Slovak Journal of Food Sciences

Potravinarstvo Slovak Journal of Food Sciences
vol. 15, 2021, p. 121-130
https://doi.org/10.5219/1500
Received: 29 October 2020. Accepted: 22 January 2021.
Available online: 28 February 2021 at www.potravinarstvo.com

ISSN 1337–0960 (online)

THE NUTRITIONAL CHARACTERISTICS AND ACCEPTABILITY OF BAOBAB (*ADANSONIA DIGITATA* L) PULP AS NUTRIENT CONCENTRATE SUBSTITUTE IN CUSTARD POWDER

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ABSTRACT

Micronutrient deficiency in the human diet is of serious concern in developing nations. The utilization potential of Baobab pulp (BP) as a micronutrient source in custard formulation was evaluated. Custard powder was formulated from corn-starch, salt, flavor, colorant, and a commercial nutrient concentrate (NC) using a standard recipe, as a control sample. The nutrient concentrate was substituted by 20 – 50% of Baobab pulp in custard formulation. Custard powder was characterized by chemical, physicochemical, pasting, and sensory properties, using standard procedures. Substitution of Baobab pulp for nutrient concentrate in custard formulation resulted in a significant ($p \leq 0.05$) increase in the crude protein (2.23 – 3.67%), fat (1.49 – 2.40%), fiber (2.95 – 4.85%), and ash (2.21 – 3.63%) contents of custard powder. The vitamins A, C, and Beta-carotene contents of Baobab pulp-fortified custard varied ($p \leq 0.05$) significantly. Substitution of Baobab pulp for nutrient concentrate increased the mineral composition (Calcium (1.16 – 5.75 ppm), Magnesium (1.09 – 1.83 ppm), Potassium (0.81 – 2.68 ppm), and Iron (0.12 – 0.39 ppm)) of custard samples significantly ($p \leq 0.05$). The addition of Baobab pulp in the custard powder formulation enhanced its chemical composition and sensory attributes. The enhancement level increases with an increase in the proportion of baobab pulp.

Keywords: Baobab pulp; nutrient concentrate; micronutrient deficiency; custard; fortification

INTRODUCTION

Vitamins and minerals are essential micronutrients for human growth and well-being and should therefore be adequately provided in the human diet. Alleviation of micronutrient deficiencies has been receiving attention for decades through different interventions **(Alimi, Workneh and Oke, 2016; Olaniran et al., 2020a)**. Studies revealed that over 2 billion people are vitamin A, zinc, iron, and iodine deficient which are crucial vitamins and minerals, in the world **(Das et al., 2013)**. Growing children are particularly prone to this menace **(De-Regil et al., 2013; Olaniran et al., 2020b)**. These nutritional concerns can be efficiently managed courtesy of food fortification. This is a cost-effective strategy towards micronutrient delivery into a large population segment, with no alterations of food consumption patterns **(Bhagwat et al., 2014)**. In communities with a high economically poor population segment, the use of synthetic chemical ingredients for food fortification is challenging to sustain. Most developing nations are dependent on energy-given foods that are deficient in micronutrients **(Affonfere, 2018; Olaniran and Abiose, 2019)**. Custard powder is a high caloric, cornstarch-based diet commonly formulated with the inclusion of synthetic micronutrients. Conventionally materials such as flavors, salt, colorants, protein sources, concentrates are added, to enhance its sensory and nutritional qualities **(Okoye, Nkwocha and Agbo, 2008; Awoyale et al., 2015)**. However, both health and cost implications of commercial concentrate inclusion make it highly imperative to hunt-out for cheap and natural micronutrient-rich food materials as a substitute, particularly for low-income earners. Hence, a trial can be giving to baobab pulp, based on its reported micronutrient profile. Baobab pulp is being reported to contain trace elements that have the potentials to alleviate micronutrient deficiency if incorporated into the human diet **(Adejuyitan et al., 2012)**. It's a reservoir of riboflavin, ascorbic acid, pectin niacin, malic, citric, succinic acids, vitamins A, D, and E **(Donkor et al., 2014)**. Many food materials of African origin had been tested with huge successes, as food fortificant. For instance, baobab fruit pulp fortified yogurt **(Abdullahi et al., 2014)**. However, literature reports on the substitution of baobab fruit pulp for synthetic nutrient concentrate as a means of improving the micronutrient profile of starch-based custard is sparse. Outcomes of the study may result in the creation of novel custard varieties with higher safety propensity and also encourage the utilization of natural food material. Therefore, substitution potentials of baobab pulp for commercial nutrient concentrate in custard powder formulation were evaluated.

