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Proximate and sensory properties of "Ipekere" produced from yellow maize and brown beans

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ABSTRACT
The study was conducted to analyse the proximate and sensory properties of *Ipekere* produced from yellow maize and brown beans. Flour samples were produced from whole maize and dehulled brown beans. The flour blends were subjected to proximate analyses and sensory test. The research methods adopted for the study were experimental and descriptive survey. The yellow maize flour was mixed with brown beans flour at rations of 100:00, 90:10, 80:20 and 70:30 respectively. Nutrient composition of *Ipekere* was significantly affected by the beans ($p \leq 0.05$) which resulted in gradual increase in protein (increased from 2.50mg/100g to 8.11mg/100g) and crude fibre contents (increased from 3.25mg/100g to 47.74mg/100g). Sensory quality evaluated showed that there was a significant difference in taste and overall acceptability at 30% brown bean flour supplement compared to the reference of 100% maize flour ($p \leq 0.05$). Beans substantially increased nutrient/energy density of *Ipekere* up to ratio 70:30 as the preferred mix. This research revealed the great potentials of beans in the enhancement of *Ipekere*. It was therefore recommended that sensitization should be made to the general public on the nutritional benefits of beans when combined with maize.

Keywords: Ipekere, yellow maize, brown beans, flour, snack

1. INTRODUCTION

In recent times, it is becoming increasingly necessary to produce highly acceptable snack foods with high nutritional quality that are yet affordable by potential consumers. This is due to a number of factors; including the fact that many people now work in places relatively far from their homes and can ill afford to spare time to prepare regular meals and hence depend on ready to eat snacks. Moreover, most school children depend to a large extent on such foods as they can hardly wait for breakfast before leaving for schools early in the morning. Furthermore, such foods, especially when appropriately enriched, could also be useful in nutritional programmes aimed at combating malnutrition and nutrient deficiencies. Cereal grains are predominantly used for the production of different snack foods, some of which may be eaten just as relishes. Some of those used traditionally for such purposes at the moment include breakfast cereals such as cornflakes, breads as well as alcoholic and non-alcoholic beverages.

It is widely known that most of these snack foods do not provide nutrients in adequate quantities to the body (Omueti & Morton, 1996) because they are deficient in some essential amino acids especially lysine. Such deficiencies may be due to their composition or in many instances due to losses during processing. Whatever may be responsible for their poor nutritional status, the need arise to ensure that every food consumed by any individual contains appropriate nutrients in adequate amounts.

Maize is predominantly starch (60-75%), in the form of amylases and amylases. The protein content of maize is very low constituting only about 9-12% when compared with other grains. It is however known to be rich in methionine, cystine and some sulphur containing amino acids (Bedolla & Rooney, 1982). Such amino acids that are lacking can be supplied to the food by supplementing the maize with legumes such as dry common beans, which are better sources of the sulphur containing amino acids (Okaka, 2005; Uzor-Peter, Arisa, Lawrence, Osondu & Adelaja, 2008). There is usually improved balance of amino acids in the products made from such combination (Ameide-Dominquez, Valencia & Higuera-Capra, 1990). Several other studies have been carried out to improve the protein quality of maize product by fortification with plant proteins such as soya bean and dry common bean (Plahar & Leung, 1983; Adelakun, Adejuyitan, Olajide & Alabi, 2005; Uzor-Peters *et al.*, 2008).

Maize (*Zea mays*) is a cereal crop that is grown widely throughout the world in a range of agro-ecological environment. About 50 species exist and consist of different colours, textures and grain shapes and sizes. White, yellow and brown are the most common types. The white and yellow varieties are preferred by most people depending on the region. It is consumed as a vegetable although it is a grain crop. The grains are rich in vitamins A, C and E, carbohydrate and essential minerals. Maize seed contain a useful concentration of vitamin B or the thiamine and yellow maize contain carotene a precursor of vitamin A (Adu, 2010). They are also rich in dietary fibre and calories which are good source of energy (International Institute of Tropical Agriculture (IITA), 2009). Maize is the most important cereal in Sub-Sahara Africa (SSA) and an important staple food for more than 1.3 billion people in SSA and Latin America. A heavy reliance on maize in the diet however can lead to malnutrition and vitamin deficiency diseases such as night blindness and kwashiorkor (IITA, 2009). Yellow maize is preferred in most parts of South America and the Caribbean (IITA, 2009).

