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Research Article

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Chemical and Sensory Assessment of Cocoyam (*Colocasia esculanta*) Puddings Blended with Plantain (*Musa paradisiaca*) and Sprouted Soybean (*Glycine max*) Pastes for Complementary Feeding

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Abstract Chemical and sensory properties of complementary puddings formulated from blends of cocoyam, firm ripe plantain and sprouted soybean pastes, seasoned, wrapped in plantain leaves and boiled for 30 min were evaluated. Results showed that 100% cocoyam pudding had the highest moisture content (52.55%), carbohydrate (39.28%) and least content of crude protein (3.22%), crude fat (1.21%), ash (2.14%), crude fiber (1.64%), and pro-vitamin A (13.55µg). The 90% cocoyam and 10% soybean pudding blend had the highest content of crude protein (4.29%), ash (2.45%), and least content of moisture (51.15%). Highest crude fat (1.49%) and crude fiber (2.11%) came from 45% cocoyam, 45% plantain 10% soybean pudding blend. Pudding with blends of 25% cocoyam, 65% plantain**,** 10% soybean had the highest pro-vitamin A (62.90µg) and least carbohydrate content of (37.86%). Pudding blend of 25% cocoyam, 65% plantain, 10% soybean had the highest respective iron, zinc and calcium content of 0.56mg, 0.35mg and 4.0mg. The least (0.36mg) iron content came from pudding blend of 90% cocoyam 10% soybean, while the respective least values of 0.36mg and 0.29mg for zinc and calcium came from 100% cocoyam pudding. Pudding with 45% cocoyam, 45% plantain and 10% soybean formulations was highly accepted while that with 90% cocoyam and 10% soybean was the least accepted.

Keywords Cocoyam, plantain, sprouted soybean, pudding, complementary feeding

Introduction

Complementary foods (CFs) are non-breast milk or nutritive foods which may be either solid, semi-solid [1] or liquid [2] prepared as special foods or modified family meal [3]. The CFs is introduced beyond six months to up to two years to the diets of breast feeding infants [2] which is called complementary feeding period [3]. Pudding is popular steamed cocoyam paste in Nigeria and other West African countries consumed alone as part of diet or eaten with other cereal based foods like *soy ogi*. Proprietary complementary foods are costly and out of the rich of poor nursing mothers in developing countries. These result in hidden hunger and infant food insecurity which makes complementary food from local staples [4, 5] the best available remedy option. Besides, some complementary foods from illiterate mothers may result in weaning deficiency associated with limitations in physical and intellectual capabilities of children [6].

Cocoyam (*Colocasia esculenta*), or *ede-cocoindia* is a starchy food crop not widely cultivated [7] but sparingly utilized for complementary formulations [5]. It is regarded as poor people's food eaten to just ward off hunger [8].

Cocoyam has nutritional advantage over other root crops [9] as regards digestible crude protein and minerals such as calcium, magnesium and phosphorous [10].The extreme small size of cocoyam starch granules renders it very easily digestible, thus making cocoyam suitable for complementary food formulation [5,11]. Cocoyam cormels are known to contain substantial amounts of protein, vitamin C, thiamin, riboflavin, niacin, significant amounts of dietary fiber [12]. Cocoyam also contains calcium, phosphorus, vitamin A, vitamins B [13] and iron [14]. Protein content of 5.87% and carbohydrate content of .46% on fresh weight basis had been reported [15]. Cocoyam had been processed by boiling, roasting, baking, frying in oil, milling, pasting, and pounding [7]. Other uses had been advanced [14, 16]. Cocoyam contains anti-nutrients like oxalate which had limited it wider utilization. Boiling not only inactivates the anti-nutrients but minerals and free amino are lost by leaching or may react with sugars to form complexes.

Chemical composition of plantain (*Musa paradisiaca*) increases during ripening [17] but varies with the variety, maturity, degree of ripeness and soil type [18]. Plantain is an important staple crop that contributes to the calories [19]. It is used as foods, breakfast cereals, and baby complementary foods [20, 21] such as *soymusa* for treatment of kwashiorkor [22]. Plantain is a good source of calcium, vitamin A, vitamin B1, vitamin B2, vitamin B3, vitamin B6, vitamin C and minerals such as iron, potassium, phosphorus, manganese and dietary fiber [23]. Plantain is a good source of anti-oxidants and flavonoids with insignificant toxic principles [24]. Regular consumption cures anemia and maintain healthy heart [25].

