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Quality assessment and consumer acceptability of custard enriched with lima bean and ripe plantain flours

J. I. Okoye[1]*, N. N. Onwuama[2] and S. I. Eze[3]

[1]Department of Food Science and Technology, Enugu State University of Science and Technology, Enugu, Nigeria.
[2]Department of Nutrition and Dietetics, University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu, Nigeria.
[3]Department of Home Economics, Federal College of Education, Eha Amufu, Enugu, Nigeria.

*Corresponding author. Email: okoyejoseph6@gmail.com

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ABSTRACT: This study was designed to evaluate the nutrient composition and sensory properties of custard enriched with lima bean and plantain flours. The lima bean and plantain flours were separately prepared from lima bean seeds and ripe plantain fruits and used at varying replacement levels (5-25% and 5-25%) for cornstarch in the production of custard formulations with the custard produced from 100% cornstarch used as control. The custard samples produced were evaluated for nutrient composition and sensory properties using standard methods. The moisture, crude protein, fat, ash and crude fibre contents of the samples increased significantly ($p<0.05$) with increase in the addition of lima bean and plantain flours from 9.19-9.91%, 9.18-19.42%, 2.10-3.23%, 3.38-3.67% and 3.38-4.90%, respectively, while the carbohydrate and energy contents decreased from 72.98-58.90% and 347.44-342.27 KJ/100g, respectively. The control sample (custard made with 100% cornstarch) had the highest carbohydrate (72.98%) and energy (347.44 KJ/100g) contents, respectively. The mineral content of the samples showed that the calcium, magnesium, phosphorus, potassium, iron and sodium contents of the custard samples ranged from 113.34-126.02 mg/100g, 48.48-69.30 mg/100g, 76.35-94.79 mg/100g, 36.10-67.30 mg/100g, 2.29-3.77 mg/100g, and 31.77-41.68 mg/100g, respectively. The vitamin content of the custard samples also showed similar increases in niacin (4.34-4.63 mg/100g), thiamine (3.03-3.33 mg/100g), riboflavin (6.35-9.27 mg/100g), vitamin A (8.10-10.17mg) and vitamin C. (3.74-4.77 mg/100g), respectively as the levels of addition of lima bean and plantain flours increased in the formulations. The colour, taste, flavour and texture of the control sample were the most acceptable to the panelists compared to the samples enriched with lima bean and plantain flours at different graded levels. The study, therefore, showed that the nutrient contents of the custard formulations could be enhanced by enriching cornstarch with lima bean and plantain flours at varying proportions, thus extending the use of these locally available novel flours in the preparation of nutrient dense custard samples.

Keywords: Cornstarch, custard, enrichment, lima bean flour, quality attributes, ripe plantain flour.

INTRODUCTION

The world is faced with increasing incidence of diseases and deaths that are related to the consumption of energy dense foods (Choo and Aziz, 2010). Energy dense foods have been implicated in devastating health problems like type-2-diabetes and obesity (WHO, 2015). Obesity is a major factor for a number of chronic non-communicable diseases like cardiovascular diseases and cancer.

Custard is a fine textured food product made from corn starch in which salt, flavouring and colouring agents are added with or without the addition of egg yolk solids, vitamins and minerals (Okoye *et al.*, 2008). The cornstarch used for the preparation of custard is basically dense, powdery flour obtained from the endosperm of the corn kernel (Awoyale *et al.*, 2013; Ajani and Adegoke, 2018).

