SENSORY QUALITIES AND PROXIMATE COMPOSITION OF *KOKORO* FORTIFIED WITH COWPEA AND CARROT FLOUR

Olawale Ogunyemi & Edwin Chigozie Nwokorie
Department of Hospitality Management,
The Federal Polytechnic Ilaro, Ogun State, Nigeria
Correspondence: olawale.ogunyemi@federalpolyilaro.edu.ng

Abstract

The study assesses the sensory qualities and proximate properties of *Kokoro* fortified with cowpea and carrot flour. Purposive sampling technique was used to select the taste panelists for the study. A 9-point hedonic rating scale was prepared and administered to respondents. Data was subjected to inferential statistics using SPSS version 23.0. Proximate analysis was carried out on the samples with Multiples Duncan Range method to separate the significant means. The analysis of variance (ANOVA) and multiple Duncan Range technique results revealed a significant difference (p 0.05) in the proximate. When the amount of cowpea flour was increased, the protein content rose from 15.20% to 23.03% and the ash percentage fell from 1.29% to 1.90%. With values ranging from 59.17% to 65.00%, 3.24% to 4.40%, and 2.23% to 2.96%, respectively, the amounts of carbohydrate, fat, and fiber decreased. The temperature and pasting time did not differ significantly ($p \geq 0.05$). With values ranging from 186.67 to 210.00 g/100 g, 163.33 to 195.00 g/mg, and 30.73 to 39.27%, respectively, the functional characteristics showed that water absorption, oil absorption, and foaming capacity considerably enhanced with an increase in cowpea flour (100% maize sample). The maximum dispersibility value was displayed (6.63%). Both the least gelatinization concentration and swelling capacity showed no significant difference ($p \geq 0.05$). Sensory results revealed that an increase in cowpea flour did not significantly alter the sensory parameters ($p \geq 0.05$). The study concludes that *Kokoro* should be fortified with cowpea and carrot flour in addition to the usual customary method to enhance the nutritional benefits. It is therefore recommended that locally grown crops should be processed and used in the production and fortification of flour for snacks production.

Keywords: Carrot, cowpea, *Kokoro*, maize, physicochemical properties.

Introduction

Traditional food commodities are gradually finding their way into the Nigerian food industry in recent time (Nwokorie & Ayogu, 2021; Nwokorie, 2017; Nwokorie, 2015). Specifically, the inhabitants of South Western Nigeria produce and consume *Kokoro* during the day, typically by themselves or with roasted groundnuts, and they frequently drink soft drinks or just water to go with it. It is manufactured with maize flour, which is mostly made up of carbohydrates. One of the traditional Nigerian snacks made from maize is called *Kokoro*. It lacks some critical amino acids, particularly lysine, and is high in carbohydrates compared to other dishes made from grain. All socioeconomic groups in Nigeria consume this regional food, which serves as an energy source for its consumers.

In Nigeria, maize is the fourth most important cereal after millet, sorghum, and rice, and ranks third in the world behind rice and wheat. It is the world's third-most important crop after rice and wheat. It also ranks fourth after millet, sorghum and rice in Nigeria FAO, (2019). It may be processed into a variety of foods and snacks and is a viable source of carbohydrates, and other essential nutrients. Some of the derivable products like Aadun (maize pudding of Yoruba origin), *Kokoro* (maize cake of Yoruba origin), and donkwa (maize-peanut ball of Hausa origin) are a few Nigerian local snacks made from maize. Notwithstanding their importance in providing protein and essential oil in the dietary intake of people in poor countries. Legumes are relatively small crops. As a source of human food, legumes are second only to cereals, and they give vegetarians a large portion of the necessary protein.

The main raw ingredient used to make various snack foods is maize (Zea mays). Despite the fact that maize products are healthy to eat, they lack some essential micronutrients (Olanipekun, 2015). A maize snack known in Western Nigeria is Kokoro, one of the popular indigenous snacks, and snack consumption in the country is on the increase (Ayinde et al., 2017). The amino acids lacking in the maize In terms of economics. The cowpea (Vigna unguiculata var. unguiculata) is a significant legume (Langyintuo et al., 2015). Aside from blackeye pea and southern pea, other names for cowpea include frijole, lubia, feijaocaupi, and niebe. Its ability to thrive in the hot, irregular rainfall conditions of Africa's Sahelian and Sudanian zones is one of its distinctive characteristics (Steele, 2019).