Soybean is an economical cheap source of good quality proteins with good balance of the essential amino acids [26] in meeting protein- energy requirement in both man and animal [27] thus making it superior to all other plant foods [30]. It has been utilized by food industries in production of soy flour, baby foods, breakfast foods, snacks and other confectioneries. Legume sprouting is associated with increase in mineral bioavailability, vitamin concentration, and bioavailability of trace elements and minerals [28] compared to the non germinated seed [29]. Sprouting also reduces some ant-nutrients and flatulence causing oligosaccharides (stachyose and raffinose), thereby increasing protein digestibility and sensory properties [30]. Soybean had been used to fortify many traditional foods of different ethnic groups in Nigeria like soy-ogi, soy-musa, soy-*garri*, and others. Fortified soy milk from sprouted soybean had been recommended for complementary feeding [31]. This study aimed at evaluating the chemical and acceptability of complementary pudding formulated from cocoyam, plantain and soybean blends as a suitable infant food to alleviate these problems.

Materials and Methods

The *ede Cocoindia* was procured from the cocoyam programme of the National Root Crops Research Institute, Umudike. Soybean, firm ripe plantain and ingredients were purchased from Urbani main market in Umuahia, Abia State, Nigeria.

Preparation of Soybeans Paste

Sprouted soybean paste was prepared (Figure 1) according to [31]. Five (5) kg of whole soybean seeds were sorted, steeped in tap water for 12 hrs, drained thereafter, spread on a clean jute sack on the floor and covered with black polyethylene. The beans were regularly sprinkled with water containing 2% of sodium metabisulphite as soon as their surface dries while being allowed to sprout for 72 hours at room temperature in the dark. The sprouts were washed and boiled in 0.5% $NaHCO_3$ solution for 20 minutes, drained and dehulled manually. The hulls and the shoots were removed by water floatation leaving soybean cotyledons which were milled into paste.

Preparation of Cocoyam Paste

Cocoyam cormels were sorted to remove rotten ones, peeled, washed and wet milled (without water) to obtain cocoyam paste (Figure 1).

Preparation of Plantain Paste

Firm ripe plantain fingers were sorted, peeled, washed and wet milled to obtain plantain paste (Figure 1).