Maize is a cereal crop widely cultivated in Nigeria and the tropics. It is used in the production of various food items such as *ogi (akamu)*, *agidi*, *kokoro*, *epiti* and *ipekere*. *Ipekere* is a popular local snack made from maize flour. It is therefore a predominantly carbohydrate food lacking in some essential nutrients. The technology of *ipekere* production is largely traditional, involving mixing maize flour with boiled water to form a paste and seasoning with salt, palm oil, pepper and onions. The dough is kneaded and cut into shapes. The pieces are then deep-fried in palm oil until dried and crispy. Consistent turning is ensured to avoid burning and the palm oil is changed intermittently to avoid undesirable crust colour as bleached oil is not suitable for the frying process. *Ipekere*is consumed during the day and guzzled down with water by the people of South Western Nigeria. Being a product consumed on a wide scale, it would be important to enhance its nutritional value. Addition of plant protein such as dry common beans could be one way of raising the nutritional value of the product by introducing more protein into the product.

Studies have shown the improvement in protein content of several cereal foods supplemented with legumes such as beans, bambara groundnut, sesame seed and fluted pumpkin seeds (Barber, 2010). Beans (*Phaseolus vulgaris*) grain legume is rich and less expensive source of dietary proteins and water-soluble vitamins. Legumes contain twice as much protein as cereals and except for the sulphur containing amino-acid (methionine and cystine which are adequate in cereals) this amino acid profile of most legumes complement those of cereals (Ogbo, 2009). Among the legumes, bean is believed to be the most widely grown, distributed and traded food commodity within Nigeria (Owolade, Akanda, Alabi & Adeiran, 2006). Beans (*Phaseolus vulgaris*) is the most widely consumed legume in Nigeria, primarily because of its taste and ease with which it is prepared and incorporated into other recipes (Muoneke, Ndukwe and Asowala, 2012). It constitutes more than 50% of all legumes consumed (Langyintuo, Lowenberg-DeBoer, Faya, Lambert, Ibro, Moussa, Kergna, Kushwaha, Musa & Ntoukam, 2003). Beans serve as the largest single contributor to the total protein intake of many rural and urban families (Muoneke, 2012). The ever escalating prices of animal protein source and insufficient local production, have led to an increasing demand for cheap good quality protein foods such as beans (Horax, Hettiarachchy, Chen & Jalaluddin, 2004).

Beans is a valuable source of plant protein, vitamins (thiamine and niacin), and minerals (phosphorus, potassium, calcium, magnesium) and dietary fibre (Muoneke, Ndukwe & Asowala, 2012). There is considerable evidence in the literature that foods high in water-soluble dietary fibre (such as oats or bean products) and purified forms of water-soluble dietary fibre can reduce blood cholesterol (Ayodele & Addo-Bediako, 2012). Several studies (Leterme, 2002; Winham, Webb & Barr, 2008) have shown that beans products can lower serum cholesterol levels. Daily consumption of 100-135g of dry beans reduced serum cholesterol levels by 20% thereby reducing the risk of coronary heart disease by 40% (Ayodele & Addo-Bediako, 2012).

Besides being a good source of both soluble and insoluble dietary fibre and possessing the health related benefits associated with both types of dietary fibre, beans have an added advantage of being an inexpensive fibre source (Winham, Webb & Barr, 2008). Beans are similar in dietary content to oat bran or any other dietary fibre extracts available to consumers (Ayodele & Addo-Bediako, 2012). Beans are low in fat (1-3%) and high in complex carbohydrates (50-60%). These characteristics make beans really suited to helping consumers meet the intake of starch and other complex carbohydrates (Ayodele & Addo-Bediako, 2012). Bean is an important food for children as well as adults and is consumed in a variety of ways. Most frequently, they are cooked together with spices and palm oil to produce a thick bean soup which is either eaten alone or as *adalu* with yam, maize or rice. They are also decorticated, ground into flour and mixed with chopped onions and spices and made into cakes which are either deep fried (*akara* balls) or steamed (*moi-moi*) (Cardador, Castano & Loarca, 2012). To reduce the prevalence of protein energy malnutrition in Nigeria especially among the rural dwellers the study produced *ipekere* from the flour blends of maize and beans in different proportions, determined the proximate composition of *ipekere* produced from maize and beans flour and determined of the sensory evaluation of the product samples.

2. MATERIALS AND METHODS

Materials

Yellow maize and brown beans.

