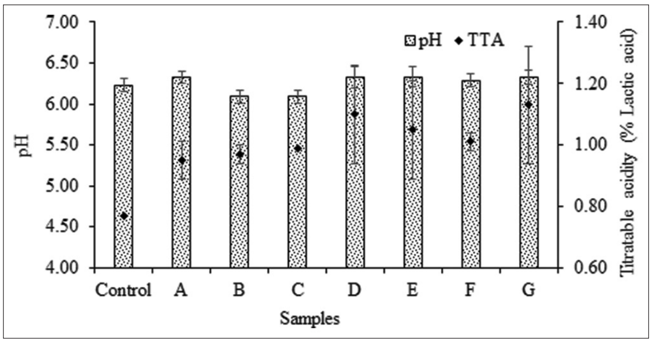


**Fig. 1: pH and total titratable acidity as % lactic acid of complementary food from blends of germinated/pre-gelatinized maize with cowpea and carrot flours. Bars and markers represent means of duplicate determination. Error bars represent±standard deviation. Control – 100% maize flour. A: 95% maize and 5% cowpea flour, B: 90% maize, 5% cowpea, and 5% carrot flour, C: 85% maize, 10% cowpea, and 5% carrot flour, D: 80% maize, 15% cowpea, and 5% carrot flour, E: 75% maize, 20% cowpea, and 5% carrot flour, F: 70% maize, 25% cowpea, and 5% carrot flour, G: 65% maize, 30% cowpea, and 5% carrot flour**

The fat content of the flour sample ranged from 2.72% to 6.39%. The control had significantly (p≤0.05) the highest fat content while sample G had the least. This result is at variance with the report by Shakpo and Osundahunsi [30], where the fat content increased with increase in cowpea addition. The reduction in fat may be associated with the fact that maize naturally contains more amount of fat than cowpea. The storage life of the blend may be increased due to low-fat content since high fatty foods are potentially susceptible to oxidative rancidity.

The samples had ash content that ranged from 1.25 to 2.05% for control and sample G, respectively. Similar results were reported for cereal-based complementary foods substituted with legumes [28,33,34]. The ash content of the control sample did not differ significantly (p≥0.05) from those of samples A–E with 5–20% of cowpea flour and constant carrot flour at 5%, while sample F and G with 25–30% had higher ash content than the control. Ash increased with increase in substitution of cowpea and carrot flour. In flour, ash content indicates mineral content of the samples in which case, higher ash content implies greater mineral content.

Crude fiber varied significantly (p≤0.05) from 2.86 to 6.63% for the control and sample G, respectively. The values are in the range reported for maize, cowpea, and carrot [35,36]. The increase in the crude fiber content with addition of cowpea and carrot flours could be attributable to the increase in cowpea flour, which is in agreement with the finding of Anisa and Anju [37]. Although the carrot flour was constant, fortification of maize flour with carrot flour by Joshua *et al*. [38] leads to significant decrease in crude fiber content. Fiber plays a role in increasing the utilization of nitrogen and absorption of some other micronutrients and improves bowel movement. According to the Codex Alimentarius guidelines, dietary fiber and other non-absorbable carbohydrate are partially fermented by the intestinal flora to short chain fatty acids, lactate, and ethanol which may be subsequently absorbed and metabolized.

There was significant (p≤0.05) decrease in the carbohydrate content from 73.59% in the control to 66.43% in sample G (with 30% cowpea flour) with the addition of cowpea and carrot flour. The control sample that is 100% pure maize flour had significantly (p≤0.05) the highest