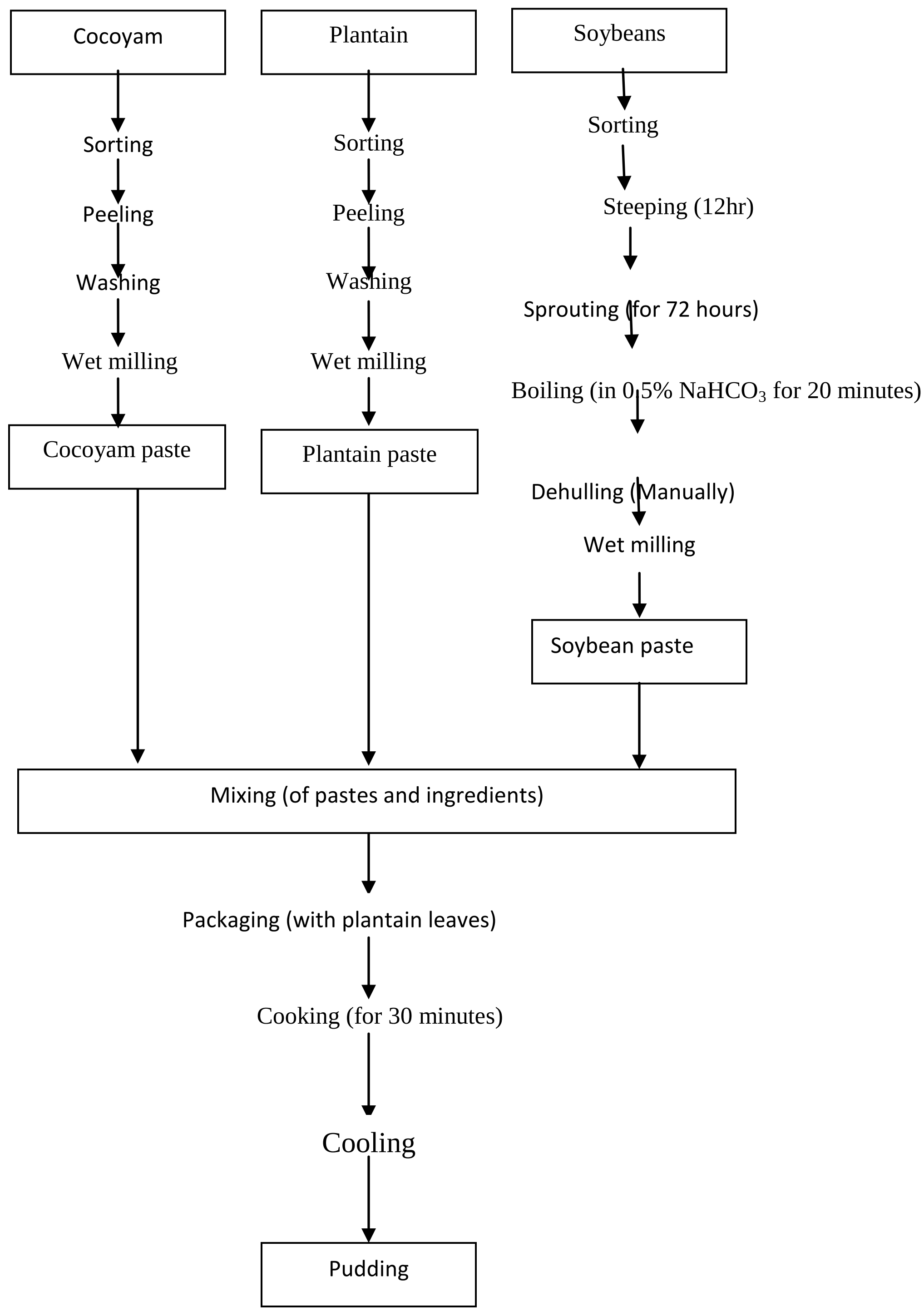

Figure 1: Flow chart for production of complementary puddings

Preparation of Complementary Puddings

The pastes were blended according to the codes, 105 (100% cocoyam), 106 (90% cocoyam and 10% soybean), 107 (25% cocoyam, 65% plantain 10% soybean), and 108 (45% cocoyam, 45% plantain 10% soybean). Each code which represents a sample was mixed with same ingredient measurements (Table 1), wrapped in banana leaves and boiled separately for 30min (Figure 1).

Table 1: Ingredients for production of cocoyam-plantain-soybean pudding

Ingredients	Quantity
Cocoyam, plantain and soybean Paste	600 g
Onion	25 g
Water	150ml
Palm oil	120 ml
Crayfish	120 g
Salt	1.5 g

Analyses

Chemical Composition

Moisture Content Determination

Oven drying method protocol described was used [32]. Five grams (5g) of each sample was put into a previously cleaned, oven dried and weighed moisture can. Weight of the can plus sample before drying was taken thereafter dried in the oven at 70 to 80 ^{0}C for 2h and at 105°C for 3 hours, cooled in a desiccator and weighed after. Drying at 105 ^{0}C was repeated at 30min interval until a constant weight was obtained. The final dry weight was recorded after cooling in a desiccator and used to calculate the percentage moisture content of the sample as shown below:

% Moisture content = $\frac{W_{2-W_3}}{W_{2-W_1}} \times \frac{100}{1}$

Where W_1 = initial weight of empty can, W_2 = weight of can + sample before drying, W_3 = weight of can + sample after drying.

Crude Protein Determination

Kjeldahl method [32] with slight difference was used. Two grams (2.0g) of the sample was mixed with 10mls of concentrated H_2SO_4 in a digestion flask. A tablet of selenium catalyst was added before heating in a fume cupboard until a clear solution was obtained (i.e. the digest) which was diluted to 100mls in a volumetric flask.

10mls of the digest was mixed with equal volume of 45% NaOH solution in a kjeldahl distillation apparatus. The mixture was diluted into 10mls of 4% buric acid containing 3 drops of mixed indicator (bromoscresssol green/methyl red). A total of 50mls of distillates was collected and titrated against 0.02N EDTA from green to deep red end point. The N_2 content and hence the protein content was calculated using the formula below:

% Protein = % N_2 x 6.25

% N_2 = $\frac{100}{W} \times \frac{N \times 14}{1000} \times \frac{V_t}{V_a} TBK$

Where: W = weight of sample, N = normality of titrant (0.02 H_2SO_4), Vt = total digest volume (100m/s), Va = volume of digest analyzed (10ml). T = titre value of sample and B = titre value of blank.

Fat Content Determination

Soxhlet ether extraction protocol [32] was employed. Two grams (2g) of the sample was accurately weighed into a labeled thimble and placed into a cool and labeled reflux flask filled with 300ml of petroleum ether (Bp 40 to 60^{0}C). The thimble was plugged with wool to Soxhlet apparatus on a heating mantle preset at 60°C to reflux for about 6h during which the vapour rises and leaches all the oil from the sample in the thimble into the round flask. Thereafter, the thimble containing the sample was removed from the reflux flask and the excess ether was recovered by heating leaving only the oil in the round flask. The flask was detached from the set up and placed on the oven set at 105°C to dry off excess ether, allowed to cool in a desiccator and then reweighed and oil content was calculated as shown below:

$$\% \text{ Fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} X\ 100$$

Ash Content Determination

Muffle furnace ignition method [32] was used. Three grams (3g) of the sample was measured into washed, dried and weighed porcelain crucible and transferred into preheated muffle furnace to ash at 550°C for 2h or until a white or gray ash was obtained. The sample was removed from the furnace allowed to ash to a grayish white ash, brought out from the furnace using a forcep and left in a desiccators to cool. The cool porcelain was re-weighed and ash content calculated as shown below:

$\% \text{ Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$

Where: W_1 = weight of empty crucible, W_2 = weight of crucible + food before drying and W_3= weight of crucible + ash.