Custard is primarily consumed either as a breakfast cereal-based food or weaning food in most developing nations of the tropics especially among children (Awoyale *et al.*, 2013). Since custard is mainly rich in carbohydrate, there is need to improve the nutritional quality of the product by the addition of vegetable proteins derived from oilseeds and legumes such as lima bean, African yam bean, cowpea, soybean and pigeon pea etc, which are relatively cheap and readily available. Custard powder is generally white in colour but turns yellow when reconstituted in water. Custard could be used either as supplement in infant feeding or consumed as breakfast cereal by many and serve as choice food for ill persons (Okoye *et al.,* 2008). Custard has a long shelf life and it is in great demand in the urban areas because of the ever busy lifestyle of most Nigerian households. It is easy to prepare and hence, it is a common food product at home with its affordability, good taste, convenience, easy and short time of preparation (Okoye *et al.,* 2009). The fortification of custard with vegetable proteins from oilseeds and legumes has received considerable attention. This is because oilseed and legume proteins are high in lysine, an essential limiting amino acid in most cereals (Enwere, 1998). Legumes generally contain relatively high amount of protein which could complement the protein in cereal grains because the chemical and nutritional characteristics of legumes make them natural complements to cereal-based diets (Marero *et al.*, 1988). In Nigeria and most other developing countries of the world, the high cost of fortified, nutritious and proprietary cereals or cereal-based foods is always beyond the reach of most Nigerian families. Such families often depend on inadequately processed traditional foods consisting mainly of un-supplemented cereal-based foods made from rice, maize, sorghum and millet which are grossly inadequate in some macro and micronutrients (Nnam, 2001). Maize, lima bean and plantain are food materials that are relatively cheap and readily available in Nigeria and they have potentials to produce nutrient dense cereal-based foods when properly blended together. Although plantain fruits are readily available in Nigeria, they are seasonable and often so plentiful that they cannot all be eaten fresh after harvest. Plantain has been described as an important staple food that is superior to other starchy staples such as cassava and yam (Adeolu and Enesi, 2013). The addition of ripe plantain flour to custard is desirable in this study because plantain fruits are valuable food resources on the account of their high energy content and significant amounts of dietary fibre and certain minerals and vitamins (Alimi *et al.,* 2016).

However, there is need for low-cost cereal-based foods that can be easily prepared at home and community kitchens from locally available food crops using the simple processing techniques that are within the reach of the general public in developing countries. Such foods can be more nutritious than most of the commercial brands that abounds in major markets. This approach would require the knowledge about the nutritional values of a variety of local food commodities that are indigenous to the affected communities. Hence the objective of the study was to evaluate the nutrient composition and sensory properties of custard supplemented with lima bean and plantain flours.

MATERIALS AND METHODS

Mature yellow maize grains, red variety of lima bean seeds and ripe plantain fruits used for the study were purchased from Afor Market in Mmaku, Awgu Local Government Area, Enugu, Enugu State, Nigeria. Other materials such as sunset yellow, vanilla flavour and salt used for the preparation of custard formulations were purchased from Ogbete Main Market, Enugu, Enugu State, Nigeria.

Preparation of cornstarch

The cornstarch was prepared according to the method described by Afolabi *et al.* (2018) with slight modifications. One kilogram (1 kg) of maize grains were cleaned from dirt and other foreign materials and cracked in the attrition mill into grits. The grits obtained were soaked in 2 litres of potable water at room temperature (30±2°C) for 18 h with occasional change of soak water at intervals of 6 h to prevent microbial fermentation. The soaked grits were drained, rinsed and wet-milled into fine slurry with 1.5 litres of potable water in the attrition mill. The resultant starch slurry was decanted, dewatered, spread on the trays and dried in a hot-air oven (Model DHG 9101 ISA) at 60°C for 8 h. The dried starch slurry was milled into cornstarch in the attrition mill and sieved through a 400 micron mesh sieve. The cornstarch produced was packaged in an airtight plastic container, labelled and kept in a refrigerator until needed for further use.

Preparation of lima bean flour

The boiled lima bean flour was prepared according to the method described by Ugwu and Oranye (2006) with slight modifications. One kilogram (1 kg) of lima bean seeds were cleaned and soaked in 2 litres of potable water at room temperature (30±2°C) for 12 h. The soaked seeds were rinsed and dehulled manually by rubbing them in-between palms to remove the hulls. The dehulled seeds were boiled with 2 litres of potable water on a hot plate at 100°C for 30 min. The boiled seeds were drained, spread on the trays and dried in a hot air oven (Model DHG 9101 ISA) at 60°C for 8 h with occasional stirring of the seeds at intervals of 30 min to ensure uniform drying. The dried seeds were milled into flour using the attrition mill and sieved through a 400 micron mesh sieve. The flour produced was packaged in an airtight plastic container,

labelled and kept in a refrigerator until needed for further use.

Preparation of ripe plantain flour

The ripe plantain flour was prepared according to the method described by Chinmah *et al*. (2004) with slight modifications. One kilogram (1 kg) of mature ripe plantain fruits were thoroughly cleaned and peeled manually with a kitchen knife. The peeled plantain fruits were cut into smaller sizes with a knife. The slices were rinsed, placed into a stainless pot and blanched with 3 litres of potable water at 85°C for 20 min on a hot plate. The blanched slices were drained, rinsed, spread on the trays and dried in a hot air oven (Model DHG 9101 ISA) at 60°C for 10 h with occasional stirring of slices at intervals of 30 min to ensure uniform drying. The dried slices were milled in the attrition mill and sieved through a 400 micron mesh sieve. The flour produced was packaged in an airtight plastic container, labelled and kept in a refrigerator until needed for further use.