Maize flour production

The maize grains were sorted, washed and oven dried at 65% for 6 hours (Gullerkamp UK). The dried maize was milled into flour using attrition mill. The maize flour was stored in air tight containers.

Beans flour production

Matured and dried bean seeds were carefully cleaned, sorted to remove defective ones from lots. Cleaning was equally done to remove stones. The clean seeds were soaked in portable water to soften the coat for easy removal, dried and milled into flour.

Formulation of *Ipekere*

The maize: beans flour blends were formulated into four ratios: 100:0, 90:10, 80:20 and 70:30 respectively.

Production of *Ipekere*

The formulated maize: bean flour blends were used and other ingredients were added as follows:

Flour (beans and maize flour blended)	**250 g**
Palm oil	**10 ml**
Salt	**to taste**
Pepper	**to taste**
Onion	**50 g**
Water (warm)	**150 ml.**

These were mixed together to form a stiff dough which was moulded with palm and flattened then, deep fried in palm oil until dry and crispy. Constant turning was ensured to avoid burning and the palm oil was changed intermittently to avoid undesirable crust colour as bleached oil is not suitable for the frying process.

Proximate composition of *Ipekere* produced from maize and bean flour blends

Moisture content Determination: The moisture content was determined by using oven drying method based on weight loss of water due to evaporation. As described by Association of Analytical Chemists (AOAC) (1990), clean and dry dishes were weighed by using metllar balance (0.0001 – 200G) and their respective weights recorded (W_1). About 2g of each sample was measured into respective glass dishes (W_2). After each weighing, it was transferred into a dessicator immediately to prevent absorption of moisture from the atmosphere. The petri dishes containing the samples were transferred from the dessicator into oven until content weights were obtained (W_3). The loss in weight during drying (in percentage) was taken to be the percentage moisture content.

$$\% \, moisture = \frac{loss \ in \ weight \ of \ sample}{weight \ of \ sample} X \frac{100}{1}$$

$$= \frac{W_2 - W_3}{W_2 - W_1} X \frac{100}{1}$$

Where

W_1 = weight of empty dish

W_2 = weight of dish + sample before drying

W_3 = weight of dish + sample after drying

Ash Content Determination

About 2g of the finely ground sample was weighed into dry per-weigh crucible (W_1). The organic matter was burnt off using Bunsen flame until the sample became charred. The crucibles were then transferred to the muffle furnace set at 550°C. Ashing continued until a light grey or white colour was obtained. The crucibles were cooled in a dessicator and weighed (AOAC, 1990).

$$\% \, ASH = \frac{W_3 - W_1}{Weight \ of \ sample} X \frac{100}{1}$$

Fat Content Determination

The thimble was weighed (W_1) before addition of the sample and 2g of each sample was weighed into the thimble. The thimble with the sample (W_2) was inserted into the soxhlet apparatus and extraction under reflux was carried out with hexare for 6 hours. At the end of the extraction, the thimble was dried in the oven for 3 minutes at 100°C to evaporate off the solvent and the thimble was allowed to cool in a dessicator and later weighed (W_3). The fat extracted from the sample was deduced (AOAC, 1990).

$$\% \, Fat = \frac{weight \ loss/extracted \ fat}{weight \ of \ sample} X \frac{100}{1}$$

$$= \frac{W_2 - W_3}{W_3 - W_1} X \frac{100}{1}$$

Crude Fibre Determination

5g of the sample was weighed into a conical flask followed by the addition of 250ml of boiling 1.25% H_2SO_4. The solution was boiled gently for 30 minutes, using cooling finger to maintain constant volume. The solution was then filtered through muslin cloth, stretched over 9cm Buchner funnels and was rinsed with hot distilled water. The residue was scrapped back into the flask with spatula and 200ml of boiling 1.25% NaOH was added. The solution was allowed to boil gently for 30 minutes with cooling finger used to maintain a constant volume. This was again washed thoroughly with hot distilled water and was rinsed once with 10% HCl and twice with industrial methylated spirit (AOAC, 1990). The residue was rinsed finally three (3) times with petroleum either (40-60°C boiling range) and was drained, dried and scrapped into a crucible. It was dried at 105°C in the oven, cooled in a dessicator and then weighed (W_2). The sample was ashed at 550°C for 30 minutes in a muffle furnace and then cooled in dessicator and re-weighed (W_3).

$$\% \, Crude \ fibre = \frac{W_2 - W_3}{W_1} X \frac{100}{1}$$

Protein Content Determination

The protein in each sample was determined by the Kjeldahl technique which consist of three stages of analysis namely digestion, distillation and titration (AOAC, 1990). About 1g of sample was digested with 10ml concentration of H_2SO_4 together with 0.8g kjeldahl digestion catalyst in a micro-kjedahl digestion flask. The mixture was digested on a heater until clear solution was obtained.