Scientific hypothesis

Baobab pulp can serve as a better and cheaper substitute for nutrient concentrate in custard.

The addition of Baobab pulp will increase micronutrients in custard **(Muthai et al., 2017)**.

MATERIAL AND METHODOLOGY

Sources of materials

The Baobab fruit was obtained from Kwara State University, Malete. Corn starch obtained from Shoprite, Ilorin; salt, flavor, color, and nutrient concentrate were purchased from the Mandate market, Ilorin.

Extraction of Baobab Fruit Pulp

Baobab fruits were split into halves using a mortar and pestle and the pulp (Figure 1) was scraped out from the seeds with a plastic spoon. The pulp was pulverized, screened through a 2 mm sieve, and packed in polyethylene bags, sealed, and kept before use **(Dendegh, Ukeyima and Dendegh, 2019)**.

Custard Formulation

The modified method of **Odimegwu et al. (2019)** was employed in the custard formulation. All ingredients were kept constant with exception of nutrient concentrate, which was replaced with 0%, 20%, 30%, 40%, 50% and 100% of Baobab pulp and samples coded as BB0, BB20, BB30, BB40, BB50 and BB100 respectively (Table 1). Samples were homogenized with a sterilized blender, (7-IN-1 ETKAL-868 blender TUV, Rheinland) cooled and packaged in polyethylene bags, sealed-up, and then kept at room temperature pending analysis (Figure 2).

Determination of Proximate Composition of the formulated custard powder

The proximate composition, including crude protein, fat, moisture, fiber, ash, and carbohydrate (by difference) contents of the formulated custard samples were determined according to **Horwitz and Latimer (2010)**.

Determination *o*f Micronutrient Content of the formulated custard powder

Determination of β-Carotene content

Petroleum ether (40 mL) and acetone (30 mL) were added to five grams of custard sample for extraction. Extracts were placed in separating funnels and distilled water was slowly added along the neck of the separating funnel without shaking, to avoid emulsion formation. The two phases were left to separate, and the lower aqueous layer was discarded. To remove residual acetone, each sample was washed 3 – 4 times with 200 mL distilled water. In the last phase, washing was done by ensuring that no amount of the upper phase was discarded. Then, the upper layer was collected into a 50 mL flask using anhydrous sodium sulfate (ACS reagent, ≥99%, Redi-Dri™ Sigma-Aldrich, Canada) filter arrangement to remove residual water as described by **Cortés-Herrera et al. (2019)**. The absorbance was read at 450 nm using a UV-visible spectrophotometer (Shimadzu-UV 1800). The concentration of beta carotene was calculated under the standard curve.

Determination of Vitamin A content.

The method described by **Okwu (2004)** was used to determine vitamin A. Sample (1 g) was weighed into a beaker and macerated with a 10 mL mixture of acetone and n-hexane (1:1) and filtered. Thereafter, 10 mL of 50% $(NH_4)_2SO_4$ solution was added, vigorously shaken, and allowed to settle. The upper layer was collected and the absorbance read in Spectrophotometer (Spectro21D, Pec Medicals, USA) at 450 nm against hexane as blank beta-carotene served as standard. Retinol equivalent was obtained by the conversion factor: 1 mg retinol equal to 12 mg of dietary beta-carotene.

Figure 1 Dried Baobab pulp.

Figure 2 Babobab flour.

Determination of Vitamin C concentration

Vitamin C concentration was determined according to the method described by **Vikram, Ramesh and Prapulla (2005)**. Precisely 1 g of the sample was mixed with meta-phosphoric acid and centrifuged at 10,000 rpm for 10 min. at 4 °C in a refrigerated centrifuge (Model H-2000C). The supernatant was sieved through Whatman No 4 filter paper. The filtrate was diluted with 1 mL of 0.8% meta-phosphoric acid and filtered with a 0.450 Millipore filter and 20 µL of the sample injected into the HPLC (Shimadzu 20 A-Series, with column -NH2 -LUNA-100A (250X4.6mm), Diameter – 5 uL and Refractive Index Detector.

Determination of Mineral Content

Three macros (Ca, Mg, K,) and one micro (Fe) mineral contents in each custard sample were determined by digesting 2.0 g of the sample with the aids of the Atomic Absorption Spectrophotometer (Buck 205 model; Buck Scientific Inc., USA). The outlined procedure of the Association of Official Analytical Chemists **(Horwitz and Latimer, 2010)**, approved method (968.08) was employed.