Crude Fiber Determination

The method of [32] was used. Two (2g) grams of each sample were digested with 200ml of solution containing 1.25g of H_2SO_4 per 100ml of solution under reflux for 30 min. The digest was then filtered with Buckner funnel equipped with muslin cloth and filtrate was washed with hot water until no longer acidic. The residue was scooped into a conical flask and boiled for 30min with 200 ml of solution containing 1.25% of carbonate free NaOH per 100ml. The final residue was filtered, scooped into a previously dried and weighed crucible and dried in electric oven at 105°C to a constant mass. The dish with its content was reweighed after drying and then placed in the muffle furnace to ash at temperature of 550°C for 3 h. The ash was withdrawn at the end and reweighed. The weight of fiber was calculated as a percentage of weight of sample analyzed as below:

$$\% \text{ Crude fiber} = \frac{W_2 - W_3}{\text{Weight of sample}} \text{ x } 100$$

Where: W_2= weight of crucible + sample after boiling, washing and drying and W_3= weight of crucible + sample as ash.

Carbohydrate

Carbohydrate was calculated by difference [33] as

% Carbohydrate =100% - (% Moisture + % ash +%fat+% crude fibre +%crude protein).

Determination of Vitamin A

Spectrophotometric method was employed [32]. Five grams (5g) of sample was dissolved in 30ml of absolute alcohol (ethanol) and 3ml of 5% potassium hydroxide was added thereafter. The mixture was boiled under reflux for 30 minutes and was cooled rapidly with running water, filtered, 30ml of distilled water was added and the mixture was transferred into a separating funnel. The mixture was washed with 6ml of ether. The lower layer was discarded and the upper layer was washed with 50ml of distilled water. The extract was evaporated to dryness and dissolved in 10ml of isoprophyl alcohol. Absorbance was measured at 325nm and vitamin A was calculated thus:

$\text{Vit. A (mg/100g)} = \frac{100}{w} \times \frac{au}{as} \times c$

Where: au = absorbance of test sample, as = absorbance of standard solution, c = concentration of the test sample, w = weight of sample.

Determination of Vitamin C

The method of [34] was used. 10g of the sample was extracted with 50ml EDTA/TCA extracting solution for 1 hour and filtered through a Whatman filter paper into a 250 ml conical flask and 10ml of 30% KI was added along side with 50ml of distilled water. This was followed by 2ml of 1% starch indicator. This mixture was titrated against 0.01ml $CuSO_4$ solution to a dark end point. Vitamin A was calculated thus:

$\text{Vit. C (mg/100g)} = 0.88 \times \frac{100}{5} \times \frac{V_f}{20} \times \frac{T}{1}$

Where: V_f = volume of the extract, T = Sample titre – blank titre,

Determination of Iron

Spectrophotometric method of [35] was used. One gram (1g) of the sample was first digested with 20ml of acids mixture (650ml concentrated HNO_3, 80ml perchloric acid and 20ml concentrated H_2SO_4). The digest was diluted by making up to 100ml flask with diluted water. Two milliliter (2ml) of the sample solution was pipette inside a flask before 3ml buffer solution, 2ml hydroquine solution and 2ml bipyridyl solution were added. The absorbance reading was taken at wave length of 520nm and the blank was used to zero the instrument. Also a standard solution of iron was prepared by dissolving 3.512g of Fe $(NH_4)_2(SO_4)$. $6H_2O$ in water and two drop of 0.5N HCL was added and diluted to 500ml with distilled water. The iron standard was further prepared at different concentration at 2ppm to 10ppm by diluting with distilled water. 3ml buffer solution, 2ml hydroquinone solution and 2ml bipyridtyl solution were added. Absorbance reading was taken at 520nm. The readings were used to plot a standard iron curve for extrapolation.

Determination of Zinc

The method of [33] was used. One gram (1g) of the sample was first digested with 20ml of acid mixture (650ml concentrated HNO_3, 80ml perchlonic acid (PCA). About 5ml of the digest was diluted to100ml with distilled water which served as sample solution for AAS reading. Also standard solutions from respective element concentrations from 00, 0.2……….. 1.0. The concentration was calculated by extrapolation in the curve.