**Table 2: Proximate composition (%) and energy content (Kcal/100 g) of complementary food from germinated/pre-gelatinized maize flour blended with cowpea and carrot flours**

| Sample | Moisture | Protein | Fat | Ash | Fiber | CHO |
|---|---|---|---|---|---|---|
| Control | $8.28 \pm 0.00^{d}$ | $7.63 \pm 0.30^{b}$ | $6.39 \pm 0.41^{c}$ | $1.25 \pm 0.22^{b}$ | $2.86 \pm 0.41^{e}$ | $73.59 \pm 1.01^{a}$ |
| A | $8.69 \pm 0.94^{cd}$ | $9.06 \pm 0.61^{ab}$ | $4.67 \pm 0.17^{ab}$ | $1.28 \pm 0.02^{b}$ | $4.02 \pm 0.00^{bc}$ | $72.28 \pm 0.92^{a}$ |
| B | $9.18 \pm 0.45^{bcd}$ | $9.09 \pm 0.75^{ab}$ | $4.32 \pm 0.07^{ab}$ | $1.35 \pm 0.12^{b}$ | $5.21 \pm 0.00^{b}$ | $70.04 \pm 0.99^{b}$ |
| C | $9.75 \pm 1.72^{abcd}$ | $9.96 \pm 0.61^{a}$ | $4.17 \pm 0.00^{ab}$ | $1.49 \pm 0.14^{b}$ | $5.31 \pm 0.71^{b}$ | $69.32 \pm 0.74^{bc}$ |
| D | $9.88 \pm 0.99^{abcd}$ | $9.97 \pm 0.62^{a}$ | $4.04 \pm 0.12^{ab}$ | $1.54 \pm 0.08^{b}$ | $5.38 \pm 0.29^{b}$ | $69.20 \pm 1.03^{bc}$ |
| E | $10.55 \pm 1.13^{abc}$ | $9.98 \pm 0.68^{a}$ | $4.03 \pm 0.17^{ab}$ | $1.54 \pm 0.07^{b}$ | $5.52 \pm 0.00^{b}$ | $69.01 \pm 0.59^{bc}$ |
| F | $11.16 \pm 0.95^{ab}$ | $9.99 \pm 0.62^{a}$ | $4.01 \pm 0.02^{ab}$ | $1.59 \pm 0.00^{ab}$ | $5.74 \pm 0.00^{ab}$ | $67.48 \pm 0.18^{bc}$ |
| G | $11.48 \pm 0.00^{a}$ | $10.59 \pm 0.30^{a}$ | $2.72 \pm 0.41^{b}$ | $2.05 \pm 0.06^{a}$ | $6.73 \pm 0.00^{a}$ | $66.43 \pm 0.13^{c}$ |

Values are means of duplicate determination±standard deviation. Values with different superscript within a column are significantly (p≤0.05) different. Control – 100% maize flour, A: 95% maize and 5% cowpea flour, B: 90% maize, 5% cowpea, and 5% carrot flour, C: 85% maize, 10% cowpea, and 5% carrot flour, D: 80% maize, 15% cowpea, and 5% carrot flour, E: 75% maize, 20% cowpea, and 5% carrot flour, F: 70% maize, 25% cowpea, and 5% carrot flour, G: 65% maize, 30% cowpea, and 5% carrot flour carbohydrate content. Maize is mostly a carbohydrate food hence it will be out of place for the substituted sample to have high carbohydrate content. The result was in line with studies of substitution of cereals with legumes and vegetables [28,39-42].

Energy content (Kcal/100 g) of complementary food from germinated/pre-gelatinized maize flour blended with cowpea and carrot flours is shown in Fig. 2. The energy content of the formulation followed a similar trend as the carbohydrate. The value ranged from 374.11 to 344.46 Kcal/100 g for the control and sample G, respectively. This result is in line with the report for orange fleshed sweet potato supplemented with cowpea and groundnut flour [43], maize-carrot pigeon pea flour blends [17], and malted pre-gelatinize maize, soybean, and carrot flour blends [28]. The daily energy requirement for infants of 6 months old is 335 KJ/kg/day for the males and 340 kJ/kg/day for the females [32]. An infant male and female weighing 7.8 and 7.2 kg, respectively, the energy content of 100 g of the formulated maize, cowpea, and carrot flour complementary food will meet 55–60 and 59–64% of the daily energy requirement, respectively, for the male and female. Although the infant may consume the food more than ones in a day, there may be need for other sources of energy to ensure that the daily requirement is adequately met.

Sensory attributes of complementary gruel made from germinated/pre-gelatinized maize flour blended with cowpea/carrot flour.

