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Original Research Report

Nutrient and Sensory Attributes of Breakfast Meal (Tom Brown) Produced from Composite Flours of Local Rice, Pearl Millet, Pumpkin Pulp and Soybean

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Abstract: Tom Brown is a porridge produced from blends of nutritious locally available ingredients. This study aimed at expanding the utilization of some indigenous crops. Tom Brown was made from toasted composite flours of local rice, pearl millet, pumpkin pulp and soybean. A total of seven formulations were obtained in this study (samples 201, 202, 203, 204, 205, 206 and 207). The proximate, mineral, vitamin composition and sensory attributes of the Tom Brown samples were assessed using standard procedures. The proximate composition result revealed significant ($p<0.05$) increase in protein, fat, ash and fiber contents. The control sample had the lowest moisture and highest carbohydrate contents (9.54% and 79.44%) respectively. There was progressive increase in the mineral and vitamin composition of the Tom Brown as the ratio of pearl millet, pumpkin pulp and soybean increased. The highest values of minerals and vitamins were observed in sample 206(35% local rice: 40% millet: 10% pumpkin pulp: 15% soybean) and they followed the same trend. The result of the sensory properties revealed that the Tom Brown samples were generally accepted by the panelists. It can be concluded that acceptable and nutrient rich Tom Brown could be produced from the composite flour formulation.

Keywords: Local Rice, Mineral, Pumpkin Pulp, Sensory Properties, Soybean, Tom Brown

1. Introduction

Tom Brown has been defined as a food supplement produced from blends of nutritious locally available ingredients and typically prepared as a porridge for infants and children between 6-59 months old (Catholic Relief Services, 2021). It has been used as a weaning food in most parts of West Africa and has attracted multiple researches all in a bid to improve its nutrient composition to meet the nutritional requirements of infants and children (Nagai et al., 2009). Its use is not only limited to household use, but also has been expanded to a humanitarian context to mitigate the challenge of Moderate Acute Malnutrition (MAM) in North-East Nigeria (Catholic Relief Services, 2021).

Pumpkin (*Curcurbita*) pulp is a nutrient-rich food containing antioxidants and carotene, which promotes immunity against diseases in the human body (Perez, 2016). Despite being a vegetable, it is under-utilized and lacks commercial recognition and market potentials, which underline its cultivation on a small-scale level (Agbugba et al., 2011). Studies have shown the potentials of pumpkin pulp as a food supplement and a food source in the mitigation of Vitamin A deficiency due to its mineral and carotene content; therefore, its utilization limited to its consumption as a vegetable and as thickeners for soups and purees at the household level is expanding to cover more beneficial grounds (Nakazibweet al., 2020).

Soybeans are nutrient rich legumes characterized by their high-quality protein content which is not only a double of the protein content of other legumes and twelve times that of milk, but also, have a relatively high amount of essential amino acids that significantly levels up to the protein requirements of humans (Adelakun et al., 2013; Chatterjee et al., 2018).

Pearl millet (*Pennisetum glaucum*) is listed as one of the most important cereals serving as a staple food for millions of people in several African and Asian countries (Dias-Martins et al., 2018). In Nigeria, millions of tons of pearl millet is cultivated and utilized as an alternative income source to poor farmers and as a staple in many homes largely in Northern Nigeria (Izge & Song, 2013). According to Bello et al. (2018), a thick binding paste known as “tuwo” can be produced from it. It is also used in the production of a popular beverage in northern Nigeria and southern Niger ("fura" in Hausa language) by rolling the ground flour into balls, parboiling them and reconstituting it using fermented milk (*nono*). Although millet flour does not contain gluten, it contains a significant amount of protein and minerals therefore, can be an excellent alternative for gluten containing cereals for people with celiac disease (Adéoti et al., 2017; Kulkarni et al., 2021).

Rice is one of the highly consumed staples in Nigeria and has the potential to provide the minimum calorie requirement of an average Nigerian per day (FAO, 2001). African rice (*Oryza glaberrima*) is native to Africa. Although its cultivation is declining due to its low yield, it is still highly sought after due to its unique taste and hardiness, which is highly desirable to its consumers (Sié et al., 2012).