Determination of Anti- nutrient contents

The method of **Olatoye and Arueya (2019)** was employed to determine the phytate content. Determination of oxalate was carried out according to **Day and Underwood (1986)** while the Folin-Denis colorimetric method described by **Kirk, Sawyer and Frait (1998)** was employed to determined tannin content.

Determination of Physicochemical properties

The pH of the formulated custard samples was measured using a pH 211 microprocessor pH meter (Hanna, Woonsocket, RI, USA). Abbe refractometer was used to determine the total soluble solids content (Brix) while titratable acidity was determined according to **Olaniran et al. (2020c)**.

Determination of Pasting Properties

Pasting properties of the custard powder were characterized using the Rapid Visco Analyzer (RVA Model 3c, Newport Scientific PTY ltd, Sydney) as described by **Olaniran, Abiose and Gbadamosi, (2019)**. The pasting parameters recorded were pasting time, pasting temperature, peak viscosity, through viscosity, breakdown viscosity, setback viscosity, and final viscosity.

Sensory Analysis

Custard gruel prepared from custard powder samples were subjected to sensory evaluation using a scoring test. Fifty (50) semi-trained panelists, selected from the students of Kwara State University, Malate, Nigeria, who are all familiar with custard products were trained on the use of sensory evaluation procedures. Custard samples were evaluated and scored for appearance, flavor, taste, mouthfeel, and general acceptability using a 9-point hedonic scale, where "9" represented "like extremely" and "1" represented "dislike extremely" **(Olaniran, Abiose and Gbadamosi, 2019)**.

Statistical analysis

All data obtained (in triplicate) were statistically analyzed using a one-way analysis of variance (ANOVA). Separation of means was done by Duncan's Multiple Range Test (DMRT), using the (SPSS) Statistical package for social science, IBM VERSION 21.0 package (Armonk, New York). Significance was accepted at the 0.05 probability level (p ≤0.05).

RESULTS AND DISCUSSION

The proximate composition of Baobab pulp-fortified custard powder is present in Table 2.

Substitution of Baobab pulp for nutrient concentrate in custard formulation resulted in a significant (p ≤0.05) increase in the crude protein, fat, fiber, and ash contents of custard powder and ranged between (2.23 – 3.67%), (1.49 – 2.40%), (2.95 – 4.85%) and (2.21 – 3.63%) respectively, (Table 2).

The starch content of Baobab pulp-fortified custard powder is present in Figure 3.

Although moisture content also increases with an increase in the addition of Baobab pulp and ranges between (9.30 and 11.53%). This range was similar to 10% moisture earlier postulated for a good shelf life of powdery products **(Ensminger et al., 1995)**. The low moisture content of food materials usually enhances their stability and adaptability for subsequent use. Improved protein content might be as a result of the fairly high protein content of baobab pulp, as a report by **Osman (2004)**. Protein is known for its importance for the growth and repair or replacement of worn-out tissues in humans. Lack of or insufficient protein usually leads to kwashiorkor in children. Although, products with high-fat content can be susceptible to rancidity, with probable off-flavor and odor development. The low range of fat (1.49 – 2.40%) obtained in this product is desirable as a carrier of fat-soluble vitamins (A, D, E, and K) and a dietary source of essential fatty acids. Fiber is considered an efficient protective agent for a wide variety of illnesses, including cardiovascular disease, colon cancer, and constipation **(Marlett, McBurney and Slavin, 2002)**. The increase of fiber content in this product is therefore a plus. The baobab pulp was reportedly high in pectin and fiber contents **(Kamatou, Vermaak and Viljoen, 2011)** and could have contributed to the increase in fiber contents. Higher ash content in fortified custard samples than the control (BB0) also indicates the possibility of a better mineral profile. Baobab pulp was reported to be a rich source of the essential mineral element, need by the human body **(Adejuyitan et al., 2012)**. The carbohydrate content (73.88 – 81.83%) reduces with the increased addition of Baobab pulp and with the control sample being the highest. The high carbohydrate content of the custard samples showed that they are a good source of energy for the body.

Table 1 Custard formulation with Baobab pulp as a replacement for commercial nutrient concentrate.

