Journal of Biological Sciences and Bioconservation
Volume 10, Number 2, 2018
ISSN: 2277-0143

Nutritional Value of Instant Breakfast Cereal from Yellow Maize fortified with *Moringa Leaf*

Akintoye Mopelola O.[1] and Adeyanju Bridget E.[1]
Department of Home Economics,
Adeyemi College of Education, Ondo, Ondo State, Nigeria.
Email: mopelolaace@gmail.com

ABSTRACT

The research work determined the nutritional value of instant breakfast cereal from yellow maize fortified with moringa leaf. Yellow maize flour was mixed with moringa leaf powder at ratios of 90:10, 80:20 and 70:30 and the laboratory analysis was conducted at the microbiology laboratory, Federal University of Technology, Akure (FUTA), Nigeria. Findings from the study revealed that as the level of substitution of moringa oleifera leaves increased in the blend, the ash content, crude fibre content, protein content, carbohydrate content of the gruel increased. The calcium, magnesium, potassium and iron contents increased significantly as the moringa oleifera content of the flour blends increased. The calcium content of the flour blend with the highest percentage of moringa oleifera leaves (92.00±0.005) was highest. Moringa leaf powder substantially increased nutrient/energy density of 'ogi' and it could be added to 'ogi' up to ratio 70:30 as the preferred mix. The research revealed the great potential of Moringa oleifera leaf in the enhancement of 'ogi'. It was therefore recommended that sensitization should be made to the general public on the nutritional benefits of Moringa oleifera leaf.

Keywords: Yellow maize, Moringa leaf, instant breakfast cereal (ogi)

INTRODUCTION

Instant breakfast cereal is a processed food manufactured from grain and intended to be eaten as a main course serve with milk during the morning meal. Some require brief cooking, but these hot cereals are less popular than cold (ready to eat cereal). Ready-to-eat breakfast cereals were invented because of religious beliefs (Okafor and Usman, 2014). The first step in this direction was taken by the American clergyman Sylvester Graham, who advocated a vegetarian diet. Kellog invented a food he called granola from wheat, oats and corn that had been mixed, baked and coarsely ground. The most important raw material in any breakfast cereal is grain. The grain most commonly used are corn wheat, oats, rice and barley. They also contain other ingredients, such as salt, yeast, sweeteners, flavouring agents, colouring agents, vitamins, minerals and preservatives (William, 2014).

The word cereal derives from Ceres, the name of the Roman goddess of harvest and agriculture. A cereal is a grass (member of the monocot components of its grain botanically, a type of fruit called a caryopsis) composed of the endosperm, germ, and bran. Cereal grain are grown in greater quantities and provide more food energy worldwide than any other types of crop, they are therefore staple crops. In their natural form (whole grain) they are a rich source of vitamins, minerals, carbohydrates, fats and oils, and protein. When refined by the removal of the bran and germ, the remaining endosperm is mostly carbohydrate (Kalp, 2000). In some developing nations like Nigeria, grain in the form of rice, wheat, millet or maize constitutes a majority of daily substance.

The word maize derives from the Spanish form of the indigenous "Taino" word for the plant, maize. It is known by other names around the world (Bonavia, 2013). Maize or corn is a cereal crop that is grown widely throughout the world in a range of agro ecological environments. More maize is produced annually than any other grain. About 50 species exists and consist of different colours, texture and grain shapes and sizes. White, yellow and red are the most common types. The white and yellow varieties are preferred by most people depending on the region (IITA, 2009). Maize (*Zee mays* L.) is the most important grain crop in Nigeria and is produced throughout the country under diverse environments. Maize constitutes the third most important food crop in the world, following on the heels of wheat and rice (Sophie, 2006). Therefore, maize constitutes a fundamental ingredient in many of the world's cuisines, ranging from Mexican enchiladas and Chinese baby corn, to African-American grits, cornflakes, popcorn, Italian polenta or gruel, corn meal, maize based alcoholic beverages, mayonnaise and corn oil. Thus maize has more than demonstrated its cross-cultural adaptability, gastronic significance and culinary versatility. In developing countries, maize is consumed directly and serves as a staple diet for some 200 million people (Karl, 2010). Most people regard maize as a breakfast cereal. However, in a processed form, it is also found as fuel (ethanol) and starch.