Formulation of flour blends

Cornstarch, lima bean and plantain flours were mixed thoroughly at different graded proportions of 100:0:0, 90:5:5, 80:10:10, 70:15:15, 60: 20:20 and 50:25:25 in a rotary mixer (Philips, type HR 1500/A Holland) to produce homogenous composite flour samples. The composite flours produced were separately packaged in airtight plastic containers, labelled and preserved in a refrigerator until needed for the preparation of custard samples.

Preparation of custard formulations

The custard samples were prepared according to the method described by Okoye *et al.* (2008) with slight modifications. During preparation, 20% sunset yellow, 15% vanilla flavour and 3% salt were added to each of the flour blends and the mixture was separately mixed thoroughly in a mixer at medium speed until custards of desired texture were obtained. The custards produced were individually packaged in airtight plastic containers, labelled and kept in a refrigerator until needed for analysis. The custard made with 100% cornstarch was similarly produced and used as control.

Proximate composition

The moisture, crude protein, ash, fat and crude fibre contents of the samples were determined according to the standard analytical methods (AOAC, 2010). The carbohydrate was calculated by difference. % Carbohydrate = 100 - % (Moisture + Crude Protein + Fat +Ash + Crude Fibre). The energy content was calculated by multiplying the percentage values of protein, fat and carbohydrate by the Atwater factors of 4, 9 and 4, respectively (AOAC, 2010). All determinations were carried out in triplicate samples.

Micronutrient analyses

The calcium, magnesium, phosphorus, potassium, iron and sodium contents of the samples were determined by the use of atomic absorption spectrophotometer (Perkin-Elmer Model 1033 Norwalk CT, USA) according to the standard analytical methods (AOAC, 2010). The niacin, ascorbic acid and thiamine contents of the custard samples were determined by the methods of AOAC (2010). The riboflavin and vitamin A contents of the samples were determined according to the methods described by Onwuka (2018). All determinations were carried out in triplicate samples.

Sensory evaluation

The control and the substituted samples of custard were individually prepared into gruels. Fifty grams (50 g) of each sample was suspended with 150 mL of potable water in a small plastic bowl. Thereafter, 80 mL of boiling water was added to each of the suspended samples, with continuous stirring to produce custard gruels. Three grams (3 g) of granulated sugar and five (5) tablespoonfuls of liquid milk were added to each of the gruels to improve their taste. The gruels obtained in each case were individually coded and served to a panel of twenty (20) semi-trained judges consisting of staff and students of the Department of Food Science and Technology, ESUT, Enugu in white ceramic cups of similar sizes with white plastic spoons at ambient temperature (30±2°C) for the attributes of colour, flavour, texture, taste and overall acceptability. Clean drinking water was also provided to the judges to rinse their mouth in-between testing of each sample to avoid residual effect. The judges were instructed to taste, assess and score each sample of the custard gruels based on their likeness and acceptance of each product using a nine-point Hedonic scale with 1 and 9 representing dislike extremely and like extremely, respectively (Okaka, 2010). Expectoration cups with lids were provided for the panellists who would not like to swallow the samples after testing each sample.

Statistical analysis

The data generated were subjected to one-way analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS, Version 20) software. Significant means were separated using Turkey's least significant difference (LSD) test at $p<0.05$.

Table 1. Proximate composition (%) of custard samples.