The flask was allowed to cool after which the solution was diluted with distilled water up to $100cm^3$ of which $10cm^3$ was transferred into the kjeldahl distillation apparatus.

The second step was the distillation stage, this involved distillation of the cooled, diluted, digested sample to which 40% NaOH solution was added to make it alkaline. 3 drops of mixed indicator (0.016g methyl red – 0.083g bromocresol green in 100ml alcohol) was added to receiver flask containing 5ml of 2% boric acid solution to produce purple colour solution. The cloudy nature or the sample solution after the addition of 4NaOH indicated that NaOH was in excess. The distillation was carried out with all punch works closed with the end of the condenser below and surface of the receiver flask containing the boric acid solution. As the distillation proceeded, the purple colour solution of the receiver turned deep blue indicating the presence of ammonia (NH_3). Distillation continued until the distillate was about 50ml after which the delivery end of the condenser was rinsed with distilled water.

Equation – Nitrogen converted to ammonia and reacted with H_2SO_4 to form $(NH_4)_2SO_4$

Distillation – $(NH_4)_2SO + 2NaOH = 2Na_2SO_4 + NH_3 + 2H_2O$

$NH_3 + H_3BO_3 = NH_4^+ + H_2BO_3$

Titration – $NH_3 + H_3BO_3 = NH_4^+ + H_2BO_3$

1 mole of HCl = 1 mole of NH_3

Calculation – %Nitrogen = M X T X 0.014 X V_1 X 100

V_2/W

Where;

M = molarity of acid

T = titre value

W = Weight of sample

V_1 = volume of digested sample

V_2 = volume of digest used.

Therefore, % protein = % Nitrogen X 6.25

Carbohydrate Content Determination

The carbohydrate content of the *ipekere* sample was determined by the summation of ash content, moisture content, fat content, crude fibre, crude protein and subtracting it from 100%.

Formula: [HO content = 100% - (protein + ash + fat + moisture + fibre)]%

Sensory Evaluation

Sensory evaluation was carried out on the colour, taste, flavour, texture and overall acceptability. A total of ten panelists were for each sensory parameter and this people were chosen on the basis of interest and some previous experience with taste panel procedure. To avoid the panelist from being biased, the samples were coded as follows:

RXM – the reference sample – 100:0 maize

DFB_1 – 90:10 maize:beans deep fried

DFB_2 – 80:20 maize:beans deep fried

DFB_3 – 70:30 maize:beans deep fried

The mean value was subjected to Analysis of Variance (ANOVA)

3. RESULTS

Result of the proximate composition of *ipekere*is presented in Table 1.

Table 1 Proximate composition of *Ipekere* from yellow maize and brown beans

Parameter	RXM	DFB_1	DFB_2	DFB_3
Moisture (%)	8.65 ± 0.198^b	7.00 ± 0.007^c	8.00 ± 0.014^a	10.50 ± 0.014^d
Fat (%)	27.50 ± 0.014^d	27.05 ± 0.063^a	32.01 ± 0.007^c	26.01 ± 0.007^b
Crude fibre (%)	3.25 ± 0.014^a	11.51 ± 0.007^c	21.25 ± 0.004^b	47.74 ± 0.014^d

Crude protein (%)	2.50 ± 0.014^a	7.20 ± 0.014^d	7.96 ± 0.078^b	8.11 ± 0.007^c
Carbohydrate (%)	55.50 ± 0.014^c	45.31 ± 0.007^b	38.11 ± 0.007^d	21.10 ± 0.007^a

Values are means ± standard deviation. The mean of each parameter followed by different letter superscript in the same row are significantly different at $p \leq 0.05$.