Moringa Oleifera is the most widely cultivated species of the morningaceae, which are native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan (Fahey, 2005). This rapidly-growing tree (also known as the horseradish tree or drumstick tree), was utilized by the ancient Romans, Greeks and Egyptians. It is now widely cultivated and has

become naturalized in many locations in the tropics (Fahey, 2005). Moringa Oleifera tree has called the tree of life in many cultures around the world, including Nigeria. It has many names based on its many uses: clarifier tree, horseradish tree and drumstick (referring to the larger drumstick shape pods) and in East Africa, moringa is known as "mother's best friend". Here in Nigeria, its names include *ewe igbala* in Yoruba, *zogelle* in Hausa and *idagbo monoye* in Igbo (Fuglier, 2004). The leaves are the most nutritious part of the plant, being a significant source of vitamin B_6, vitamic C, pro-vitamin A as a beta-carotene, magnesium and protein, among other nutrients (Fahey, 2005).

Moringa is also actively cultivated by the world vegetable centre in Taiwan, a centre for vegetable research with mission to reduce poverty and malnutrition in developing countries through improved production and consumption of vegetables (Makkar, 2007). Moringa leaf is a tree that boosts energy in a natural manner, and is a remarkable source of the nutrition. This energy promotion does not happen because of sugar, so it last for a long time. Individuals ingesting it says that their ulcers are healed, tumours restricted, there are reduction in the arthritis pains and inflammations, controlled blood pressure, the skin problems are restored and finally, they have stronger defenses against diseases. Another property of the moringa leaf is its soothing ability because of which it can lower the blood pressure and promote good sleep. It can also purify water since, it has a detoxifying effect. Also, as a coagulant agent, moringa leaf can attach itself to hazardous bacteria and other materials, a process that is surmised to occur in the body too. The happy outcome is more sustained energy without any over activity balanced hormone

and gland system, controlled blood pressure and arrested nervous system.

The production and preparation of most instant cereals (particularly yellow maize gruel in this regard) give room to loss of important micronutrients especially the B-vitamins. This is as a result of the process of sieving the grinded cereals and the discarded portion after sieving which houses the micronutrients. On the other hand, the composition of moringa leaf have been shown to have significant quantities of vitamins A, B, C, Calcium and iron. The fortification of instant cereals with moringa leaf can therefore help to supply some of the nutrients that might have been lost during the production and preparation of cereal gruels.

Purpose of the Study

The major purpose of the study was to determine proximate composition and sensory evaluation of instant breakfast cereal from yellow maize fortified with moringa leaf in our daily intake. Specifically, the study:

- found out the nutritional composition (proximate and minerals) of yellow maize gruel fortified with moringa leaf
- found out the acceptability of yellow maize gruel fortified with moringa leaf among households in Ondo West Local Government Area of Ondo State.

METHODOLOGY

Materials: The yellow maize grains and *Moringa oleifera* leaf

Methods

Preparation of yellow maize gruel "ogi" (dried form): *Ogi* powder was prepared using a standard method. This method includes:

Soaking
↓
Washing
↓
Grinding
↓
Sieving

Procedure

Soaking: The corn was soaked in a large bowl for up to 2days, the water used for soaking was changed at an interval of 12 hours.

Washing: The corn was thoroughly washed with cold water repeatedly thrice.

Grinding: The corn was ground with a grinding machine until extremely smooth.

Sieving: Using a sieve (cheese cloth could be used alternatively), the purreed corn was ran in lots of water. This process separated the shaft. The shaft was discarded. The sieved corn was allowed to rest for over 1 hour until the solid part settled at the bottom. The excess water was poured out and the gruel was left to rest for over 2 days (for tartness). The surface water was changed at an interval of 12 hours. It was then cooked to stiffed gel called *agidi* or *eko* prior to consumption (Otunola, 2007).

Preparation of Moringa leaf Powder

This was done using the method of Beth and Lindsay (2005). This method includes:

Harvesting
↓
Air drying
↓
Milling

Procedure

Leaves with stems were harvested and brought to the laboratory; they were stripped off the stems and rinsed in clean water to remove dirt and germs. The leaves were air-dried in an area (shade) protected from direct sunlight to prevent the loss of vitamins e.g. vitamin A. when leaves became brittle and crush easily, it means the drying process is complete. Dried leaves were made into powder using a mortar and pestle. When the dried leaves have been transformed into powder, the power was sieved to remove any remaining stem.

Preparation of *ogi* and moringa leaf powder mixtures

Ogi (fermented) powder was added to *Moringa oleifera* leaf powder at addition levels of 90:10, 80:20 and 70:30 (i.e. *ogi*: moringa leaf powder). Each sample was thoroughly mixed together.