The Apiaceae family's most significant crop is the carrot (Daucus Carota L.). It is a root vegetable that is sold all over the world. The usage of carrots as food began after they were first used medically. Before the tenth century, carrots were planted in Europe, according to written documents. The flesh of carrot roots can be white, yellow, orange, red, purple, or an extremely dark purple tint.can be complemented with pulses such as groundnut, maize, and cowpea, which are better sources of lysine and tryptophan (Okaka, 2015). The comparatively low level of methionine and cysteine in legumes is to a large extent replaced by its higher proportions in most cereals. The valine and lysine content of soybean and those of groundnuts are high when compared with that of animal proteins (Okaka, 2015).

The original cultivars of carrots had yellow and purple flesh. During the 15th and 16th centuries in Central Europe, orange carrots were produced, which are more extensively consumed in recent times. With the innovation of orange carrots' high pro-vitamin A concentration, their acceptance grew rapidly (Simon, 2017). The two main pigments that act as antioxidants in carrots are carotenoids and anthocyanins. The type of pigments present determines the cultivar differences in carrots. The majority of cultivars with yellow and orange flesh include phytochemicals called carotenoids, which have yellow, orange, or red coloring. The regular orange carrot contains a lot of beta- and gamma-carotene and is a good source of provitamin A. Lutein, an essential component in preventing retinal degeneration, gives carrots their characteristically yellow color. (Dias, 2015).

Additionally, carrots contain a special blend of three flavonoids called kaempferol, quercetin, and luteolin. They include a lot of cinnamic acid derivatives as well as other phenols such as chlorogenic, caffeic, and p-hydroxybenzoic acids. Chlorogenic acid, a derivative of hydroxycinnamic acid, accounts for 42.2% to 61.8% of all phenolic chemicals found in various carrot tissues. Carrots contain bioactive polyacetylenes like falcarinol (also known as panaxynol) and falcarindiol. Falcarinol concentration in fresh carrots is influenced by the cultivar and water stress. The majority of the time, snack foods do not offer the body with enough nutrients in sufficient amounts (Omueti & Morton, 2016). This could be as a result of their composition or the manufacturing procedure they underwent.)

Regardless of the cause of the poor nutritional value, it is imperative that every food that is consumed provides the necessary nutrients in an acceptable quantity (Lui-ping, et al., 2015). This is especially true considering how several individuals prefer to work outside the home and how they are increasingly reliant on snacks to meet some of their daily nutritional needs. The creation of a highly palatable snack with superior nutritive value that could be helpful in dietary programs to treat underfeeding and dietary deficiencies is therefore important (Rosa et al., 2016).

There seem to be an increase in the production and consumption of snacks, most especially maize-based snacks, by children and other age groups as a result of urbanization. There equally seem to be an increase in the number of working-class women, mostly in Nigeria, leading to drastic reduction in the act of cooking meals for the family. This situation has caused an upsurge in consumption of snacks and ready to eat foods, thus the need to improve the nutritional content, add value and create varieties to snacks based meals.

The main goal is to assess the nutritional content of *Kokoro* made from maize, cowpea, and carrot flour. Additional goals include examining the effects of various processing variables on the physio-chemical, functional, nutritional, and sensory characteristics of flour blends and *Kokoro* made from maize, conducting a sensory assessment of *Kokoro* fortified with carrot and cowpea flour, and estimating the approximate composition of *Kokoro*.

Maize is the third most common and useful cereal globally next to rice and wheat and fourth after millet, sorghum and rice in Nigeria (FAO, 2019). Maize is the most essential cereal crop in sub-Saharan Africa (Akingbala et al., 2017). Generally and chemically, whole maize contains essential nutrients and amino acids requisite for good health and healthy growth for the underage (Szostek et al., 2021; Bressani, 1972).

Maize has numerous commercial importance that enhances food security and medicine. For example, maize is used in the production of ethanol, processing of livestock feed and other animal feed usage. In terms of domestic consumption, maize could be roasted, boiled, fried, or transformed into pulp through fermentation and used for neonatal feeding, and also used in the production of other traditional and non-traditional food products of the various Nigerian ethnic nationalities (Erenstein et al., 2022; Szostek et al., 2021; Shah et al., 2016).