Samples	NC/BP	Nutrient concentrate (g)	Baobab (g)	Corn starch(g)	Salt (g)	Flavor (g)	Colouring (g)
BB_0	100:0	10.0	0	35.0	1.0	1.5	2.5
BB_{20}	80:20	8.0	2.0	35.0	1.0	1.5	2.5
BB_{30}	70:30	7.0	3.0	35.0	1.0	1.5	2.5
BB_{40}	60:40	6.0	4.0	35.0	1.0	1.5	2.5
BB_{50}	50:50	5.0	5.0	35.0	1.0	1.5	2.5
BB_{100}	0:100	0	10.0	35.0	1.0	1.5	2.5

Note: *(NC: Nutrient concentrate and BP: Baobab pulp) **BB_0**: 100% Nutrient concentrate and 0% Baobab pulp; **BB_{20}**: 80% Nutrient concentrate and 20% Baobab pulp; **BB_{30}:** 70% Nutrient concentrate and 30% Baobab pulp; BB_{40}: 60% Nutrient concentrate and 40% Baobab pulp; **BB_{50}:** 50% Nutrient concentrate and 50% Baobab pulp; **BB_{100}:** 0% Nutrient concentrate and100% Baobab pulp.

Table 2 Proximate composition of Baobab pulp-fortified custard powder.

Sample	NC/BP	Moisture (%)	Protein (%)	Fat (%)	Fibre (%)	Ash (%)	Carbohydrate (%)
BB_0	100:0	9.30 ±0.36 ^{e}	2.23 ±0.51 ^{e}	1.49 ±0.02 ^{e}	2.95 ±0.05 ^{e}	2.21 ±0.04 ^{e}	81.83 ±0.50 ^{a}
BB_{20}	80:20	9.77 ±0.55 ^{d}	3.31 ±0.04 ^{d}	2.21 ±0.03 ^{d}	4.38 ±0.06 ^{d}	3.28 ±0.04 ^{d}	77.06 ±0.39 ^{b}
BB_{30}	70:30	10.43 ±0.35 ^{c}	3.49 ±0.10 ^{c}	2.33 ±0.07 ^{c}	4.61 ±0.13 ^{c}	3.45 ±0.10 ^{c}	75.69 ±0.36 ^{c}
BB_{40}	60:40	10.47 ±0.61 ^{c}	3.58 ±0.04 ^{b}	2.38 ±0.02 ^{b}	4.73 ±0.05 ^{b}	3.54 ±0.04 ^{b}	75.30 ±0.70 ^{c}
BB_{50}	50:50	10.63 ±0.35 ^{b}	3.61 ±0.03 ^{b}	2.40 ±0.02 ^{b}	4.77 ±0.04 ^{b}	3.57 ±0.03 ^{b}	75.01 ±0.26 ^{d}
BB_{100}	0:100	11.53 ±0.46 ^{a}	3.67 ±0.06 ^{a}	2.44 ±0.04 ^{a}	4.85 ±0.08 ^{a}	3.63 ±0.06 ^{a}	73.88 ±0.64 ^{e}

Note: Means ± standard deviation of triplicate samples with different superscripts along the columns differ significantly at $p \leq 0.05$. Key: NC (nutrient concentrate), (BP) baobab pulp.

Table 3 Vitamin content of Baobab pulp fortified-custard powder.

Sample	NC/BP	Vitamin C ($mg.100g^{-1}$)	Vitamin A ($mg.100g^{-1}$)	Beta-Carotene ($mg.100g^{-1}$)
BB_0	100:0	238.00 ±0.00 ^{a}	0.34 ±0.00 ^{c}	2.00 ±0.00 ^{e}
BB_{20}	80:20	238.25 ±0.66 ^{a}	0.34 ±0.00 ^{c}	2.06 ±0.00 ^{d}
BB_{30}	70:30	236.50 ±1.39 ^{b}	0.34 ±0.00 ^{c}	2.08 ±0.00 ^{c}
BB_{40}	60:40	237.00 ±0.25 ^{b}	0.34 ±0.00 ^{c}	2.10 ±0.00 ^{b}
BB_{50}	50:50	235.50 ±0.75 ^{c}	0.53 ±0.23 ^{b}	2.10 ±0.00 ^{b}
BB_{100}	0:100	156.50 ±9.55 ^{d}	0.66 ±0.23 ^{a}	3.49 ±1.21 ^{a}