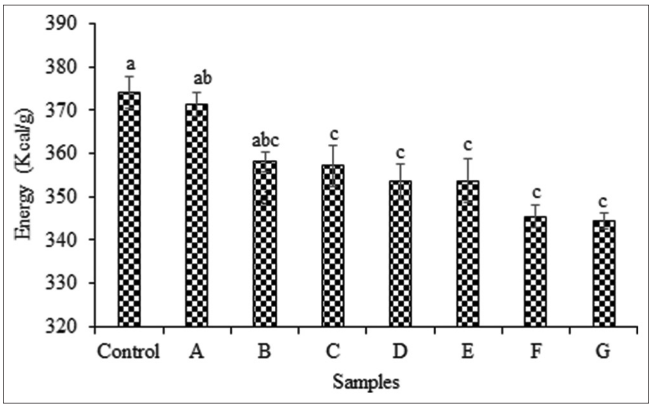


**Fig. 2: Energy (Kcal/g) of complementary food from blends of germinated/pre-gelatinized maize with cowpea and carrot flours. Bars and error bars represent means of duplicate determination±standard deviation. Control – 100% maize flour. A: 95% maize and 5% cowpea flour, B: 90% maize, 5% cowpea, and 5% carrot flour, C: 85% maize, 10% cowpea, and 5% carrot flour, D: 80% maize, 15% cowpea, and 5% carrot flour, E: 75% maize, 20% cowpea, and 5% carrot flour. F: 70% maize, 25% cowpea, and 5% carrot flour, G: 65% maize, 30% cowpea, and 5% carrot flour**

The sensory properties of the complementary food from blends of germinated/pre-gelatinized maize flour with cowpea and carrot flours are shown in Table 3. The mean score for the assessors' degree of likeness for aroma, color, and taste ranged from 2.35 to 7.55, 3.50 to 7.60, and 2.70 to 8.10, respectively. While the degree of likeness for texture in terms of smoothness, mouth feel, thickness, and the overall acceptability varied, respectively, from 3.05 to 4.50, 3.25 to 7.55, 7.45 to 2.80, and 2.57 to 7.75 for overall acceptability. There was significant (p≤0.05) decrease in the assessors' degree of likeness for all attributes except for the color. The assessors' degree of likeness for aroma, taste, mouth feel, thickness/consistency, and the overall acceptability for the control sample (100% maize flour) was that of like moderately to like very much while samples A and B with 5% substitution with cowpea and carrot flours were moderately to slightly liked. The other test samples were disliked to various degrees: Disliked moderately and disliked slightly to neither liked nor disliked. The decrease in the degree of likeness of the aroma and taste could be attributed to the beany flavor of the cowpea and probably because the assessors are used to the normal maize complementary food as compared to the newly formulated product. The texture in terms of the smoothness of the samples was disliked moderately to extremely by the assessors. The smoothness of the control sample had significantly (p≤0.05) the highest score of 4.50 which indicated liked slightly while sample G had significantly (p≤0.05) the least score of 2.10 indicating moderate dislikeness. The smoothness of gruels is a function of the particle size of the flour. Food products from flour of finer particle size have been demonstrated to show higher sensory scores than those of coarse fractions [44]. The assessors' degree of likeness for the color increased with the addition of cowpea flour. The control sample was disliked very much while sample G with 50% cowpea flour was liked moderately. The increase in cowpea flour with the 5% carrot flour enhanced the slightly creamy-yellowish color of the control with 100% maize flour to a more appetizing and attractive light brownish color mimicking that of addition of light chocolate to the gruel. Assessors have been reported to have high overall acceptability for chocolate products [45]. The degree of likeness of the appearance of the gruel in terms of its thickness and consistency decreased significantly (p≤0.05) with the increase in substitution. The control sample without substitution was liked very much and the thickness and consistency can be attributed to the higher carbohydrate content compared to the test samples. In general, with the exception of color, samples A, B, and C with 5 and 10% cowpea flour and with or without 5% carrot flour competed favorably with the control in all sensory attributes and had overall acceptability of liked slightly to liked moderately. This implies that assessor's likeness of the germinated/pre-gelatinized maize, cowpea, and carrot complementary food blends for samples with 5 and 10% cowpea flour inclusion (samples A, B, and C) will be recommended.