Kokoro is one of the ethnic-based Nigerian food products manufactured from maize. *Kokoro* is popular in the Southwest region of Nigeria where a large proportion of the indigenous and non-indigenous residents consume it as a regular snack. The *Kokoro* snack is cereal-based and rich in carbohydrate with low in protein. However, the traditional *Kokoro* is deficient in other essential nutrients like protein and lysine enriching the food product is complementary in refining its dietary quality (Akinsola et al., 2020; Ewulo et al., 2017).

Food fortification involves the addition of essential nutrients to frequently consumed food products via the processing method to improve their nutritive value (Neufeld & Friesen, 2018). It is a demonstrated, nontoxic and cost-effective approach for enhancing food products, and for the prevention and control of nutritional deficiencies.

Food fortification is beneficial as it helps to minimize micro-nutrient deficiency. It improves dietary intake and nutritional status of an individual. Fortified food products are good at reducing the risk of various inadequacy that may arise from the deficiency in the nutritional supply and low-quality eating practice. The quantity of micronutrients supplied to the food is minute and all-around managed. In this case, the possibility of an overdose is unlikely and the fundamental attributes of the food such as the taste, appearance and the texture are unchanged.

Methodology

Source of Materials

Raw materials for the study were sourced domestically from the local markets in the Yewa Area of Ogun State, Nigeria. Materials used are samples of cowpea, improved varieties of yellow and white maize grains, and white maize (which is typically utilized by local farmers). Other items used for the study include the frying medium (vegetable oil), seasonings, salt, and onions. The tools used to create the samples are mixing bowls, frying spoons, gas cookers, plastic bowls, weighing scales, measuring spoons, spatulas, strainers, sieves, colanders, working tables, frying pans, knives. The study **w**as conducted at the HND kitchen of the Department of Hospitality Management at Federal Polytechnic Ilaro, Ogun State, Nigeria.

Production Method

The *Kokoro* was produced as described with a slight variation in the recipe as onion and salt were used in place of sugar and salt. The maize-lima beans were mixed thoroughly in various proportions as follows:

Winnowing
↓
Conditioning
↓
Drying Dry
↓
Milling
↓
Sieving
↓
Packaging
↓
Maize flour

Fig1: Flow chart for the procedure of Maize Flour

A paste was created by combining and stirring 100 g of each flour mixture with 400 ml of hot water. The remaining 100 g of each flour mixture was then mixed with 3 g of salt and 10 g of onion before being added to the paste and continuously agitated for about 3 minutes to create an identical dough. The dough was kneaded on a cutting board after being left to cool to 40°C. The kneaded dough was extruded into uniform diameters using a locally made extruder and deep fried at 80°C for around 10 minutes in heated vegetable oil with a specific gravity of 0.918;.The fried snack was drained and allowed to cool. The snack was later packed in polyethylene bags (100 µm gauge) and stored at ambient environments (24.2±3o C, 61±3% relative humidity).

Flowchart for Preparation of *Kokoro*

Cleaning
↓
Dry milling 100µm size mesh)
↓
Mixing maize flour with sugar and salt Boiling (5min)
↓
Cooling (40ºC)
↓
Kneading
↓
Shaping
↓
Frying
↓
Cooling
↓
Packing

Figure 2: Flow chart of Kokoro production

Recipe

Items	Quantity
Cornmeal	50g
Flour	100g
Salt	5miligram
Water	50g
Veg oil to deep fry	0.5 litre

Method of Preparation

All the dry ingredients were combined in a medium bowl. Water was added to a small pot and boiled to 100ºC, divided into two equal parts and set aside. While the water was boiling, one part of the dry ingredients was added and stirred. After one minute, the pot was removed from the heat to then let the mixture cool fully. After that, the remaining dry ingredients were combine with the mixture in the pot. The mixture was transferred to a work surface and kneaded until it forms a solid ball. Some quantity of the dough was taken and rolled with a long rolling pin. The process was repeated for the rest of the mix; oil was poured into a deep saucepan and allowed to heat. The dough were gently rolled into the hot oil and fried until they become golden brown. The fried *Kokoro* were transferred to a paper towel to drain off excess oil, and ready to serve.

Cowpea Flour

The outer layer of the cowpea was washed off, by hand, after soaking in clean water for about 15-20 minutes. The washed cowpea were spread in the sun (using a clean sac) on a single layer to dry. The spread cowpea were turned around, occasionally, to ensure every part of the product receives sufficient air and heat to make for quick drying. The cowpea were ground into flour, allowed to cool and sieved to separate chaff from flour.