Determination of Calcium

The EDTA complexiometic titration method of [35] was used. Ten (10ml) of the sample solution was dispensed into separate conical flasks and pinches of the masking agents (potassium cyanide, potassium ferrocyanide and hydroxyl hydrochloride) were added followed by 20ml of ammonia buffer to raise the pH to 12. To the flask at pH of 10.0 (for calcium) a pinch of Erichrome dark black indicator was added and titrated against 0.02N EDTA solution while Solochrome dark blue indicator was added and titrated against 0.02N EDTA solution at pH of 12.0. A reagent blank was titrated as a control. The calcium content of the samples was calculated using the standard that 1ml of 1N EDTA has an equivalence of 20.04mg calcium.

% calcium = (100/W x N/100 x Vf/Va)

Where: W= Weight of sample analyzed, Vf = Volume of extract, Va = Volume of extract used, N = Normality.

Sensory Evaluation

Sensory evaluation was carried out on the coded puddings after cooling to room temperature using consumer preference test [36]. Twenty (20) randomly selected semi trained panelists comprising male and female staff and students of the University aged between 18 to 35yrs were used. The coded samples were presented to each panelist separately in same types of saucers along with bottled water. They were to taste the sample one after the other, rinse their mouths after each tasting and score the samples using 9-point Hedonic scale [37] where 9 represents dislike extremely, 1 dislike extremely, and 5 neither like nor dislike. .Appearance, flavour, taste, texture and general acceptability were evaluated under bright illumination.

Statistical Analyses

Data obtained from both analyses were subjected to analysis of variance (ANOVA). A completely randomized design was used to lay out the experiment. SPSS version 22 for personal computer was used to analyze the data. Means were separated using Duncan multiple range test at 95% confidence level ($p<0.05$).

Results and Discussion

Proximate Composition

Results of proximate analysis of the pudding samples were presented in Table 2. Significant ($p<0.05$) higher moisture content (52.55%) of sample 105 (100% cocoyam) than 106 (90% cocoyam, 10% soybean) with 51.15% could be due to inclusion of soybean paste which is protein rich. Protein had been reported to bind and holds water [38]. Higher moisture content of cocoyam [39] and non inclusion of protein rich soybean in sample 105 (100%

cocoyam) may have contributed to the difference as well. Higher moisture will soften the pudding and aids easy mastication and swallowing of the pudding by the child.

Table 2: Proximate composition of puddings prepared from *ede-cocoindia* cocoyam blended with plantain and soybean (%)

Sample	Moisture content	Crude protein	Crude fat	Ash	Crude fiber	Carbohydrate
105	$52.55^{d}\pm 0.35$	$3.22^{f}\pm 0.01$	$1.21^{e}\pm 0.01$	$2.14^{e}\pm0.01$	$1.64^{g}\pm0.01$	$39.28^{a}\pm0.03$
106	$51.15^{f}\pm 0.07$	$4.29^{c}\pm 0.01$	$1.36^{d}\pm 0.03$	$2.20^{b}\pm0.01$	$1.77^{f}\pm0.01$	$38.99^{b}\pm0.01$
107	$52.10^{de}\pm0.28$	$4.20^{d}\pm 0.01$	$1.43^{c}\pm 0.01$	$2.35^{c}\pm0.01$	$2.10^{c}\pm0.01$	$37.86^{d}\pm0.03$
108	$51.90^{e}\pm0.14$	$4.17^{d}\pm 0.01$	$1.49^{b}\pm 0.02$	$2.31^{d}\pm0.01$	$2.11^{c}\pm0.02$	$38.03^{c}\pm0.01$

Values are mean triplicate values ± standard deviation. Values in same column with different superscripts are significantly different ($p<0.05$). Samples 105 = 100% cocoyam ,106 = 90% cocoyam, 10% soybean; 107 = 25% cocoyam, 65% plantain, 10% soybean, and 108 = 45% cocoyam, 45% plantain, 10% soybean.

Significantly ($p<0.05$) higher crude protein (4.29%) of sample 106 (90% cocoyam, 10% soybean) than 3.22% from sample 105 (100% cocoyam) may have stemmed from inclusion of soybean paste which is protein rich [30, 40]. Protein increase with increase in soybean and plantain pastes validated the report [39] that cocoyam does not have substantial amount of crude protein. Protein is crucial for regulation and maintenance of infants and young children body. Consumption of 200 grams of the pudding will meet the recommended daily intake of 9.1g/d for protein for infants between the ages of 6 months and above [41]. This is possible considering infant stomach capacity of 200ml [42]. Therefore, the pudding will meet protein-energy requirement which deficiency is common among children of developing countries like Nigeria.

Fat content (1.49%) of sample 108 (45% cocoyam, 45% plantain and 10% soybean) was significantly ($p<0.05$) higher than 1.21% from sample 105 (100% cocoyam). However, fat content which increased with inclusion of sprouted soybean paste agreed with literature reports [43]. Fat increase is in line with the recommendations of including vegetable oils in infants and children foods to increase their energy density [44], and as transport vehicle for fat soluble vitamins. Fat also boost taste and helps to release the puddings from the packaging materials. Children are more active and therefore need more energy to meet their energy need.