Tom brown is one of the nutritious foods among Nigerians that is consumed by adults and children either as breakfast or in between meals. According to Catholic Relief Services (2021), Tom Brown is produced from roasting six parts cereals (sorghum, maize and millets), three parts soybean and one-part groundnuts. In this study, the addition of pumpkin pulp will serve as a good source of vitamin A.

1.1. Statement of Problem

Energy, protein and micronutrients are essential for adequate development and growth in infants and for adequate body functioning in adults (UNICEF, 2019).

Vitamin A deficiency is common amongst children and infants in the world and causes adverse

effects in their growth and development and can even lead to death if not attended to (Tenagashaw et al., 2017). According to FAO (2001) reports, malnutrition is one of the leading global health challenges and has been reported as the leading root cause of some ailments suffered in adulthood.

1.2. Purpose of the Study

The main objective of this present study was to produce Tom Brown from flour blends of Nigerian rice *(Oryza glaberrima)*, pearl millet *(Pennesietum glaucum)*, pumpkin (*Curcurbita*) pulp and soybean *(Glycine max)*.Other specific objectives were to:

(a) Produce from blends of local rice, pearl millet, pumpkin pulp and soybean and toast them into Tom Brown.

(b) Determine the proximate, mineral and vitamin composition of the Tom Brown.

(c) Carry out sensory evaluation on the Tom Brown.

1.3. Research Questions

(a) How was the breakfast meal (Tom Brown) produced?

(b) Does the inclusion of pearl millet, pumpkin pulp and soybean flour have any positive effect on the proximate composition, mineral and vitamin contents of the breakfast meal (Tom Brown)?

(c) Will the inclusion of pearl millet, pumpkin pulp and soybean affect the sensory/general acceptability of the Tom Brown by the consumers?

(d) What makes addition of pearl millet, pumpkin pulp and soybean better than local rice?

2. Materials and Methods

2.1. Design for the Study

The experimental design used in this study was completely randomized design (CRD).

2.1.1. Ethics Statement

Ethical permission was not requested from the ethics committee because it is not an animal/human study. However, the study was carried out with informed consent, anonymity, and confidentiality of the respondents who voluntarily participated in the organoleptic properties of the study. The procedures for the organoleptic studies were strictly followed. There was strict compliance with the ethical demands of sensory evaluation as required in research studies.

2.2. Area of the Study

This study was carried out in the Food Processing laboratory of the Department of Food Science and Technology, Michael Okpara University of Agriculture Umudike and Central Laboratory of National Root Crop Research Institute (NRCRI) Umudike, all in Abia State of Nigeria.

2.3. Procurement of Raw Materials

Freshly mature and healthy pumpkin *(Cucurbita)* fruits were procured from Bende Local Market, while millet, soybean and local rice were purchased from Ubani Main Market, Umuahia, all in Abia State, Nigeria.

2.4. Sample Preparation

2.4.1. Production of Toasted Local Rice Flour

Toasted local rice flour was produced using the method described by Joy and Ledogo (2016) with slight modification. The rice grains were sorted, steeped in clean water (16 h), drained (with a stainless screen), oven dried with Galle kemp, 300 Plus, England(60^{O}C for 12 h), toasted with stainless pot on a gas flame for 10 min and milled into fine flour with an attrition mill (model

SK-30-SS).

2.4.2. Production of Toasted Millet Flour

Toasted millet flour was produced according to the method described by Mridula et al. (2008). Millet grains were sorted, washed in clean tap water, tempered (2 h), drained (using plastic sieve), oven dried with Gallenkemp, 300 Plus, England(60^{O}C for 4 h), toasted with stainless pot on a gas flame for 10 min and milled into fine flour with an attrition mill (model SK-30-SS).

2.4.3. Production of Toasted Pumpkin Pulp Flour

The method described by Shamaail and Saher (2020) was used to produce toasted pumpkin pulp flour. The Pumpkin fruits were sorted, washed, cut open, deseeded. The pulps were extracted, drained using perforated plastic screen, oven dried with Gallenkemp, 300 Plus, England (60^{O}C for 72 h), toasted with stainless pot on a gas flame for 5 min and milled into fine flour using an attrition mill (Yoshita model GX 390, 13.0 HP, made in China).