Parameters	Samples					
	A	B	C	D	E	F
Moisture	$9.19^{f} \pm 0.01$	$9.25^{e} \pm 0.42$	$9.61^{d} \pm 0.10$	$9.77^{c} \pm 0.01$	$9.88^{b} \pm 0.01$	$9.91^{a} \pm 0.01$
Protein	$9.18^{f} \pm 0.01$	$10.43^{e} \pm 0.01$	$12.68^{d} \pm 0.01$	$14.25^{c} \pm 0.01$	$16.54^{b} \pm 0.01$	$19.42^{a} \pm 0.01$
Fat	$2.10^{f} \pm 0.01$	$2.34^{e} \pm 0.01$	$2.65^{d} \pm 0.01$	$2.83^{c} \pm 0.01$	$3.07^{b} \pm 0.01$	$3.23^{a} \pm 0.01$
Ash	$3.38^{c} \pm 0.01$	$3.26^{e} \pm 0.01$	$3.32^{d} \pm 0.01$	$3.10^{f} \pm 0.01$	$3.53^{b} \pm 0.01$	$3.67^{a} \pm 0.01$
Crude Fibre	$3.38^{f} \pm 0.01$	$3.65^{e} \pm 0.01$	$3.85^{d} \pm 0.01$	$4.18^{c} \pm 0.01$	$4.49^{b} \pm 0.01$	$4.90^{a} \pm 0.03$
Carbohydrate	$72.98^{a} \pm 0.01$	$71.09^{b} \pm 0.03$	$67.90^{c} \pm 0.06$	$65.59^{d} \pm 0.02$	$62.52^{e} \pm 0.01$	$58.90^{f} \pm 0.01$
Energy (KJ/100g)	$347.44^{a} \pm 0.09$	$347.02^{b} \pm 0.00$	$346.09^{c} \pm 0.29$	$344.75^{d} \pm 0.18$	$343.79^{e} \pm 0.01$	$342.27^{f} \pm 0.01$

Values are mean ± standard deviation of triplicate determinations. Means in the same row with different superscripts are significantly different ($p<0.05$).
Key: A - Custard produced from 100% cornstarch, B - Custard produced from 90% cornstarch, 5% lima bean flour and 5% plantain flour, C - Custard produced from 80% cornstarch, 10% lima bean flour and 10% plantain flour, D - Custard produced from 70% cornstarch, 15% lima bean flour and 15% plantain flour, E - Custard produced from 60% cornstarch, 20% lima bean flour and 20% plantain flour, F - Custard produced from 50% cornstarch, 25% lima bean flour and 25% plantain flour.

RESULTS AND DISCUSSION

Proximate composition of custard samples

The proximate composition of the custard samples is presented in Table 1. The moisture content of the custard samples ranged from 9.19 to 9.91%. The moisture content of the control sample (custard made with 100 % cornstarch) was the least (9.19%), while the sample substituted with 25% lima bean and 25% plantain flours had the highest value (9.91%). The moisture content (9.19-9.91%) obtained in this study were lower than the maximum level of moisture that is compatible with proper storage of dried (12%) and powdered (13%) cereal-based products (Okoye *et al.,* 2009). The low moisture content obtained in this study is an indication that the products will have longer shelf life with proper packaging and storage.

The crude protein content for the custard samples ranged from 9.18 to 19.42%. The sample supplemented with 25% lima bean and 25% plantain flours had the highest protein content (19.42 %), while the control sample (custard made with 100% cornstarch) had the least value (9.18%). The increase in the protein content of the sample could be attributed to the high amount of lima bean flour added to the product which has high protein content. The result is in agreement with the findings of Okoye *et al.* (2008) who reported an increase in the protein content of custard supplemented with soybean flour.

The fat content of the custard samples ranged from 2.10 to 3.23%. The result showed that the sample substituted with 25% lima bean and 25% plantain flours had the highest fat content (3.23%), while the control sample (custard made with 100 % cornstarch) had the lowest value (2.10%). This showed that the fat content of the custard samples increased with decrease in the amount of cornstarch added which is an indication that corn starch is not a good source of fat (Awoyale *et al.,* 2013). Fat increases the energy density and also supplies the body with fat soluble vitamins and essential fatty acids needed for proper neural development (Okaka *et al.,* 2006).

The ash content of the custard samples which ranged from 3.2 to 3.67% increased with increase in substitution with lima bean and plantain flours. The concomitant increase in the ash content of the samples may be due to the high mineral contents of lima bean and plantain fours used for the preparation of the products (Nnam, 2001).

The crude fibre content of the custard samples ranged from 3.38 to 4.90%. The sample substituted with 25% lima bean and 25% plantain flours had the highest crude fibre content (4.90%), while the control sample (custard made with 100 % cornstarch) had the lowest crude fibre content (3.38 %). The result showed that the crude fibre content of the substituted custard samples increased as the levels of substitution with lima bean and plantain flours increased and this is an indication that lima bean and plantain are good sources of crude fibre (Ojukwu *et al*., 2012; Adebayo, 2014). The presence of fibre in the diets help in the normal functioning of the gastro intestinal tract and it also aids in the digestion of food (Okaka *et al*., 2006).

The carbohydrate content of the custard samples ranged from 58.90 to 72.98%. The control sample had the highest carbohydrate content (72.98%), while the sample substituted with 25% lima bean and 25% plantain flours had the lowest value (58.90%). The carbohydrate content of the samples decreased with increase in substitution of lima bean and plantain flours in the products. The result is in agreement with the findings of Okoye *et al*. (2008) who reported a decrease in the carbohydrate content of custard formulations with increase in the addition of soybean flour.