**Table 3: Sensory properties of complementary food from blends of germinated/pre-gelatinized maize with cowpea and carrot flours**

| Samples | Aroma | Color | Taste | Texture | Mouth feel | Appearance | Overall acceptability |
|---|---|---|---|---|---|---|---|
| Control | $7.55±1.05^{a}$ | $3.50±1.15^{e}$ | $8.10±0.19^{a}$ | $4.50±1.50^{a}$ | $7.55±1.09^{a}$ | $7.45±0.99^{a}$ | $7.75±1.12^{a}$ |
| A | $6.10±1.88^{b}$ | $4.50±1.61^{de}$ | $6.85±1.14^{b}$ | $4.75±1.33^{a}$ | $6.25±1.48^{b}$ | $6.30±1.26^{b}$ | $6.75±1.29^{a}$ |
| B | $5.50±1.66^{c}$ | $5.30±1.72^{cd}$ | $5.95±1.19^{cb}$ | $4.05±0.95^{a}$ | $5.60±1.09^{bc}$ | $5.65±1.53^{bc}$ | $5.35±1.38^{b}$ |
| C | $4.20±1.67^{cd}$ | $5.80±1.82^{bcd}$ | $4.80±1.39^{cd}$ | $3.50±1.28^{a}$ | $5.00±1.52^{c}$ | $4.70±1.22^{cd}$ | $4.95±1.09^{b}$ |
| D | $3.95±1.60^{cd}$ | $6.65±1.57^{abc}$ | $4.20±1.39^{de}$ | $3.40±1.54^{a}$ | $4.45±1.15^{cd}$ | $4.70±1.45^{cd}$ | $4.35±0.87^{bc}$ |
| E | $3.95±0.83^{cd}$ | $6.85±1.78^{ab}$ | $3.10±1.25^{ef}$ | $3.10±1.02^{a}$ | $3.75±0.91^{de}$ | $3.70±1.17^{de}$ | $3.55±1.09^{cd}$ |
| F | $3.25±1.12^{de}$ | $6.80±1.19^{ab}$ | $3.60±1.67^{ef}$ | $3.10±1.07^{a}$ | $3.50±1.32^{de}$ | $3.50±1.27^{e}$ | $3.35±1.38^{cd}$ |
| G | $2.35±1.23^{e}$ | $7.60±1.50^{a}$ | $2.70±1.03^{f}$ | $3.05±0.01^{a}$ | $3.25±1.07^{e}$ | $2.80±1.11^{e}$ | $2.57±1.21^{d}$ |

Values are means of scores from 20 assessors ± standard deviation Values with different superscript within a column are significantly (p≤ 0.05) different. Control – 100% maize flour, A: 95% maize and 5% cowpea flour, B: 90% maize, 5% cowpea, and 5% carrot flour, C: 85% maize, 10% cowpea, and 5% carrot flour, D: 80% maize, 15% cowpea, and 5% carrot flour, E: 75% maize, 20% cowpea, and 5% carrot flour, F: 70% maize, 25% cowpea, and 5% carrot flour, G: 65% maize, 30% cowpea, and 5% carrot flour

## CONCLUSION

The substitution of germinated/pre-gelatinized maize flour with cowpea and carrot flours in the formulation of complementary food resulted in significant ($p \leq 0.05$) increase in protein, fat, ash, and crude fiber content with sample G containing the highest values while carbohydrate and energy values decreased significantly ($p \leq 0.05$) with the control sample having the highest. The degree of likeness of the sensory properties, however, decreased with increase in substitution except for color. Samples A and B with 5% cowpea substitution compared favorably with the degree of likeness of the control sample. On the basis of nutrient composition, higher substitution (>5%) of cowpea flour could be recommended while considering the consumers' likeness samples A and B would be recommended. In general, substitution of 5% would be recommended for a complementary food acceptable to the consumer and at the same time has sufficient nutrient to meet their needs.

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