Table 2 Sensory properties of maize snacks

Sample	Colour	Aroma	Taste	Texture	Overall Acceptability
DFB_1	7.90 ± 1.10^a	7.00 ± 2.16^a	6.60 ± 2.01^b	7.30 ± 1.76^a	7.50 ± 1.08^a
DFB_2	6.40 ± 2.17^b	7.60 ± 1.82^a	6.70 ± 1.44^b	6.90 ± 1.44^a	7.40 ± 1.57^a
DFB_3	6.80 ± 2.04^b	6.80 ± 1.68^a	8.10 ± 1.19^a	6.90 ± 2.51^a	7.50 ± 1.71^a
RXM	6.80 ± 2.48^b	6.30 ± 1.49^a	7.00 ± 2.78^b	6.90 ± 2.42^a	6.20 ± 2.93^b

Values are means ± standard deviation. Values followed by different alphabet superscripts along the same column are significantly different at $p \leq 0.05$.

4. DISCUSSION

The proximate composition of the samples is presented in Table 1. According to these results, there are significant differences ($p \leq 0.05$) in the moisture contents of the four blends. The result of the proximate composition of *ipekere* sample produced from yellow maize and brown beans flour blend as depicted in Table 1 showed several data trend. The moisture content of *ipekere* was higher when prepared with just maize until the level of supplementation with brown beans increased to 30% (at100% maize 8.65 ± 0.198; 90% maize and 10% brown beans 7.00 ± 0.007; 80% maize and 20% brown beans 8.00 ± 0.014; and at 70% maize and 30% brown beans 10.50 ± 0.014). The increase at this level indicates that *ipekere* is best stored when the brown beans contents is about 10%. Moisture content in the food material plays a significant role in the modern world. Moisture rich foods are easily susceptible to the microbial attack and got rotted and damaged. Thus the shelf life of the food material is determined by the moisture content in the food. The moisture content observed were in agreement with that reported by Olapade and Ogunade (2013). As a snack, the moisture content of *ipekere* is quite important. Materials such as flour and starch containing more than 12% moisture have less storage stability than those with lower moisture content. Water content of 10% is generally specified for flours and other related products (Adedeji, Jegede, Abdulsalam, Umeohia, Ajayi & Iboyi, 2015).

Fat content ranged from 27.05% to 32.01%. The fat content in the blends was not as consistent as the increase in brown beans content. Initially, there was a decrease (significant at $p \leq 0.05$) in fat content when the percentage of brown beans in the flour was 10%. A significant increase was however observed when the brown bean in the flour was 20%. Contrary to this trend a significant decrease was observed in the flour when maize content increased to 30%. DFB_2 had the highest fat content followed by RXM. The sample with the greatest fat content can be said to be the sample with the greatest oil absorption capacity which is an important functional proper that enhances the mouth feel and retains the flavour of food products (Olanipekun, Olapade, Suleiman &Ojo, 2015). The fat content reported in this study is slightly different from that reported by Olanipekun, Olapade, Suleiman and Ojo (2015). The storage life of the blend may be increased due to low fat content since high fatty foods are potentially susceptible to oxidative rancidity (Abegunde, Bolaji & Adeyemo, 2014).

Brown beans increased the crude fibre content in the flour blends. The crude fibre content in RXM was 3.25± 0.014, significant increases (at $p \leq 0.05$) were observed in DFB_1, $DFB_2$and DFB_3. Crude fibre is a measure of the quantity of indigestible cellulose, pentosans, lignin, and other components of this type in present foods. Ihekoronye and Ngoddy (1985) noted that crude fibre is known to aid the digestive system of humans. Crude fibre offers a variety of health benefits and is essential in reducing the risk of chronic disease such as diabetes, obesity, cardiovascular disease and diverticulitis. Increasing the content of brown beans in *ipekere* will improve the crude fibre contents of the snack. Brown beans is one of the sources of plant protein cheap available in the society. The trend in the increase of crude protein from 2.50% to 8.11% as brown beans supplement increased from 0% to 30% was not surprising. This increase was significant. Protein is required for tissue repairs and development (Winham, Webb & Barr, 2008); it is one of the significant nutrients required in snacks. Protein content of *ipekere* produced from this flour blends (maize and brown beans) can help reduce the prevalence of protein-energy malnutrition in the country.

Unlike protein, carbohydrate was observed to decrease from 55.5% to 21.1% as the beans content increased. The decrease was consistent and significant. This was in agreement with the findings of Jimoh and Olatidoye (2009) and Adebayo-Oyetoro, Olatidoye, Ogundipe and Abayomi (2013). The major chemical component of the maize kernel is starch, which provides up to 72 to 73 percent of the kernel weight (Food and Agriculture Organisation, FAO, 1992).