2.4.4. Production of Toasted Soybean Flour

The method described by Agume et al. (2017) was employed in the production of toasted soybean flour. The soybeans were sorted, soaked in water (12 h), drained using plastic sieve, dehulled manually by robbing the seeds in between hands, washed off the seed coats, drained again, oven dried (60^{o}C for 60 h), toasted with stainless pot on a gas flame for 20 min and milled into fine flour with an attrition mill (model SK-30-SS).

Table 1: Tom Brown Formulations (%).

Sample	Local Rice	Pearl millet	Pumpkin pulp	Soybeans
201	100	0	0	0
202	30	60	10	0
203	60	30	10	0
204	30	50	10	10
205	50	30	10	10
206	35	40	10	15
207	40	35	10	15

Key:

201= 100% local rice

202= 30 local rice: 60% millet: 10% pumpkin pulp

203= 60% local rice: 30% millet: 10% pumpkin pulp

204= 30% local rice: 50% millet: 10% pumpkin pulp: 10% soy bean

205= 50% local rice, 30% millet, 10% pumpkin pulp, 10% soy bean

206= 35% local rice: 40% millet: 10% pumpkin pulp: 15% soy bean

207= 40% local rice: 35% millet: 10% pumpkin pulp: 15% soy bean

2.5. Chemical Analyses

The proximate composition (moisture, ash, fat, crude fibre, crude protein and carbohydrate contents), minerals (magnesium, calcium, sodium, iron), vitamins (vitamin B_1, vitamin B_2 and vitamin B_3) and pro-vitamin A contents of the Tom Brown were determined according to the method described by Onwuka (2005).

2.5.1. Sensory Evaluation

The method described by Iwe (2007), was employed in the evaluation of the sensory attributes of the Tom Brown produced. 25 panelists on a 9-point Hedonic scale assessed the taste, texture, colour, aroma and general acceptability of all the formulated Tom Brown.

2.5.2. Statistical Analysis

All experiments in this study were reported as mean of duplicate analyses. One way analysis of variance was carried out using the Statistical Product of Social Sciences version 22.0 to compare between the means while treatment means were separated using Duncan multiple range test at 95 % confidence level ($p<0.05$).

3. Results and Discussion

3.1. Proximate Composition of the Tom Brown Samples

The proximate compositions of the Tom Brown produced in this study are presented in Table 2. The results of the proximate composition showed a regular trend in the parameters investigated apart from moisture and carbohydrate contents. There were significant differences ($p<0.05$) in all the parameters determined. The moisture content of the Tom Brown samples ranged from 9.54 to 10.46%. The highest moisture content was observed in Tom Brown produced from 60% pearl millet substitution (sample 202). The lowest moisture level was recorded for the 100% local rice (control). The crude protein of the Tom Brown samples ranged from 7.81-15.82%. The protein progressively increased with increase in the level of pearl millet and soybean (Table 2). The fat content significantly increased from 0.07-2.56% for the control (100% local rice) and sample 207(40% local rice: 35% millet: 10% pumpkin pulp: 15% soy bean) respectively. The ash content significantly increased from 1.08(control-100% rice) -3.24% (40% local rice: 35% millet: 10% pumpkin pulp: 15% soy bean)**.** The crude fiber content values ranged from 1.28 - 4.79% with sample 201 (100% local rice) recording the least value while sample 206(35% local rice: 40% millet: 10% pumpkin pulp: 15% soy bean) had the highest. Carbohydrate content of the Tom Brown samples ranged from 61.09(sample 206) to 79.44% (control-100% local rice) and significantly decreased with increase in the proportions of millet and soybean in the formulations.

3.2. Mineral Composition of the Tom Brown

In Table 3, the calcium content of Tom Brown ranged from 184.76 - 234.65 mg/100g with sample 201 (100% local rice) recording the least value (184.76mg/100g), while sample 206 had the highest value for calcium. The magnesium content of the Tom Brown ranged from 147.83 to 189.31 mg/100g for samples 210 (control-100% rice) and 207(40% local rice: 35% millet: 10% pumpkin pulp: 15% soy bean) respectively. Iron content increased from 2.79 to 5.28 mg/100g with an increase in the proportions of millet and soybean in the Tom Brown formulations while the control sample had the least. The Sodium content were significantly different ($p<0.05$) and ranged from 75.27 to 92.46 mg/100g for samples 201 and 206 respectively.