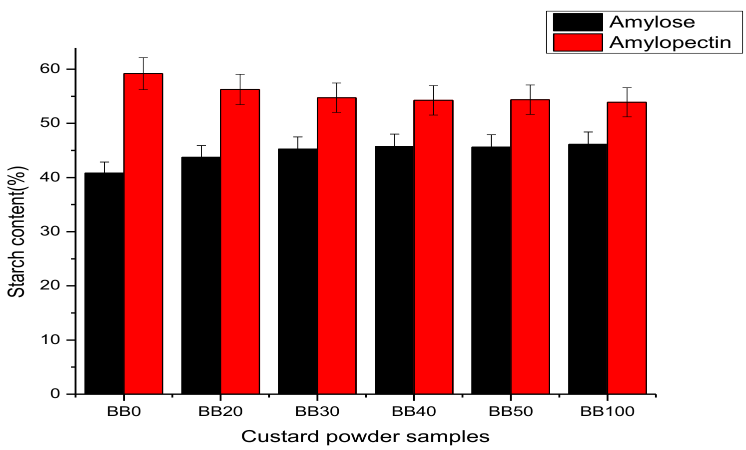

Figure 3 Starch content of Baobab pulp-fortified custard powder.

The vitamins A, C, and Beta-carotene content of Baobab pulp-fortified custard varied ($p \leq 0.05$) significantly (Table 3). The vitamin C content ranged from 156.50 to 238.25 mg.100g^{-1} with the highest value recorded for the control sample (BB0) and lowest value for sample BB100. These values were higher than the ranged (34 – 200 mg.100g^{-1}) reported by **Sidibe and Williams (2002)**, but lower than 300mg.100g^{-1} reported by **Gebauer, El-Siddig and Ebert (2002)** in similar studies. The variations can be associated with differences in growth conditions, genetic factors and geographical locations of the baobab tree used, together with the analytical procedure employed **(Olatoye and Arueya, 2019)**. The recommended daily intake (RDI) of ascorbic acid is about 30 mg per day for adults and 17 mg per day for children **(Othman, Kihel and Amara, 2019)**. Consequently, this needed concentration of ascorbic acid can be easily obtained from the consumption of this custard powder. Ascorbic acid is well known as a good antioxidant against free radical damage **(Chambial et al., 2013)**. The vitamin A and beta carotene contents significantly increased in custard powder with an increase in the addition of Baobab pulp. Perhaps as a result of high contents of both vitamins A and its precursor (beta carotene) in the baobab pulp used. Baobab pulp was earlier reported as a reservoir of riboflavin, ascorbic acid, pectin niacin, malic, citric, succinic acids, vitamins A, D, and E **(Donkor et al., 2014)**. The beta carotene content ranged between 2.00 and 3.49 mg.100g^{-1}, with Sample BB100 being the highest. Carotenoids are photosynthesized pigments that cannot be produced by the human body. These pigments, which can be transformed into vitamin A should be provided through dietary intake **(van den Berg, Dentener and Lelieveld, 2000)**. The Vitamin A contents ranged from 0.34 to 0.66 mg.100g^{-1} with Sample BB100 being the highest. Consumption of Baobab fruit pulp-fortified custard powder, therefore, constitutes a rich source of carotene and vitamins A.

The mineral composition of custard samples significantly ($p \leq 0.05$) increases with an increase in substitution levels of Baobab pulp for nutrient concentrate (Figure 4). Ca, Mg, P and Fe ranged between (1.16 – 5.75 ppm), (1.09 – 1.83 ppm), (0.81 – 2.68 ppm) and (0.12 – 0.39 ppm) respectively. Baobab pulp, being a rich source of mineral might have responsible for this trend. Magnesium and calcium are essential in human and animal health, especially for children, pregnant and lactating mothers, and the elderly. Inadequate dietary supply and a high risk of calcium deficiency in sub-Sahara African have been previously reported, based on food balance sheets (FBSs) **(Broadley et al., 2012; Joy et al., 2014)**. Adequate consumption of Potassium was closely linked to lower blood pressure in individuals with raised blood pressure **(He and MacGregor, 2008)**. Potassium also plays a prominent role in the synthesis of amino acids and proteins. Iron is an essential constituent of hemoglobin found in blood and contributes to the combat of anemia **(Blanco-Rojo and Vaquero, 2019)**. Therefore, the results of this study suggest that custard powder enriched with baobab fruit pulp may be a good source of macro and micro minerals need for body functions. The findings can also support the recommendation of fruit pulp as a possible strategy to tackle the problem of macro and microelements deficiencies through its inclusion in food consumption.