Flow chart of cowpea flour production

Cowpea Seeds cleaning and sorting
↓
Cracking
↓
Winnowing
↓
Hulls out cotyledon
↓
Sieving
↓
Carrot flour

Fig 3: Flow chart for the production of cowpea flour

Method of preparation

The outer skin of the carrot should be washed and peeled. Cut the carrots as thinly as you can, spread them out on a wide platter, and bake for 5 to 6 hours, or until the sides begin to shrivel. The oven should be preheated for 10 minutes at 180 degrees Celsius. Sun-dried carrots should be heated in a warm oven for 10 to 20 minutes at 120 degrees Celsius. Keep an eye on the pieces; they must not become black and must still appear orange. To make fine "carrot flour/powder," grind the crunchy carrot pieces or slices in an electric mixer and sift. Keep chilled and store in an airtight container.

Flow chart for the production of carrot flour

Washing and peeling
↓
Cutting into cubes
↓
Water blanching
↓
Dehydration
↓
Grinding of cubes
↓
Sieving of powder
↓
Powder

Fig 4: Flow diagram for the production of carrot flour

Selection of Taste Panelists

The population of this study includes the academic staff, and Applied Science students of Federal Polytechnic Ilaro. The population that was used for this research work consists of 50 academic staffs and students of Federal Polytechnic, Ilaro. The sample size for the study was determined by a convenient sample technique, and the selection of 50 respondents who constituted the taste panelist for this research.

Sensory Evaluation

Data was collected using sensory evaluation sheet which was presented to the respondents. A hedonic scale prepared in a descending order (9,8,7,6,5,4,3,2,1) was completed by the taste panelist to determine the sensory attributes of samples of *Kokoro*. The attributes measured are; texture, aroma, appearance, color, taste, flavour and overall acceptability. Both primary and secondary sources were also employed in the data collection for this study. In order to get the essential data about *Kokoro*, primary data was gathered by distributing the sensory evaluation forms. The secondary data come from books and journals, respectively.

Data Analysis

The Statistical Package for Social Science (SPSS) version 23.0 was used to examine the information gathered from the taste panelists using the sensory rating questionnaire. Least significant differences (LSD) analysis ($p \leq 0.05$) was used to separate means and the analysis of variance was used to examine the significance of the difference in sample/treatment means. The degree of significance was calculated using the Multiple Duncan Range System, and the proximate composition was calculated using AOAC 2010 (Association of Official Analytical Chemist).

Results and Discussion

Below are the findings and an explanation of the data analysis. Utilizing descriptive statistics like mean and standard error, data were examined. Additionally, a 5% level of significance one-way analysis of variance (ANOVA), also known as a completely randomized design (CRD), was performed to determine whether there were significant differences between the treatments for each of the parameters. Statistical Package for Social Science (SPSS 20) was the statistical program used to help analyze the data. The findings of the analyses are listed below;

Table 1: Proximate composition of *Kokoro* fortified with cowpea and carrot flour

Samples	Moisture	Dry Matter	Fat	Ash	Crude Fibre	Crude Protein	Carbohydrate
A	76.36^{b}	23.64^{a}	3.62^{c}	1.66^{c}	7.89^{d}	6.72^{a}	8.75^{ab}
B	75.10^{b}	24.90^{c}	3.58^{d}	1.72^{b}	7.58^{a}	7.36^{a}	9.66^{a}
C	73.28^{a}	26.72^{a}	3.92^{a}	1.96^{a}	3.03^{b}	8.01^{c}	9.80^{a}
D	84.21^{b}	15.79^{c}	2.43^{a}	1.84^{a}	2.23^{d}	4.13^{a}	3.16^{ab}

Source: Field Survey, 2023
a, b, c, d mean values of the samples in the same columns are significantly different ($p \leq 0.05$)
***Note:** Proximate Results are in g/100g sample.*
Sample A: 100% maize flour
Sample B: 70% maize flour, 20% cowpea flour, carrot flour 10%
Sample C: 60% maize flour, 30% cowpea, 10% carrot flour
Sample D: 50% maize flour, 40% cowpea flour, 10% carrot flour

Formulation of Samples

The samples presented to the panelists were
A=100% maize flour
B=70% maize flour with 20% Cowpea and20% l0% of Carrot.
C=60% maize flour with 30% cowpea and 10% carrot
D=50% maize flour with 40% cowpea and 10% carrot