Table 2: Proximate Composition (%) of Breakfast Meal (Tom Brown)

Sample codes	Moisture	Crude protein	Fat	Ash	Crude fibre	Carbohydrate
201	9.54^{d}±0.08	7.81^{f}±0.01	0.85^{g}±0.01	1.08^{g}±0.00	1.28^{g}±0.02	79.44^{a}±0.08
202	10.46^{a}±0.06	13.66^{e}±0.06	2.38^{f}±0.3	2.17^{f}±0.01	3.25^{f}±0.01	68.58^{b}±0.87
203	9.77^{c}±0.10	14.53^{d}±0.01	4.12^{e}±0.00	2.83^{c}±0.01	3.59^{d}±0.01	65.16^{c}±0.08
204	9.80^{c}±0.06	14.61^{c}±0.01	4.21^{d}±0.01	2.61^{e}±0.01	3.73^{c}±0.01	65.05^{c}±0.12
205	10.23^{b}±0.04	14.49^{d}±0.01	4.29^{c}±0.01	2.78^{d}±0.00	3.44^{e}±0.02	64.78^{c}±0.01
206	9.81^{c}±0.01	15.82^{a}±0.03	5.25^{a}±0.01	3.24^{a}±0.00	4.79^{a}±0.01	61.09^{d}±0.07
207	10.26^{b}±0.08	15.57^{b}±0.04	5.16^{b}±0.00	3.19^{b}±0.00	4.31^{b}±0.01	61.51^{d}±0.14

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscript are significantly different ($p<0.05$).

Key:

201= 100% local rice
202= 30% local rice: 60% millet: 10% pumpkin pulp
203= 60% local rice: 30% millet: 10% pumpkin pulp
204= 30% local rice: 50% millet: 10% pumpkin pulp: 10% soy bean
205= 50% local rice, 30% millet, 10% pumpkin pulp, 10% soy bean
206= 35% local rice: 40% millet: 10% pumpkin pulp: 15% soy bean
207= 40% local rice: 35% millet: 10% pumpkin pulp: 15% soy bean

Table 3: Mineral Composition (mg/100g) of Breakfast Meal (Tom Brown)

Sample codes	Calcium	Magnesium	Iron	Sodium
201	184.76^{g}±0.06	147.83^{g}±001	2.79^{g}±0.01	75.27^{g}±0.04
202	198.31^{f}±0.16	158.61^{f}±0.01	3.81^{f}±0.01	79.42^{f}±0.25
203	214.66^{e}±0.06	174.29^{e}±0.01	4.22^{e}±0.02	82.55^{e}±0.07
204	223.82^{c}±0.03	180.34^{c}±0.03	4.61^{c}±0.01	89.76^{c}±0.06
205	221.73^{d}±1.45	178.46^{d}±0.08	4.90^{d}±0.01	85.54^{d}±0.34
206	234.65^{a}±0.07	189.31^{a}±0.16	5.28^{a}±0.00	92.46^{a}±0.08
207	229.79^{b}±0.01	187.50^{b}±0.14	5.18^{b}±0.00	91.56^{b}±0.06

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscript are significantly different ($p<0.05$).

Key:

201 = 100% local rice(control)
202 = 30% local rice: 60% millet: 10% pumpkin pulp
203 = 60% local rice: 30% millet: 10% pumpkin pulp
204 = 30% local rice: 50% millet: 10% pumpkin pulp: 10% soy bean
205 = 50% local rice, 30% millet, 10% pumpkin pulp, 10% soy bean
206 = 35% local rice: 40% millet: 10% pumpkin pulp: 15% soy bean
207 = 40% local rice: 35% millet: 10% pumpkin pulp: 15% soy bean

3.3. Vitamin Composition of Breakfast Meal (Tom Brown)

The result of vitamin composition of breakfast meal is shown in Table 4. There was significant differences ($p<0.05$) in the vitamins determined among all the Tom Brown samples. Vitamin B1 content of the Tom Brown ranged from 0.16 to 0.43 mg/100g for samples 201 (control-100% local rice) and 206 respectively. The result followed the same trend with the results of the proximate and mineral contents of Tom Brown. Vitamin B_2 values ranged from 0.08 to 0.38 mg/100g for samples 201 (control=100% rice) and 206 respectively in the same trend observed in vitamin B1. Vitamin B_3 values ranged from 0.28 to 0.72mg/100g in the same trend as observed in vitamins B1 and B2. Significant differences ($p<0.05$) existed amongst the vitamins analyzed. The Pro-vitamin A **(**carotene) content of the Tom Brown ranged from 4.84 to 15.44 mg/100g and increased with the increase in the proportion of pearl millet and soybean.