Anti-nutrient (phytate, tannin and oxalate) contents of the custard powder ranged from (0.01 to 0.02 mg.g^{-1}), (0.06 to 2.12 mg.g^{-1}) and (0.35 to 36 mg.g^{-1}) respectively and increases, with higher substitution level of Baobab pulp for nutrient concentrate (Figure 5). Phytate and oxalate could adversely affect mineral bioavailability **(Bhandari, Kasai and Kawabata, 2003)**. Tannins, also inhibit the absorption of minerals like iron and zinc but their ranges in the product were within the level that the human body can tolerate as safe **(Ojinnaka, Okudu and Uzosike, 2017; Olatoye and Arueya, 2019)**. Health benefits of tannin had been reported **(Ugwu and Oranye, 2006)**. These include reductions in the pathogenesis of cancer development and damage to the intestinal tract **(Makkar and Becker, 1996; Ugwu and Oranye, 2006)**. Therefore, the presence of low concentrations of tannin in the formulated custard powder is an added value. Titratable Acidity (TTA) and pH values of custard powder samples ranged between (0.15 – 0.96 mg.100g^{-1}) and (2.84 – 3.43) respectively as shown in Table 4. Both are significantly varied among samples. pH decreases with increase addition of Baobab pulp, the reverse was the case with TTA. Sample BB0 (without Baobab pulp) had the highest pH (3.34) and lowest TTA (0.15 mg lactic acid per 100g) values, while sample BB100 (with 100% Baobab pulp) had the lowest pH (2.84) and highest (0.96 mg lactic acid per 100g) TTA values. This implies that the product becomes more acidic with the inclusion of Baobab pulp, probably due to the presence of organic acids citric, tartaric, malic, succinic, and ascorbic **(Besco et al., 2007; Donkor et al., 2014)**. This acidity can bring about self-sanitation of this product during storage. More so, high Titratable Acidity (TTA) and very low pH recorded is a contributing factor to the fact that; the taste of the Baobab fruit pulp is tart and acidic and can improve the flavor of the custard. However, the Brix value, (probably a reflection of soluble sugar, particularly sucrose) was low in all samples. This may be desirable for a product of this kind, where consumers are used to the addition of excess sucrose before consumption. High sucrose consumption on consumer's health, has been closely linked with certain implications, such as incidences of obesity, diabetes, and dental decay **(Ajieroh, 2010)**.

Peak viscosity values ranged from 238.79 to 261.46 RVU with samples BB0 as the lowest and BB100 the highest (Table 5). The peak viscosity is defined as the maximum viscosity attained by gelatinized starch during heating in water **(Ojo, Ariahu and Chinma, 2017)**. The peak viscosity is closely associated with the degree of starch damage and its high value may indicate higher starch granule damage and starch binding capacity **(Ribotta et al., 2007)**. It is also an indication of the solubility of the blends for products with high gel strength and elasticity requirements. It can be inferred that the solubility and the degree of starch damage in this product could increase with the addition of Baobab pulp. The values of breakdown viscosity ranged from 71.33 to 116.25 RVU. Sample BB0 had the lowest and BB100 the highest values.

Table 4 Physicochemical properties of Baobab pulp-fortified custard powder.

SAMPLE	NC/BP	TTA (mg.100g^{-1})	pH	Brix
BB_0	100:0	0.15 ±0.02 ^{e}	3.43 ±0.02 ^{a}	2.00 ±0.00 ^{a}
BB_{20}	80:20	0.36 ±0.00 ^{d}	3.23 ±0.02 ^{b}	2.00 ±0.00 ^{a}
BB_{30}	70:30	0.42 ±0.00 ^{c}	3.14 ±0.02 ^{c}	2.00 ±0.00 ^{a}
BB_{40}	60:40	0.49 ±0.02 ^{c}	3.09 ±0.02 ^{d}	2.00 ±0.00 ^{a}
BB_{50}	50:50	0.60 ±0.03 ^{b}	3.02 ±0.04 ^{e}	2.00 ±0.00 ^{a}
BB_{100}	0:100	0.96 ±0.02 ^{a}	2.84 ±0.02 ^{f}	2.00 ±0.00 ^{a}

Note: Means ± standard deviation of triplicate samples with different superscripts along the columns differ significantly at $p \leq 0.05$. Key: (NC) nutrient concentrate, (BP) baobab pulp.

Table 5 Pasting properties of Baobab pulp-fortified custard powderSAMPLE.