The energy content of the custard samples ranged from 342.27 to 347.44 KJ/100g. The control sample (custard made with 100% cornstarch) had the highest energy value (347.44 KJ/100g), while the sample substituted with 25% lima bean and 25% plantain flours had the lowest energy value (342.27 KJ/100g). The variation in energy value could be attributed to differences in protein, fat and carbohydrate contents of the samples. Fat on its own contributes about twice the food energy value of a food

Table 2. Mineral composition (mg/100g) of custard samples.

Parameters	Samples					
	A	B	C	D	E	F
Calcium	113.34^{f} ± 0.03	114.36^{e} ± 0.03	117.47^{d} ± 0.64	120.36^{c} ± 0.03	123.15^{b} ± 0.04	126.02^{a} ± 0.14
Magnesium	48.84^{f} ± 0.03	50.14^{e} ± 0.14	55.82^{d} ± 0.08	60.04^{c} ± 0.11	64.54^{b} ± 0.11	69.30^{a} ± 0.45
Phosphorus	76.35^{f} ± 0.01	77.92^{e} ± 0.16	82.05^{d} ± 0.07	84.96^{c} ± 1.32	87.75^{b} ± 0.67	94.79^{a} ± 1.28
Potassium	36.10^{f} ± 0.01	36.94^{e} ± 0.07	42.21^{d} ± 0.06	47.44^{c} ± 0.08	55.54^{b} ± 2.09	67.30^{a} ± 0.03
Iron	2.29^{e}± 0.19	2.88^{f}± 0.08	3.08^{d} ± 0.05	3.40^{c} ± 0.08	3.66^{b} ± 0.04	3.77^{a} ± 0.01
Sodium	31.77^{f} ± 0.01	34.09^{e} ± 0.66	38.10^{d} ± 0.74	43.26^{b}± 0.67	48.38^{a}± 0.69	41.68^{c}± 8.43

Values are mean ± standard deviation of triplicate determinations. Means in the same row with different superscripts are significantly different ($p<0.05$). **Key:** A - Custard produced from 100% cornstarch, B - Custard produced from 90% cornstarch, 5% lima bean flour and 5% plantain flour, C - Custard produced from 80% cornstarch, 10% lima bean flour and 10% plantain flour, D - Custard produced from 70% cornstarch, 15% lima bean flour and 15% plantain flour, E - Custard produced from 60% cornstarch, 20% lima bean flour and 20% plantain flour, F - Custard produced from 50% cornstarch, 25% lima bean flour and 25% plantain flour.

product than the protein and carbohydrate. The result of this study is in agreement with the findings of Mahmoud *et al*. (2016) who reported similar decrease in the energy content of custard formulations with increase in the amount of date fruit flour added to the products.

The substitution of cornstarch with lima bean and plantain flours in the preparation of custards greatly enhanced the protein, fat, ash and crude fibre contents of the samples while their carbohydrate and energy contents were significantly reduced.

Mineral composition of custard samples

The mineral composition of the custard samples is presented in Table 2. The calcium content of the custard samples ranged from 96.02 to 110.14 mg/100g. The sample substituted with 25% lima bean and 25% plantain flours had the highest calcium content (110.14 mg/100g), while the control sample (custard made with 100% cornstarch) had the lowest value (96.02 mg/100g). The result showed that the calcium content of the custard samples increased as the levels of lima bean and plantain flours increased in the formulations. Calcium is a constituent of bones and it helps in muscular contraction and blood clotting in the body. Calcium is also essential for disease prevention and control and may therefore contribute to the medicinal influences of some plants (Etong *et al*., 2014).

The magnesium content of the custard samples ranged from 48.84 to 69.30 mg/100g. The result showed that the sample substituted with 25% lima bean and 25% plantain flours had the highest magnesium content (69.30 mg/100g), while the control sample had the lowest value (48.84 mg/100g). The observation is an indication that lima bean and plantain are good sources of magnesium (Adeolu and Enesi, 2013). Magnesium is beneficial in the control of high blood pressure. It is also an important component of bone which contributes to its structural development (Jacob *et al*., 2015). Magnesium deficiency results in uncontrolled twisting of muscles which causes convulsion and this is common in people with chronic alcoholism (Etong *et al*., 2014).