Table 4: Vitamin Composition of Breakfast Meal (Tom Brown) (mg/100g)

Samples	Vitamin B_1	Vitamin B_2	Vitamin B_3	Pro-vitamin A(Carotene)
201	0.16^{f}±0.00	0.08^{f}±0.00	0.28^{e}±0.01	4.84^{f}±0.02
202	0.24^{e}±0.00	0.17^{e}±0.01	0.43^{d}±0.01	13.14^{e}±0.03
203	0.34^{c}±0.02	0.20^{d}±0.00	0.61^{b}±0.01	13.81^{e}±0.01
204	0.39^{b}±0.01	0.23^{c}±0.00	0.64^{b}±0.01	14.74^{C}±0.02
205	0.32^{c}±0.00	0.21^{d}±0.01	0.57^{c}±0.01	14.63^{d}±0.00
206	0.43^{a}±0.01	0.38^{a}±0.00	0.72^{a}±0.00	15.44^{a}±0.02
207	0.29^{d}±0.01	0.32^{b}±0.00	0.71^{a}±0.02	15.15^{b}±0.04

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscript are significantly different ($p<0.05$).

Key:

201 = 100% local rice (control)
202 = 30% local rice: 60% millet: 10% pumpkin pulp
203 = 60% local rice: 30% millet: 10% pumpkin pulp
204 = 30% local rice: 50% millet: 10% pumpkin pulp: 10% soy bean
205 = 50% local rice, 30% millet, 10% pumpkin pulp, 10% soy bean
206 = 35% local rice: 40% millet: 10% pumpkin pulp: 15% soy bean
207 = 40% local rice: 35% millet: 10% pumpkin pulp: 15% soy bean

3.4. Sensory Properties of Tom Brown

The results of the sensory properties of the Tom Brown are presented in Table 5. There was no significant difference ($p>0.05$) recorded for taste, texture, and colour however, there was a significant difference ($p>0.05$) in aroma. The aroma was significantly ($p>0.05$) highest (7.16) in sample 201(100% rice, control) but was not significantly different from sample 202. Sample 204 had the least value (5.96) in terms of aroma of the Tom Brown. The results revealed that all the Tom Brown produced were generally accepted except for sample 204, which neither was liked nor disliked going by the 9-point hedonic scale.

Table 5: Sensory Properties of Breakfast Meal (Tom Brown)

Samples	Taste	Texture	Colour	Aroma	General Acceptability
201	6.12^{b}±1.69	6.76^{a}±1.94	6.36^{a}±1.78	7.16^{a}±1.31	6.48^{a}±2.14
202	6.40^{a}±1.83	6.32^{a}±2.01	6.68^{a}±1.52	6.88^{a}±1.36	6.60^{a}±1.61
203	6.88^{a}±1.33	6.76^{a}±1.42	6.60^{a}±1.47	6.32^{b}±1.28	6.48^{a}±1.56
204	6.24^{a}±2.31	6.20^{a}±1.71	5.88^{a}±1.96	5.96^{b}±1.93	5.84^{a}±1.99
205	6.68^{a}±1.57	6.28^{a}±1.84	6.24^{a}±1.67	6.48^{b}±2.35	6.48^{a}±2.00
206	6.00^{a}±1.61	6.52^{a}±1.81	6.28^{a}±2.21	6.20^{b}±1.58	6.64^{a}±1.52
207	6.72^{a}±1.65	6.40^{a}±1.78	6.04^{a}±2.26	6.68^{a}±1.40	6.96^{a}±1.67

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscript are significantly different ($p<0.05$).