SAMPLE	NC/BP	Peak (RVU)	Trough (RVU)	Breakdown (RVU)	Final viscosity (RVU)	Setback (RVU)	Peak Time (sec)	Pasting Temperature(ºC)
BB0	100:0	238.79 ±36.06 ^{d}	122.54 ±48.79^f	71.33 ±41.01^f	163.50 ±15.56 ^{f}	40.96 ±33.23 ^{e}	4.97 ±0.05 ^{d}	79.45 ±0.57 ^{c}
BB20	80:20	149.83 ±22.63 ^{e}	149.83 ±22.63 ^{e}	78.88 ±119.50 ^{e}	195.29 ±6.36 ^{e}	45.46 ±16.26 ^{d}	5.07 ±0.00 ^{c}	80.33 ±0.60 ^{a}
BB30	70:30	161.21 ±6.36 ^{d}	161.21 ±6.36 ^{d}	90.54 ±60.10 ^{c}	207.33 ±19.80 ^{d}	46.13 ±13.44 ^{c}	5.17 ±0.05 ^{ab}	80.28 ±0.60 ^{ab}
BB40	60:40	170.92 ±33.94 ^{b}	170.92 ±33.94 ^{d}	86.75 ±15.56 ^{d}	222.29 ±37.48 ^{b}	51.38 ±71.42 ^{a}	5.10 ±0.14 ^{ab}	79.88 ±0.04 ^{b}
BB50	50:50	166.25 ±56.57 ^{c}	166.25 ±56.57 ^{c}	96.46 ±36.06^b	213.00 ±155.56 ^{c}	46.75 ±98.99 ^{b}	5.03 ±0.05 ^{c}	79.88 ±0.04 ^{b}
BB100	100:00	180.5 ±67.88 ^{a}	180.50 ±67.88 ^{a}	116.25 ±84.85^a	231.88 ±36.06 ^{a}	51.38 ±31.82 ^{a}	5.23 ±0.14 ^{a}	80.38 ±0.60 ^{a}

Note:Means ± standard deviation of double samples with different superscripts along the columns differ significantly at $p \leq 0.05$. Key: (NC) nutrient concentrate, (BP) baobab pulp fruit.

Table 6 Sensory acceptability of Baobab pulp-fortified custard powder.

SAMPLE	NC/BP	Overall Acceptance	Appearance	Taste	Mouthfeel	Flavor
BB_0	100:0	7.73 ±0.70 ^{a}	7.73 ±0.70 ^{a}	7.00 ±1.11 ^{b}	6.47 ±0.97 ^{d}	6.87 ±0.94 ^{e}
BB_{20}	80:20	6.67 ±0.61^b	6.90 ±0.76 ^{b}	6.03 ±1.22 ^{d}	6.20 ±1.10^e	6.87 ±0.78 ^{e}
BB_{30}	70:30	6.63 ±1.00 ^{b}	6.67 ±0.84 ^{c}	7.03 ±1.07 ^{b}	6.83 ±0.99 ^{c}	6.93 ±1.11 ^{d}
BB_{40}	60:40	6.53 ±0.51 ^{c}	6.67 ±0.96 ^{c}	7.10 ±1.24 ^{b}	7.17 ±1.02 ^{b}	7.11 ±0.88 ^{c}
BB_{50}	50:50	6.43 ±0.50 ^{d}	6.33 ±0.80 ^{d}	6.30 ±0.80 ^{c}	6.50 ±1.11 ^{d}	7.27 ±0.64 ^{b}
BB_{100}	0:100	6.20 ±0.93 ^{e}	6.23 ±0.90 ^{e}	7.73 ±0.91 ^{a}	8.10 ±0.76 ^{a}	7.37 ±0.72 ^{a}

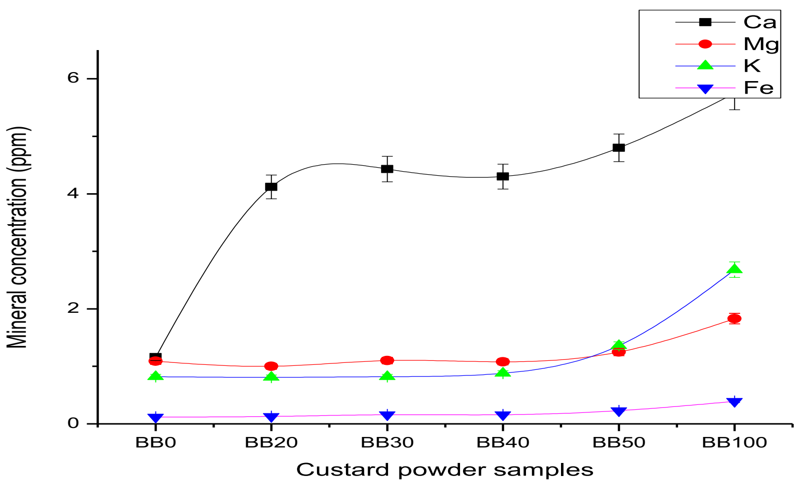

Figure 4 Mineral content of Baobab pulp-fortified custard powder.