The phosphorus content of the custard samples which ranged from 76.35 to 94.79 mg/100g increased significantly $p<0.05$) with increase in substitution of lima bean and plantain flours in the formulations. The values (76.35 to 95.79 mg/100g) obtained in this study were higher than the values (63.74 to 88.96 mg/100g) reported by Ajani and Adegoke (2018) for breadfruit-pigeon pea based custard. Phosphorus enhances the quick release of energy in the body and it may combine with calcium for the development of bones and teeth. The deficiency of phosphorus is rare because of the prevalence of phosphorus in foods but its deficiency is generally observed only during starvation (Etong *et al*., 2014).

The potassium content of the custard samples ranged from 36.10 to 67.30 mg/100g. The study showed that the potassium content of the samples increased steadily with increase in substitution of lima bean and plantain flours in the products. The observation is in agreement with the reports of Adeolu and Enesi (2013) and Farinde *et al.* (2017) that lima bean and plantain are rich sources of potassium. Potassium is the principal cation in extracellular fluids which helps in the maintenance of acid-base balance in the body. It is also involved in the maintenance of osmotic pressure of the body fluids. The changes in osmotic pressure are largely dependent on potassium concentration and metabolism of potassium is regulated by aldosterone (Osman, 2007).

The iron content of the custard samples ranged from 2.29 to 3.77 mg/100g. The sample substituted with 25% lima bean and 25% plantain flours had the highest iron content (3.77 mg/100g), while the control sample had the lowest iron content (2.29 mg/100g). The study showed that the iron content of the custard samples increased with increase in substitution of lima bean and plantain flours in the formulations. Iron is part of haemoglobin, a protein which carries oxygen from the lungs to different parts of the body. It also helps the muscles to store and use

Table 3. Vitamin composition (mg/100g) of custard samples,

Parameters	Samples					
	A	B	C	D	E	F
Niacin	$4.34^{e} \pm 0.03$	$4.36^{d} \pm 0.03$	$4.43^{f} \pm 0.01$	$4.49^{c} \pm 0.01$	$4.54^{b} \pm 0.01$	$4.63^{a} \pm 0.01$
Thiamine	$3.03^{e} \pm 0.01$	$3.08^{e} \pm 0.01$	$3.12^{d} \pm 0.01$	$3.17^{c} \pm 0.01$	$3.24^{b} \pm 0.01$	$3.33^{a} \pm 0.01$
Riboflavin	$6.35^{f} \pm 0.01$	$7.93^{e} \pm 0.16$	$8.55^{d} \pm 0.04$	$8.90^{c} \pm 0.02$	$9.15^{b} \pm 0.04$	$9.27^{a} \pm 0.01$
Vitamin A	$8.10^{f} \pm 0.01$	$8.44^{e} \pm 0.03$	$8.71^{d} \pm 0.07$	$8.94^{c} \pm 0.07$	$9.04^{b} \pm 0.03$	$10.17^{a} \pm 0.02$
Vitamin C	$3.74^{f} \pm 0.03$	$3.83^{e} \pm 0.01$	$4.02^{d} \pm 0.01$	$4.25^{c} \pm 0.01$	$4.45^{b} \pm 0.04$	$4.77^{a} \pm 0.01$

Values are mean ± standard deviation of triplicate determinations. Means in the same row with different superscripts are significantly different ($p<0.05$).
Key: A - Custard produced from 100% cornstarch, B - Custard produced from 90% cornstarch, 5% lima bean flour and 5% plantain flour, C - Custard produced from 80% cornstarch, 10% lima bean flour and 10% plantain flour, D - Custard produced from 70% cornstarch, 15% lima bean flour and 15% plantain flour, E - Custard produced from 60% cornstarch, 20% lima bean flour and 20% plantain flour, F - Custard produced from 50% cornstarch, 25% lima bean flour and 25% plantain flour.

oxygen. Iron is also part of many other proteins and enzymes that are important in human body (Asoiro and Ani, 2011).

The sodium content of the custard samples which ranged from 31.47 to 41.68 mg/100g increased significantly ($p<0.05$) with increase in substitution of lima bean and plantain flours in the products. Sodium is one of the chief extracellular ions of the body which is primarily involved in the maintenance of osmotic equilibrium and body fluid volume (Welch and Graham, 2004).

The substitution of cornstarch with lima bean and plantain flours in the preparation of custards generally increased the calcium, magnesium, phosphorus, potassium, iron and sodium contents of the products.