Key:
201 = 100% local rice (control)
202 = 30% local rice: 60% millet: 10% pumpkin pulp
203 = 60% local rice: 30% millet: 10% pumpkin pulp
204 = 30% local rice: 50% millet: 10% pumpkin pulp: 10% soy bean
205 = 50% local rice, 30% millet, 10% pumpkin pulp, 10% soy bean
206 = 35% local rice: 40% millet: 10% pumpkin pulp: 15% soy bean
207 = 40% local rice: 35% millet: 10% pumpkin pulp: 15% soy bean

The moisture content of the samples were all at the safe level, which indicates the shelf stability of the products. The range of values for moisture content fall below the moisture content limit (14%) for shelf stable flours (Simsek, 2021). It was observed that the protein, fat, ash and fibre followed the same trend as they progressively increased as the ratio of pearl millet and soybean flours increased. This result showed that pearl millet, soybean are good sources of these nutrients. Previous studies have shown that soybeans are nutrient rich legumes characterized by their high-quality protein content (Adelakun et al., 2013; Chatterjee et al., 2018) and that pearl millet contains a significant amount of protein and minerals (Adéoti et al., 2017; Kulkarni et al., 2021). The high fat content as observed in Tom Brown samples with increase in the proportion of millet and soybean can be linked to a significant fat content naturally present in soybean and some amounts present in the endosperm of millets (Meghwal & Sahu, 2015; Kulkarniet al.,2021). The range of values (0.85 to 5.25%) recorded for fat content in this study is higher than values (0.07 – 2.56g/100g) reported by Anigo et al. (2009) for fat contents of commonly used complementary foods in North Western Nigeria. The result of the ash content followed the same trend as observed in the protein and fat contents of the Tom Brown as the proportion of pearl millet and soybean increased to 40 and 15% respectively. The mineral composition of a food is determined by the ash content and this further indicates that millets and soybean have significant mineral. The ash content of the samples was higher than the values (1.5-2.5%) reported by Mbaeyi (2005).The values of crude fibre were similar to the range of values (1.54-4.0%) reported by Mbaeyi (2005) for breakfast cereal produced from pigeon pea and sorghum. It is also worthy to note that the consumption of fibre improves digestion and it is useful in alleviating constipation (McKevith, 2004).The highest value of carbohydrate (79.44%) recorded for the control (sample 201) shows that rice is a good source of carbohydrate, which is not strange because millet and soybean contains low carbohydrate compared to rice. Previous study reported that rice is a very good source of carbohydrate, which makes it an important source of dietary energy (Ryan, 2011). Results recorded in this study for carbohydrate (61.51-79.44%) are similar to the results (67.80 -75.08%) reported by Bonsi et al.(2014) for carbohydrate content of complementary food produced from blends of orange fleshed sweet potato and roasted/fermented maize-soy mix.

The result of the minerals investigated followed a similar trend with that of the proximate composition. The results showed progressive increase in all the minerals evaluated with increase in the ratio of pearl millet and soybean increased. According to FAO (2001), calcium provides rigidity to the human skeleton and is essential for most metabolic processes in the human body. Interestingly, values of calcium (184.76- 234.65 mg/100g) obtained in this study was within the range of values (100.28 – 290.58 mg/100g) reported by Bonsi et al.(2014) for weaning food produced from orange fleshed sweet potato and fermented/roasted maize-soy meal. Lower calcium content value (137.05-156.34 mg/100g) was reported by Mbaeyi, (2005) for breakfast cereals made from sorghum and pigeon pea. However, the calcium content (184.76 to 234.65 mg/100g) of the Tom

Brown produced in this study was lower than the recommended calcium allowance of 400mg/day for infants between 7-12months and 500mg/day for children between 1-3years (FAO, 2001). The magnesium content (147.83 to 189.31 mg/100g) of the Tom Brown recorded in this study was higher than values (29.0-43.0 mg/100g) reported by Okafor and Usman (2013) for breakfast cereal produced from African yam bean, maize and coconut. They are also higher than the range of values (110-153mg/100g) reported by Dimaria et al. (2018) for magnesium content of cereal-based blends of complementary foods with added premixes sold in some selected low- and middle-income countries in Africa. Magnesium is a cofactor of many enzymes involved in the maintenance of the electrical potential in the nerves, in energy metabolism and in the synthesis of RNA, DNA and protein (FAO, 2001; Adeyeye and Agesin, 2007). The highest value obtained for iron (5.28 mg/100g) was observed in Tom Brown samples produced from 40% pearl millet and 15% soybean which is an indication that both pearl millet and soybean have higher iron content than rice. The values obtained in this study were higher than values (0.45-1.10 mg/100g) recorded by Mbaeyi and Uchendu (2016) for breakfast cereals from blends of *acha* and fermented soybean paste. There was significant ($p<0.05$) increase in the sodium content as the proportion of millet and soybean increased.