Ash content increased significant ($p<0.05$) from 2.14% in sample 105 (100% cocoyam) to 2.35% in sample 107 (25% cocoyam, 65% plantain, 10% soybean).This could be traced to higher (65%) proportion of plantain inclusion which is rich in minerals [30, 45]. Significant difference ($p<0.05$) among all the samples may mean that the formulations had significant variations in their ash contributions. Ash content is an index of minerals content [46]. Iron enhances protein absorption, increases protein efficiency ratio and synergizes with protein and copper to transport oxygen from lungs to body tissues [6,]. Calcium helps nutrient flow across the cell walls, healthy development and growth of baby's bones, teeth [47], muscle and heart [48]. The pudding will promote infant growth and strong bones.

Crude fiber content of the pudding was significantly ($p<0.05$) higher (2.11%) in sample 108 (45% cocoyam, 45% plantain, 10% soybean) and least (1.64%) in sample 105 (100% cocoyam). The different may be due to plantain and soybean pastes in sample 108 (45% cocoyam, 45% plantain, 10% soybean). Soybean contains crude fiber [49], likewise plantain with dietary fiber content of 2.3% [40].The value (1.64%) obtained from sample 105 (100% cocoyam) is lower than 2.54% reported [39] from pudding prepared from cocoyam flour probably due to variety and drying. Dietary fiber is the indigestible component of plant material [43] that lowers serum cholesterol, obesity and healthy intestines in infants and young children [50].

There was significant ($p<0.05$) higher carbohydrate content (39.28%) of sample105 (100% cocoyam) than 37.86% from 107 (25% cocoyam, 65% plantain, 10% soybean) probably due to higher carbohydrate content of cocoyam [51]. Carbohydrate content decreased with increase in plantain paste inclusion also validated the difference. General lower carbohydrate content obtained in this study agreed with literature report [40]. Consumption of.75g to 241.9 g/d of the puddings will meet 60 to 95g/d carbohydrate RDI [41] for infants between the ages of 6 to 12 months. Carbohydrate synergizes with fat, fiber and protein to enhance protein-energy requirement for infants. Protein-energy malnutrition results in marasmus [41].

Vitamin Content of the Puddings

Vitamin content results are recorded in Table 3. Sample 107 (25% cocoyam, 65% plantain, 10% soybean) had a significant ($p<0.05$) higher (62.90µg) vitamin A than 105 (100% cocoyam) with 12.9µg. This could be attributed to inclusion of higher quantity (65%) of plantain, a better source of vitamin A than other staples [52], and soybean [30]. Vitamin A which increased with plantain inclusion is an important micronutrient in complementary foods whose early sign of deficiency is night blindness [53]. However, ingestion of 251 to 315 grams of the pudding will meet the RDI for infants and young children between the ages of 6 months to 2 years [54]. Therefore, pudding formulated with plantain and soybean is a good source of vitamin A precursor liable to prevent night blindness.

Table 3: Vitamin composition of puddings prepared from Ede coco India blended with plantain and soybean

Samples	Vitamin A (µg)	Vitamin C (mg)
105	$13.55^{g} \pm 0.07$	$6.32^{b} \pm 0.01$
106	$26.3^{e} \pm 0.07$	$11.10^{b} \pm 0.14$
107	$62.90^{a} \pm 0.14$	$33.05^{a} \pm 0.07$
108	$45.35^{d} \pm 0.07$	$11.95^{b} \pm 0.07$

Values are mean triplicate determinations ± Standard deviations. Values in same column with different superscript are significantly different ($P<0.05$). Samples 105 = 100% cocoyam; 106 = 90% cocoyam, 10% soybean, 107 = 25% cocoyam, 65% plantain and 10% soybean, and 108 = 45% cocoyam, 45% plantain and 10% soybean.

Vitamin C content of the puddings increased significantly ($p<0.05$) from 6.32mg in sample 105 (100% cocoyam) to 33.05mg in sample 107 (25% cocoyam, 65% plantain and 10% soybean). Vitamin C content increase with plantain inclusion validated the discrepancy and the report [45] that plantain is a good source of vitamin C. Therefore, sample 107 (25% cocoyam, 65% plantain, 10% soybean) is a good source of vitamin C [55] liable to meet the RDI (30mg) of infants aged between 0 to 12 months [56]. Vitamin C helps to maintain healthy immune systems, improves nutritional quality, reduces nutritional disorders, stabilizes food products and enhances nutrient absorption, growth and health in infants [57].