Vitamin composition of custard samples

The vitamin composition of the custard samples is presented in Table 3. The niacin content of the custard samples ranged from 4.23 to 4.63 mg/100g. The sample substituted with 25% lima bean and 25% plantain flours had the highest niacin content (4.63 mg/100g), while the control sample had the lowest niacin content (4.23 mg/100g). The increase in niacin content could be attributed to the addition of high proportions of lima bean and plantain flours in the products. Niacin which is a B-complex vitamin functions as co-enzymes (NAD and NADP) in the body. It also has specific effect on the growth and plays an important role in reducing the levels of blood cholesterol in human body (Potter and Hotchkiss, 2006).

The thiamine content of the custard samples which ranged from 3.03 to 3.33 mg/100g increased significantly ($p<0.05$) with increase in substitution of lima bean and plantain flours in the formulations. Thiamine functions as a coenzyme in energy metabolism. It also helps in the functioning of peripheral nerves and in the treatment of beriberi (Potter and Hotchkiss, 2006).

The riboflavin content of the custard samples ranged from 6.35 to 9.27 mg/100g. The sample substituted with 25% lima bean and 25% plantain flours had the highest riboflavin content (9.27%), while the control sample (custard made with 100% cornstarch) had the lowest niacin content (6.35 mg/100g). The riboflavin content of the custard samples increased significantly ($p<0.05$) with increase in substitution with lima bean and plantain flours in the products. The increase in the riboflavin content could be due to substitution effect caused by the addition of lima bean and plantain flours to the products. Riboflavin functions as part of a group of enzymes called flavoproteins. Flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD) which assist in the respiratory chains of cellular metabolism especially in the oxidation-reduction reaction involving the release of energy. More so, the presence of this vitamin improves the growth and reproduction and it also prevents anaemia and abnormal gait in human body (Okaka *et al.,* 2006).

The vitamin A content of the custard samples ranged from 8.10 to10.17 mg/100g with the control sample (custard made with 100% cornstarch) and the sample substituted with 25% lima bean and 25% plantain flours having the least (8.10 mg/100g) and highest (10.17 mg/100g) values, respectively. The result of this study is in agreement with the report of Mahmoud *et al.* (2016) for custard produced from date fruit flour. Vitamin A helps in the maintenance of normal vision of the eyes (Okaka *et al*., 2006). A deficiency of vitamin A leads to blindness and poor bone and tooth development in the young children (Potter and Hotchkiss, 2006).

The ascorbic acid content of the custard samples ranged from 3.74 to 4.77 mg/100g. The sample substituted with 25% lima bean and 25% plantain flours had the highest ascorbic acid content (4.77 mg/100g), while the control sample (custard made with 100% cornstarch) had the value (3.74 mg/100g). The result showed that the ascorbic acid content of the substituted samples increased significantly ($p<0.05$) with increase in substitution of lima bean and plantain flours in the products. The result of this study is in agreement with the report of Mohamoud *et al.* (2016) for custard prepared from date fruit flour. Ascorbic acid plays an important role in the prevention of scurvy. It also promotes the wound healing, healthy immune system

Table 4. Sensory properties of custard samples.

Parameters	Samples					
	A	B	C	D	E	F
Colour	$7.67^{a} \pm 1.18$	$7.27^{b} \pm 0.96$	$6.80^{c} \pm 1.27$	$6.33^{d} \pm 1.05$	$6.13^{e} \pm 0.91$	$5.67^{f} \pm 1.35$
Taste	$8.00^{a} \pm 0.93$	$7.13^{b} \pm 1.06$	$7.07^{c} \pm 1.10$	$6.07^{d} \pm 1.03$	$6.80^{e} \pm 1.26$	$5.73^{f} \pm 1.31$
Flavour	$7.20^{a} \pm 1.37$	$6.33^{d} \pm 1.11$	$6.67^{c} \pm 1.54$	$7.00^{b} \pm 1.10$	$5.67^{e} \pm 1.23$	$5.67^{e} \pm 1.13$
Texture	$7.73^{a} \pm 1.16$	$7.60^{b} \pm 1.35$	$7.63^{b} \pm 1.35$	$6.33^{c} \pm 1.18$	$5.47^{e} \pm 0.92$	$5.73^{d} \pm 1.33$
Overall acceptability	$8.00^{a} \pm 1.00$	$6.13^{b} \pm 0.83$	$6.00^{c} \pm 1.51$	$5.93^{d} \pm 0.96$	$5.87^{e} \pm 1.46$	$5.67^{f} \pm 1.18$