Table 1 reveals that sample A contains moisture content of 76.36g/100g, dry Matter content of 23.64g/100g, Fat content of 3.62g/100g, Ash content of 1.66g/100g, crude fibre content of 2.89g/100g, Crude protein content of 6.72g/100g, carbohydrate content of 8.75g/100g. Sample B contains moisture content of 75.10g/100g, dry Matter content of 24.90g/100g, Fat content of 3.58g/100g, Ash content of 1.72g/100g, crude fibre content of 2.58g/100g, Crude protein content of 7.36g/100g, carbohydrate content of 9.66g/100g. Sample C contains moisture content of 73.28g/100g, dry Matter content of 26.72g/100g, Fat content of 3.92g/100g, Ash content of 1.96g/100g, crude fibre content of 3.03g/100g, Crude protein content of 8.01g/100g, carbohydrate content of 9.80g/100g. Sample D contains moisture content of 84.21g/100g, dry Matter content of 2.23g/100g, Fat content of 2.43g/100g, Ash content of 1.84g/100g, crude fibre content of 2.23g/100g, Crude protein content of 4.13g/100g, carbohydrate content of 5.16g/100g. Sample E contains moisture content of 71.50g/100g, dry Matter content of 28.50g/100g, Fat content of 4.51g/100g, Ash content of 1.92g/100g, crude fibre content of 3.32g/100g, Crude protein content of 8.11g/100g, carbohydrate content of 10.84g/100g.

Sample D recorded the highest moisture content with 84.21g/100g, Sample C recorded the highest dry Matter content of 27.72g/100g and Fat content of 3.92g/100g, Sample C recorded the highest Ash content of 1.96g/100g, Sample C recorded the highest crude fibre content of 3.03g/100g likewise Crude protein content with 8.01g/100g and carbohydrate content of 9.80g/100g.

Sample D (*Kokoro* with 50% maize, 40% cowpea, and 10% carrot flour) recorded the lowest mean value (2.43) in terms of fat, and this was unconnected to the high concentration of cowpea in the sample in agreement with the findings of Ghosh and Konishi (2017). The relatively high concentration of cowpea in Sample D was responsible for the highest moisture content recorded (84.21), which agrees with the findings of Adeyemo et al. (2016).

Table 2: Sensory Evaluation of the *Kokoro* Samples Fortified with Cowpea and Carrot Flour

Samples	Appearance	Colour	Texture	Taste	Flavour	Aroma	Overall Acceptability	Binding Effect
A	7.09^{a}	7.07^{a}	8.99^{a}	7.01^{a}	8.07^{b}	8.30^{c}	8.11^{a}	8.41^{ab}
B	7.76^{a}	7.69^{a}	8.30^{a}	8.32^{a}	8.09^{d}	8.21^{c}	8.41^{a}	8.33^{b}
C	8.89^{b}	8.70^{b}	8.03^{a}	8.41^{a}	7.10^{a}	8.20^{d}	8.31^{c}	8.11^{a}
D	7.96^{c}	8.81^{a}	7.89^{a}	8.42^{b}	7.12^{a}	8.17^{d}	8.39^{a}	7.99^{b}

Source: Field Survey, 2023
a, b, c, d mean values in the columns are significantly different ($p \leq 0.05$)
Sample A: 100% maize flour
Sample B: 70% maize flour, 20% cowpea flour, carrot flour 10%
Sample C: 60% maize flour, 30% cowpea, 10% carrot flour
Sample D: 50% maize flour, 40% cowpea flour, 10% carrot flour

Table 2 shows the sensory evaluation result of the *Kokoro* snack which was enriched with cowpea and carrot flour. The result reflects the average responses with their respective mean values in terms of the various sensory attributes measured. The mean values of the responses ranged between 7.09-7.96 for appearance, 7.07-8.81 for colour, 7.89-8.99 for texture, 7.01-8.42 for taste, 7.12-8.07 for flavour, 8.17-8.30 for aroma, 8.11-8.39 for overall acceptability, and 7.99-8.41 for the binding effect. The difference in all the sample is significantly different.