Mineral Composition (mg)

Table 4 presents the mineral results analyzed. Iron content of sample 107 (25% cocoyam, 65 plantain, 10% soybean) was significantly ($p<0.05$) higher (0.56mg/100g) than $0.36mg100g^{-1}$ from sample 106 (90% cocoyam, 10% soybean). Higher value of iron obtained in sample 107 (25% cocoyam, 65% plantain, 10% soybean) could be attributed to inclusion of higher percentage of plantain, a good iron source [45]. Apart from working in synergy with protein and copper to transport oxygen from lungs to tissues, iron is an integral part of many proteins that maintain good health [6]. However, general low iron values obtained in this study can meet the RDI of 11mg/d for infants aged between 6 months to 2 years or more [58] by increasing plantain inclusion levels.

Table 4: Mineral composition of puddings prepared from Ede coco Indian blended with plantain and soybean

Samples	Iron (mg)	Zinc (mg)	Calcium (mg)
105	$0.40^{f} \pm 0.02$	$0.29^{g} \pm 0.00$	$5.01^{b} \pm 0.02$
106	$0.36^{h} \pm 0.01$	$0.33^{c} \pm 0.10$	$4.70^{d} \pm 0.01$
107	$0.56^{b} \pm 0.00$	$0.35^{a} \pm 0.21$	$4.00^{h} \pm 0.01$
108	$0.48^{d} \pm 0.02$	$0.34^{b} \pm 0.01$	$4.32^{f} \pm 0.14$

Values are mean triplicate determinations ± standard deviation. Values in same column with different superscripts are significantly different ($p<0.05$). Samples 105 = 100% cocoyam; 106 = 90% cocoyam, 10% soybean; 107 = 25% cocoyam, 65% plantain 10% soybean; 108 = 45% cocoyam, 45% plantain 10% soybean.

Sample 107 (25% cocoyam, 65% plantain, 10% soybean) had significantly ($p<0.05$) higher zinc content (0.35mg/100g) than 0.29mg /100g from sample 105 (100% cocoyam) probably due to inclusion of plantain and soybean in the formulation. Both values were lower than 0.44mg obtained by [39] from pudding made with cocoyam flour which may be due to drying and varietal differences. Despite the lower zinc content in this study, the RDI (2mg to 3mg per day) for infants between the ages of 6 months to 2 years [54] could be met by consumption of 689g to 857g per day of the pudding which is possible considering infants' stomach capacity of 200ml [42]. The puddings are therefore good sources of zinc, a trace element essential for growth, brain development and central nervous system function [59]. Combination of zinc in oral rehydration salt (ORS) is an intervention strategy to combat diarrhea [60]. Pediatrics zinc deficiency leads to retarded or growth failure most especially in central nervous, immune, skeletal and reproductive system [61].

Sample 105 (100% cocoyam) recorded a significant ($p<0.05$) higher calcium value (5.01 mg /100g) than 4.00mg /100g from sample 107 (25% cocoyam, 65% plantain, 10% soybean). The difference could be attributed to the levels of cocoyam substitutions with plantain and soybean pastes in the formulations as cocoyam is a rich calcium source [62]. Hence the least calcium value in sample 107 (25% cocoyam, 65% plantain, 10% soybean) due to lowest level (25%) of cocoyam in the formulation. Soybean and plantain are not good sources of calcium [30]. Lower calcium levels in this study could be enhanced by protein and vitamin C [6] levels for creditable functions. Calcium is of tremendous importance to infants and young children, especially in the healthy development of their bones and teeth [47]. Although the puddings are poor sources of calcium, inclusion of calcium rich food materials in the formulations along-side breast feeding will meet calcium RDI of 210mg per day [47] for infants aged between 0 to 6 months.

Sensory Evaluation

Sensory scores of the Puddings are presented in Table 5. Appearance (6.45) of sample 105 (100% cocoyam) was rated significantly higher than the least value (4.95) from sample 107 (25% cocoyam, 65% plantain, 10% soybean). The variation may be due to colour contribution of plantain whose sugar may have caramelized to give deeper colour and improper blending of the formulations by the kitchen blender used unlike in sample 105 (100% cocoyam). Appearance is an important sensory attribute of any food because of its influence on acceptability. Consumers eat with their eyes and use what they observed to judge quality [63]. Proper blending of the formulations is inevitable for a better appearance.