Values are mean ± standard deviation of twenty (20) semi-trained judges. Means in the same row with different superscripts are significantly different ($p<0.05$). **Key:** A - Custard produced from 100% cornstarch, B - Custard produced from 90% cornstarch, 5% lima bean flour and 5% plantain flour, C - Custard produced from 80% cornstarch, 10% lima bean flour and 10% plantain flour, D - Custard produced from 70% cornstarch, 15% lima bean flour and 15% plantain flour, E - Custard produced from 60% cornstarch, 20% lima bean flour and 20% plantain flour, F - Custard produced from 50% cornstarch, 25% lima bean flour and 25% plantain flour.

and prevents cardiovascular diseases (Okaka *et al*., 2006). Ascorbic acid is easily destroyed by oxidation, especially at high temperatures and it is the most easily destroyed vitamin during food processing (Potter and Hotchkiss, 2006).

The enrichment of custard formulations with lima bean and plantain flours generally enhanced the niacin, thiamine, riboflavin, vitamin A and vitamin C contents of the products.

Sensory properties of custard samples

The sensory properties of custard samples are presented in Table 4. The colour of the custard samples ranged from 5.67 to 7.67. The result showed that the colour of the sample substituted with 25% lima bean and 25% plantain flours had the lowest value (5.67), while the control sample (custard made with 100% cornstarch) had the highest value for colour (7.67). The result obtained in the study is in agreement with the findings of Okoye *et al*. (2008) who reported that the colour of custard formulated from 100% corn starch was most acceptable compared to the colour of the custard formulations fortified with different proportions of soybean flour.

The taste of the custard samples ranged from 5.73 to 8.00. The sample substituted with 25% lima bean and 25% plantain flours had the lowest value (5.73), while the control sample (custard made with 100% cornstarch) had the highest value for taste (8.00). This showed that the taste of the samples decreased significantly ($p<0.05$) with increase in substitution of lima bean and plantain flours in the products. The result obtained from the study is in agreement with the report of Ajani and Adegoke (2018) for breadfruit-pigeon pea based custard.

The flavour of the custard samples ranged from 5.67 to 7.20. The result showed the sample substituted with 25% lima bean and 25% plantain flours had the lowest value for flavour (5.67), while the control sample (custard made with 100% cornstarch) had the highest value (7.20). The observation is in agreement with the findings of Mahmoud *et al*. (2016) who reported that the flavour of custard formulated from 100% corn starch was rated higher by the panelists than the samples substituted with date fruit flour at different graded levels.

The texture of the custard samples ranged from 5.73 to 7.60. The sample substituted with 25% lima bean and 25% plantain flours had the lowest value (5.73), while the control sample (sample with 100% cornstarch) had the highest value (7.60). The texture ranges in foods are very important and a deviation from an expected texture is regarded as a quality defect. Processing also affects the texture of foods. This is because there are correlations between colour and texture in some food products, hence colour may be used as an indication of acceptable texture in such products (Onimawo *et al.,* 2005; Makame *et al.,* 2019).

The overall acceptability of the custard samples ranged from 5.67 to 8.00 with the control sample and the sample substituted with 25% lima bean and 25% plantain flours having the highest (8.00) and least (5.67) values, respectively. The overall acceptability is an indication of acceptable colour, taste, flavour, texture and other sensory attributes in a given food. The consumer's acceptance of a food is referred to as the overall or general acceptability of such a food product (Okaka, 2010). Although, the control sample (custard made with 100% cornstarch) was generally more acceptable compared to the substituted samples, the formulated custard samples were equally rated high organoleptically by the panelists.

Conclusion

The study showed that the enrichment of custard with lima bean and plantain flours greatly enhanced the proximate, mineral, and vitamin compositions of the products. The results revealed that the increase in the addition of lima bean and plantain flours resulted in remarkable increase in protein, fat, ash, crude fibre, calcium, potassium, phosphorus, magnesium, zinc, iron, niacin, thiamine, riboflavin, vitamin A and ascorbic acid contents with slight

decrease in carbohydrate and energy contents. The sensory properties of the samples equally showed that the custard prepared from 100% cornstarch (Control) was the most acceptable to the panelists and showed significant ($p<0.05$) differences in colour, taste, texture and flavour from the substituted custard samples. Although the control sample was the most acceptable organoleptically, the custard formulations enriched with various proportions of lima bean and plantain flours were equally acceptable because they were also rated high in all the sensory parameters evaluated by the judges.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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