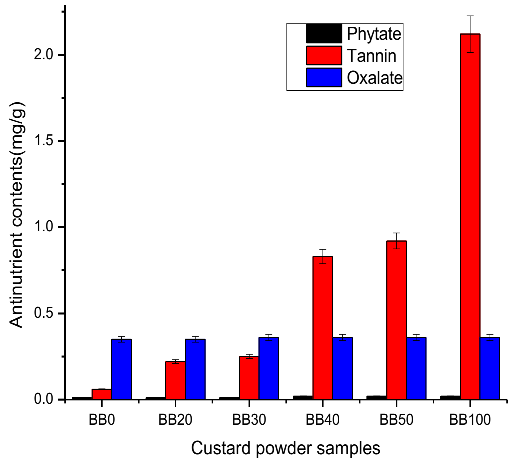

Figure 5 Anti-nutritional properties of Baobab pulp-fortified custard powder.

The recorded high values supported the fact that high peak viscosities are associated with higher breakdown viscosity **(Shimelis, Meaza and Rakshit, 2006)**. This is in agreement with **Adebowale, Afolabi and Olu-Owolabi (2006)** who reported that the higher the breakdown viscosity, the lower the ability of the sample to withstand heating and shear stress during cooking. Hence, resistance to heating and shear stress becomes lower with the addition of Baobab pulp to the formulated custard. Final viscosity ranged from 163.5 RVU to 231.88 RVU with samples BB0 as the lowest and BB100 as the highest. Starch molecules (especially amylose), usually re-associate during cooling, leading to the formation of a gel structure, and thereafter, the viscosity will increase to a final viscosity **(Ragaee and Abdel-Aal, 2006)**. Setback viscosity ranged from 40.96 RVU to 51.38 RVU with sample BB0 as the lowest and sample BB100 as the highest. Higher setbacks viscosity results in lower retro-gradation during the cooling of products **(Ikegwu, Okechukwu and Ekumankana, 2010)**. Starch retro-gradation is usually characterized by a series of physical changes such as increased viscosity and turbidity of pastes, gel formation, exudation of water **(Hoover, 2001)**. Starch retro-gradation is the phase where the mixture's association between the starch's molecules (during cooling) occurs to a greater or lesser degree and a measure of the stability of a paste after cooking. Pasting time ranged from 4.97 to 5.23 s with sample BB0 as the lowest and sample BB100 as the highest. Pasting time is the measure of the cooking time **(Adebowale, Afolabi and Olu-Owolabi, 2006)**; pasting temperature ranged from 79.45 °C to 80.38 °C with sample BB0 as the lowest and the highest was sample BB100. The pasting temperature gives an idea of the minimum temperature required to cook a sample. It indicates the temperature required to cook the flour beyond its gelatinization points **(Alake et al., 2016)**.

Sensory evaluation is the expression of an individual likes or dislikes for a product as a result of biological variation in man. It is a subjective source of product information. Sensory properties respond to people to products in terms of appearance, aroma, taste, texture, and after taste, without the benefit of the label, pricing, or other imagery **(Olaniran, Abiose and Gbadamosi, 2019)**. There were significant differences ($p \leq 0.05$) in organoleptic qualities of custard powder fortified with Baobab pulp (Table 6). Overall acceptability values ranged between (6.20 and 7.73) while the appearance ranged from (7.73 to 6.23) and both reduces with the substitution of Baobab pulp for commercial nutrient concentrate. This could be associated with the creaminess (color) of Baobab pulp. However, no rejection of any sample was recorded as all values were greater than 5 on a 9-point hedonic scale.

This implied that all custard samples were generally acceptable for all evaluated parameters as none scored below the minimum acceptable rating of five on a 9-point hedonic. However, taste, mouthfeel, and flavor improved with an increase in the proportion of baobab pulp as adjudged by the panelists. Samples BB0 and BB100 had the lowest and highest value in each case. Therefore, the involvement of Baobab pulp in custard powder formulation enhanced its sensory attributes.

CONCLUSION

Substitution of Baobab pulp for nutrient concentrate in custard formulation increased the proximate composition, carotene, and vitamin A contents of the formulated custard powder. Therefore, consumption of Baobab fruit pulp-fortified custard powder may have health benefits since the formulated custard is rich in macro and micronutrients. Further studies on the impact of baobab pulp substitution for synthetic concentrate on the bioavailability of trace elements and storage properties of custard powder are recommended.

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Acknowledgments:

This is to appreciate everyone who contributed one way or the other to the success of this study.

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