The mean scores obtained from the sensory analyses as tabulated in Table 2 showed that there is a significant difference among the samples examined. Sample DFB_1 had the highest score (7.90 ± 1.10) in colour. Next to DFB_1 were DFB_3 and RXM with mean score of 6.80 ± 2.04 and 6.80 ± 2.48 respectively. DFB_2had the lowest mean score (6.40 ± 2.17). DFB_1 was most appealing to the eye. This is in disagreement with the findings of Edema, Sanni and Abiodun (2005) and Olanipekun *et al.* (2015) that addition of soy flour to maize flour in the production of sour maize bread affected the physical properties as well as nutritional value of the bread, since beans improved the appearance of *ipekere*. Colour is very important in the production of snacks, it sends the first message to the consumer. It is responsible for attraction of a particular snack to consumer especially for adolescents and young ones. The appearance of DFB_1 could be associated to the presence of brown beans in the flour.

Although DFB_2 had the lowest mean score in colour, it had the highest mean score in aroma (7.60 ± 1.82). $DFB_1$and DFB_3 had mean scores of 7.00 ± 2.16 and 6.80 ± 1.49 respectively. The lowest mean score was observed in RXM (6.30 ± 1.49). In snacks aroma is only useful during production process. In most cases the final product are packaged and their aroma curtailed within the package. However, the aroma of snacks is also important. A test for palatability (taste) showed that DFB_3 had the highest means score (8.10 ± 1.19). RXM and DFB_2 had 7.00 ± 2.78 and 6.70 ± 1.44 mean scores respectively. The lowest mean score for taste was observed in DFB_1 (6.60 ± 2.01). $DFB_3$is softer and more beans taste can be felt in it which means that, it is more palatable when compared to other samples. DFB_2, DFB_3 and RXM had similar score (6.90 ± 1.44, 6.90 ± 2.51 and 6.90 ± 2.42 respectively) for texture. The DFB_1 had the highest mean score of 7.30 ± 1.76. On the overall, DFB_1(7.50 ± 1.08) and DFB_3(7.50 ± 1.71) had the highest mean scores. The overall acceptability mean score of DFB_2 was 7.40 ± 1.57. The RXM had the lowest overall acceptability (6.20 ± 2.93). The overall acceptability of the sample DFB_1 and DFB_3 which had 30% brown beans and 70% yellow maize had the best score in taste and overall acceptability, likewise sample DFB_1 which had 10% brown beans and 90% yellow maize had the best score in colour, texture and overall acceptability but with the lowest score in taste. Therefore, 30% brown beans inclusion into yellow maize to produce *Ipekere* could be recommended as the sample produced with the best outcome when compared with the control sample and it scored better than the control sample in taste, aroma and overall acceptability with equal score in texture and colour. This is in agreement with previous studies (Edema *et al.,* 2005; Otunola, Sunny-Roberts, Adejuyitan & Famakinwa, 2012; Olanipekun *et al.,* 2015) in which consumers were reported to prefer products made from composite mixtures of legume and maize to products from 100% maize flour.

Sample DFB_1 was significantly different from all other samples examined under colour because it had a value greater than samples DFB_2, DFB_3 and RXM. Under aroma, there was no significant difference in all the samples examined as the differences between the values were greater than 0.05. Sample DFB_3had significantly different value from the RXM in taste. In texture there was no significant difference as all the samples examined had the same superscript in their values. The overall acceptability also showed that samples DFB_1, DFB_2 and DFB_3 had no significant difference but sample RXM was significantly different from others.

5. CONCLUSION

Variety and nutrient adequacy are factors of importance in the formulation of food for the benefit of people. *Ipekere* is an indigenous snacks consumed by all and sundry. The nutritional content and acceptability of the snack can be improved if brown beans flour is substituted into the primary flour (yellow maize) flour in the ratio 70:30. *Ipekere* produced from yellow maize and brown beans composite flour is highly nutritious. It has a better protein and crude fibre content. The addition of brown beans to yellow maize in the production of *Ipekere* proved to be more nutritious and better accepted. It should therefore be incorporated into complementary mixes.

Recommendations

Based on the research findings, the following are recommended:

1. The local producers of *Ipekere* should fortify the maize with brown beans
2. Developing countries that suffer food and nutrient inadequacies should fortify maize with brown beans to improve their nutritional status.
3. Enlightenment campaigns should be made to the general public on the nutritional benefits of brown beans.

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