In terms of the appearance, Sample C recorded the highest mean value (8.89), while the lowest value was seen in Sample A. Sample D has the highest mean value (8.81), and Sample A has the lowest (7.07) for colour. For texture, Sample A has the highest mean value (8.99) against Sample D with the lowest mean score (7.89), while Sample D topped the mean score for taste with the value of 8.42. For flavour attribute, Sample B has the highest mean score (8.09), with Sample C scoring the lowest (7.10) in that category. The attributes of aroma and overall acceptability have samples A and B leading with 8.30 and 8.41 respectively, while samples D and A scoring the lowest mean values respectively with 8.17 and 8.11. For the binding effect, Sample A has the highest score (8.41) while Sample D has the lowest with 7.99 mean score.

The highest mean value attributed to Sample A (*Kokoro* with 100% maize flour) for the binding effect agreed with the findings of Okaka (2015) stressing the thickening effect of starch which maize is rich in. Sample A also has the highest mean value for texture which was a result of the binding effect of starch, according to Fasasi and Omotayo (2018). Sample D has the highest mean value in relation to taste and overall acceptability in compliance with Adeyemo et al. (2016), that cowpea enhances the sensory attributes of taste and aroma when used for food fortification.

Conclusion

The conclusion of this research study, as is seen above, is that *Kokoro* should be fortified with cowpea and carrot flour in addition to the usual standard. To enhance the sensory attributes, nutritional value, and general acceptance. Cowpea and carrot flours are used to increase nutritional value, add value, and generate different kinds of *Kokoro*. It will allow for more cowpea use, resulting in the creation of both agricultural and industrial jobs.

Recommendation

- Local snacks should be fortified to improve their nutritional and dietary values
- Locally grown crops should be processed and used in the production and fortification of flour for snacks production.
- Local snacks should be fortified so as to enhance their sensory properties
- More researches should be carried out on or pertaining to fortification of snacks so as enrich them and substantiate their quality.

References

Abdel-Aal E.M., Young J.C., & Rabalski, I. (2016). Anthocyanin composition in black acceptability of *Kokoro* prepared from maize supplemented with Bambara nut, proceeding of 26th annual conference and general meeting of Nigerian Institute of Food Science and Technology, 2002.

Adeyemo, T.B., Abegunde, T.A., & Bolaji, O.T. (2016). Quality Evaluation of maize chips (*Kokoro*) fortified with cowpea flour. *Nigerian Food Journal 32, 94-104.*

Akinsola, O.T., Alamu, E.O., Otegbayo, B.O., Menkir, A., Maziya-Dixon, B. (2020). Evaluation of quality and acceptability of snack (Kokoro) produced from synthetic provitamin a maize (zea mays) genotypes. *Frontiers in Sustainable Food Systems, 4*. DOI=10.3389/fsufs.2020.576217

Ames-Jiang, Y.Z., & Wang, T. (2015). Phytosterols in cereal by-products. *Journal of the American Oil Chemists' Society, 82, 439-44.*

AOAC Official Methods (2015) Association of Official Analytical Chemists. (17th Ed) Washington, USA.

Bolade, M.K. (2018). Physical and organoleptic characteristics of non-sour '*Kokoro*' (a Nigerian maize-based snack) as influenced by flour particle size differential. *LWT - Food Science and Technology 87*, 287-92.

Ching, L.S. & Mohamed, S. (2016), Alpha-Tocopherol Content of 62 Edible Tropical Plants. *Journal of Agricultural and Food Chemistry, 49*, 3101-3105.

Darrah L.L., Mc-Cullen, M.D., & Zuba, M.S. (2018). Breeding, genetics and seed corn production, chapter two. In: PJ White, L.A *Johnson, eds. Corn-chemistry and technology. (2nd edn)* American Association of cereal chemist, Inc St.paul, Minesota, USA 35-68.

Donahaye, E., Navarro, S. & Calderon, M. (2016). Observations on the life-cycle of Caryedongonagra (F.) on its natural hosts in Israel, Acacia spirocarpa and A. tortilis. *Tropical Science. 8*(2), 85-89.

Erenstein, O., Jaleta, M., Sonder, K., Mottaleb, K., Jaleta, M., & Prasanna, B.M. (2022). Global maize production, consumption and trade: trends and R&D implications. *Food Secutiry, 14*, 1295–1319.

Ewulo, T. O., Oluwalana, I. B., Ewulo, B. S., & Awolu, O. O. (2017). Enrichment of traditional maize snack (Kokoro) with moringa (Moringa oliefera) leaf and soybean. *African Journal of Food Science, 11*(5), 140-145.