The result of the vitamin content followed similar trend as the proximate and mineral content of the Tom Brown. The values of all the vitamins evaluated increased significantly as the proportion of pearl millet, pumpkin and soybean flour increased.

Vitamin B1(Thiamin) is a water-soluble vitamin essential in carbohydrate and amino acid metabolism (FAO, 2001). Being a micro nutrient, it is required in very minute amounts nonetheless. According to FAO (2001), Vitamin B_3 functions in reductive biosynthesis and in the oxidation of some sugars in the pentose phosphate pathways. Deficiency in vitamin A can result to irreversible blindness and can also impair growth in children (FAO, 2001).

The sensory properties of the Tom Brown showed that all the Tom Brown samples were generally accepted except for sample 204(30% local rice: 50% millet: 10% pumpkin pulp: 10% soy bean) which was neither liked nor disliked going by the 9-point hedonic scale. This is an indication that the Tom Brown samples produced in this study are not only nutritious, but also generally accepted. The results obtained from this study implies that generally accepted and nutritious breakfast meal can be produced from local rice,pearl millet, pumpkin pulp and soyabean This study did not assess the invitro-digestibility and glycemic index of the breakfast meal produced from these indigenous crops, however this can serve as area for further research.

4. Conclusion

Tom Brown has been regarded as a cereal-based complementary food produced basically from larger portions of cereals and lesser portions of legumes. This study has shown that acceptable and nutrient dense Tom Brown can be produced with inclusion of millet, pumpkin pulp and soybean. Its use has expanded and it has become not just a meal prepared and consumed at the household level, but also, can serve as an intervention measure in mitigating some forms of malnutrition especially in North-East Nigeria. The addition of millet, pumpkin pulp and soybean in this study were seen to have enriched the protein, ash, fiber and fat. More so, the high level of vitamins and minerals obtained from the samples deduced that the substitutions would go a long way to prevent malnutrition, dress the problem of deficiency of vitamins such as Pro vitamin A. Therefore, Tom Brown produced in this study can meet the Magnesium requirement (60mg/day) for children (1-3years old). On the other hand, they cannot be relied upon as the sole source of Magnesium for adult male (260mg/day) and female (220mg/day) but should be complemented by other Magnesium

sources.

The result of this study revealed a progressive increase of virtually all the chemical components evaluated, with increase in pearl millet and pumpkin pulp and soybean substitute, showing that they possess more of the nutrients comparable to the control (100% rice). From the results of this, it is therefore, suggested that substitution of millet and soybean for up to 40% and 15% respectively is the best to produce enriched Tom brown, Tom Brown can be consumed by all groups of people and not only children as seen in the responses from the sensory evaluation of this study in which virtually all the Tom Brown samples were generally accepted, Rather than using only rice flour (as used as control in this study) in any form, perhaps in the production of Two shinkafa as applicable in the Northern part of Nigeria or elsewhere, it is recommended that at household level, hotels and Food processing Units, that rice flour should be blended with millet and soybean to have a balanced diet, finally, Consumers at the level of families are by this study enlightened on the nutrient and health benefit of blending rice with meal and soybean.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Stella C. Ubbor designed the study, validated, supervised the work, wrote and typed the article. Rosemary I. Elekeh assisted in carrying out the sensory evaluation and edited the article. Data collection and preparation of products for sensory evaluation was carried out by Vanessa C. Ezeocha and Queen-Felicia N. Johan, Josephine I. Ekeh. Sample preparation for analysis was carried out by Oluwatoyin O. Ogunsola and Queen-Felicia N. Johan. The authors read and approved the final draft for publication.

Data Availability Statement

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

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