Table 5: Sensory scores of puddings prepared from two varieties of cocoyam blended with plantain and soybean

Samples	Appearance	Flavour	Taste	Texture	General Acceptability
105	$6.45^{ab} \pm 1.23$	$5.75^{c} \pm 1.12$	$6.75^{b} \pm 0.91$	$6.80^{a} \pm 0.77$	$6.65^{bcd} \pm 0.59$
106	$6.35^{ab} \pm 0.81$	$5.20^{cd} \pm 1.40$	$5.70^{c} \pm 1.34$	$6.80^{a} \pm 1.11$	$6.10^{cd} \pm 0.85$
107	$4.95^{cd} \pm 1.57$	$6.75^{b} \pm 1.12$	$6.80^{b} \pm 1.06$	$6.00^{ab} \pm 1.56$	$6.60^{bcd} \pm 1.39$
108	$5.50^{bc} \pm 1.91$	$6.60^{b} \pm 1.10$	$7.30^{ab} \pm 1.08$	$6.50^{ab} \pm 1.85$	$7.20^{ab} \pm 1.06$

Values are mean triplicate determinations ± standard deviations. Values in same column with different superscripts are significantly different ($P<0.05$). 105 = 100% cocoyam, 106 = 90% cocoyam, 10% soybean, 107 = 25% cocoyam, 65% plantain, 10% soybean, 108 = 45% cocoyam, 45% plantain, 10% soybean

Flavour rating (6.75) of sample 107 (25% cocoyam, 65% plantain, 10% soybean) which was significantly ($p<0.05$) higher than 5.20 from samples 106 (90% cocoyam, 10% soybean) may be due to inclusion of ripe plantain which imparts flavour to foods.

Taste ratings (7.30) of sample 108 (45% cocoyam, 45% plantain, 10% soybean) was the highest while 5.70 from samples 106 (90% cocoyam, 10% soybean) was the least. Significantly ($p<0.05$) different between them may stem from non inclusion of plantain in sample 106 (90% cocoyam, 10% soybean). Plantain tastes sweeter as a result of hydrolysis of starch to sugar during ripening [17], 2011) and boiling [64]. Plantain is therefore the major flavour determinant in the puddings.

Texture ratings (6.80) of samples 105 (100% cocoyam) and 106 (90% cocoyam, 10% soybean) were significantly ($p<0.05$) higher than 6.0 from sample 107 (25% cocoyam, 65% plantain, 10% soybean). The difference depended on the levels of substitutions of cocoyam with plantain in the formulations as cocoyam has higher fiber content than plantain [12]. Similarity between samples 105 (100% cocoyam) and 106 (90% cocoyam, 10% soybean) may mean that fiber content contribution of 10% soybean [65] may have counter balanced that loss by 10% cocoyam reduction in sample106 (90% cocoyam, 10% soybean). Same reason may explain textural similarity between samples 107 (25% cocoyam, 65% plantain, 10% soybean) and 108 (45% cocoyam, 45% plantain, 10% soybean) [23]. Texture is a measure of sense of filling by the skin to determine textural attributes like crispness, hardness or hardness or softness, chewiness, fibrousness, sliminess and others [63] which will in turn determines the amount of food an infant can consume. Smooth puddings will be easier to swallow than coarse and hard ones by infants.

General acceptability level (7.20) of sample 108 (45% cocoyam, 45% plantain, 10% soybean) was rated highest and sample 106 (90% cocoyam, 10% soybean) the least (6.10). The difference may be due to significant ($p<0.05$) higher flavor (6.60) and taste (7.30) ratings of sample 108 (45% cocoyam, 45% plantain 10% soybean). This validated the report [63] that maximum general acceptability depends on maximum acceptability levels in most of the attributes. Also, this harmonized with the report [16] that flavour of a food ultimately determines its acceptance or rejection even though its appearance may evoke initial response. Similarity between samples 105 (100% cocoyam) and 107 (25% cocoyam, 65% plantain, 10% soybean) may be due to similarity in their taste with little textural difference (0.80). Taste and flavour therefore were the basis of acceptability. Higher acceptability of sample 108 (45% cocoyam, 45% plantain, 10% soybean) translates to like moderately while that of sample 106 (90% cocoyam, 10% soybean) to dislike slightly in the Hedonic scale. Flavour of food ultimately determines its acceptance or rejection even though its appearance may evoke initial response [16]. Acceptability in this study may be improved by inclusion of other acceptable food materials.

Conclusion

Preparation of an economic, nutritious and acceptable semi solid complementary food from underutilized locally available cocoyam, ripe plantain and sprouted soybean is feasible. Plantain and sprouted soybean are compatible food ingredients with cocoyam in complementary food formulation. Significant nutritional changes due to variations in plantain and soybean inclusions as well as small starch granule sizes predispose *ede-cocoindia* as a good nutrient vehicle for infant complementary food formulations, Puddings with 45% cocoyam, 45% plantain, 10% soybean formulation developed in this study can be an economic way of preventing weaning deficiency in developing countries like Nigeria. More so, it will mitigate post harvest losses, boost cocoyam production, reduce hidden hunger and enhance food security.

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