Fakorede, M.A.B. (2016). Revolutionizing Nigerian Agriculture with golden seed. Inaugural lecture series Obafemi Awolowo University press limited Ile-Ife Nigeria 82: 456-510.

Fasasi, O.S., & Omotayo, A. (2018). Physiochemical properties, vitamins, antioxidant activities and amino acid composition of ginger spiced maize snacks "*Kokoro*" enrich hed with soya flour. Department of Food Science and Technology, Federal University of Technology 4: 73-7.

Ghosh, D. & Konishi, T. (2017). Anthocyanins and anthocyaninrich extracts: Role in diabetes and eye function. *Asia Pacific Journal Clinical Nutrition 16*, 200-208.

Higgins, J.A. (2015). Resistant starch: Metabolic effects and potential health benefits. *J AOAC Int 87*, 761-768.

Horbowicz, M., Kosson, R., Grzesiuk, A. & Bski, H.D. (2018). Anthocyanins of fruits and vegetables: Their occurrence analysis and role in human nutrition. *Vegetable Crops Research Bulletin, 68*, 5-22.

Kopsell, D.A., Armel, G.R., Mueller, T.C., Sams, C.C., Deyton, D.E., et al. (2019) Increase in nutritionally important sweet corn kernel carotenoids following mesotrione and atrazine applications. *J Agric Food Chem 57*: 6362-6368.

Kumar D. & Jhariya, N.A. (2018). Nutritional, medicinal and economical importance of corn: A mini review. *Research Journal of Pharmaceutical Sciences 2*, 7-8.

Lauritzen, J.I. (2015). Development of certain storage and transit diseases of carrots. *Journal of Agricultural Research 44*: 861 -912.

Neufeld, L.M. & Friesen, V.M. (2018). Impact evaluation of food fortification programs: Review of methodological approaches used and opportunities to strengthen them. In: M.G. Venkatesh Mannar, Richard F. Hurrell. (eds). *Food Fortification in a Globalized World* (p 305-315). Academic Press.

Nwokorie, E.C. & Ayogu, C.A. (2021). Acceptability of selected indigenous rice for sale in local restaurants in Nigeria. *HATMAN Journal of Hospitality and Tourism*, *11*(1), 12-19.

Nwokorie, E.C. (2015). Food tourism in local economic development and national branding in Nigeria. *HATMAN Journal of Hospitality and Tourism*, *5*(1), 20-26.

Nwokorie, E.C. (2017). Acceptability of roast dioscorea rotundata with fortified gongronema latifolium sauce for consumption in Nigeria restaurants. *International Journal of Innovative Research and Advanced Studies, 4*(1), 27-33

Okaka, J.C. (2015). *Basic processing of garri cereals and legumes in handling, storage and processing of plants food.* OCJ Academic publishers, Enugu Nigeria 30-60.

Olapade, A.A., Oke, O.V., & Okafor, J.N.C. (2017). Consumer acceptability of *Kokoro* prepared from maize, supplemented with Bambara nut, proceedings of 26th Annual Conference and general meeting of Nigerian Institute of Food Science and Technology.

Oranusi, S. & Dahunsi, S.O. (2015). Preliminary study on hazards and critical control points of *Kokoro*, a Nigerian indigenous fermented maize snack. *Springerplus 4*, 253

Rose, R.A.C., Chavez-Jauregul, E.M., Mariam, E.S., & Pinto, J.A. (2018). Acceptability of snacks produced by extrusion of Amaranth and blend of chicken pea and bovine lung. *International Journal of food science technology 38: 795-798.*

Sade, F.O. & Aderonke, A.O. (2018). Physicochemical properties, vitamins, antioxidant active and amino acid composition of ginger spiced maize snack *Kokoro* enriched with soyflour a Nigerian based snack). Department of Food science and Technology 4: 73-7. 15.

Shah, T.R., Prasad, K., & Kumar, P. (2016) Maize – A potential source of human nutrition and health: A review, *Cogent Food & Agriculture, 2*:1

Simon, P.W. (2015) Domestication, historical development and modern breeding of carrot. *Plant Breeding Reviews*, *19*, 157-190.

Szostek R, Ciećko Z, Rolka E, Wyszkowski M. (2021) Content of Amino Acids in Maize and Yellow Lupine after Fluorine Application to Soil. *Agriculture*, *11*(11), 1120.