Chemical Analysis

Determination of Proximate composition:

Moisture Content Determination

This was done by the gravimetric method according to AOAC (2008). Weight of a previously washed and dried empty

evaporating dish was determined using a mettle balance as (W_1). 10g of the sample was weighed into the evaporating dish (W_2). The dish and sample was then placed in the oven and dried for 8hrs at 105°C. After drying, the dish and sample was then placed in the dessicator to cool to room temperatures after which it was then weighed. This process was continued until a constant weight was obtained, (W_3), (i.e., drying, cooling and weighing were done repeatedly at 30 minutes interval until a constant weight was obtained). The weight of the moisture was calculated and expressed as a percentage of weight of the sample analysed. This was given by the expression below:

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

where; W_1 = weight of empty evaporating dish

W_2 = weight of sample + evaporating dish

W_3 = weight of sample + evaporating dish after drying at 105°C

1. Ash Content Determination

This was done by the gravimetric method according to AOAC (2008). Weight of a previously washed and dried empty crucible was determined using a mettle balance as (W_1). 5g of the sample was weighed into the crucible (W_2). The crucible and sample were then placed in muffle furnace set at 550°C and was ashed for 4 hours. After ashing, the crucible and sample was then placed in the dessicator to cool to room temperatures after which it was then washed (W_3). The percentage ash content was then calculated thus:

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

where; W_1 = weight of empty crucible

W_2 = weight of sample + crucible

W_3 = weight of sample + crucible after ashing at 550°C

2. Fat Content Determination

The fat content was determined using the soxhlet type of the direct solvent extraction method. A previously dried empty extraction thimble was weighed (W_1). 3g of the sample was then weighed into the thimble and placed in a 500ml capacity soxhlet extractor apparatus (W_2). The extractor apparatus and condenser with the 500ml round bottom flask was then set up and mounted on a heating mantle. Light boiling range petroleum ether solvent (40-60°C) was then poured into the round bottom flask. The extraction was then continued for 6 hours until the sample was completely defatted. The thimble was then removed and placed in a hot-air oven and dried at 105°C for 1 hour. The thimble was then placed in a dessicator and allowed to cool to room temperatures before being weighed (W_3). The crude fat content was then calculated thus:

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

where; W_1 = weight of empty extraction thimble

W_2 = weight of sample + extraction thimble

W_3 = dried weight of defatted sample + extraction thimble

3. Crude Fibre Determination

This analysis was done using the AOAC (2008) method. About 26 of each of the defatted sample was weighed into a litre conical (W_1). 200ml of 1.25% sulphuric acid was the added and the content was then boiled for 30 minutes. This was then

filtered under vacuum followed by repeated washing with distilled water. The sample was then returned to the flask with the addition of 200ml of 1.25% NaOH solution. This was boiled for 30 minutes and filtered. The sample was thoroughly washed with distilled water followed by 10% HCl solution and further washing with distilled water to free the sample of any adhering acid. The sample was further treated with about 10ml of light boiling petroleum ether and 10ml of absolute ethanol. The sample was then scooped back into an empty crucible and placed in a hot-air oven set at 105°C to dry for about 1 hour. The sample was then placed in a dessicator and allowd to cool to room temperature and was weighed (W_2). This was later placed in the muffle furnace and ashed for about 90 minutes. The sample was then allowed to cool in a dessicator and was finally weighed as W_3. The loss of weight on incineration is the mass of crude fibre expressed thus:

% crude fibre = $\frac{W_2 - W_3}{W_2 - W_1} \; X \; \frac{100}{1}$

where; W_1 = weight of defatted sample

W_2 = weight of sample at 105°C

W_3 = weight of sample at 550°C

4. Crude Protein Determination

The protein content of the sample was determined by the micro-kjedhal method. About 0.30g of each sample was weighed into a 50ml micro kjedhal digestion flask. A tablet of copper sulphate catalyst and 5ml of concentration tetraoxosulphate (vi) acid (H_2SO_4) were added. The flasks were then placed on a digestion block and digested at low temperatures for about 30 minutes and the temperature increased to red hot in a fume cupboard for 2 hours until the samples became clear. The digests were transferred into a volumetric flask each. Each of the transferred digests was

diluted to 50ml with distilled water. 10ml of each digested sample was then measured into the distillation apparatus dilution with gradual introduction of 10ml of 40% NaOH solution. The mixture was distilled by steam-powered heat and the distillate collected into 5ml of 2% boric acid solution containing 3 drops of mixed indicator. 50ml of distillate from each duplicate was titrated with 0.01M HCl solution to a pink colour end point. The percentage nitrogen content in each sample calculated was multiplied with a factor 6.25 to get the percentage protein content.

Calculation:

$$\% \text{ protein} = \frac{\text{N.F X M X } V_1 \text{X PF X } 100}{V_2 \text{ X W}}$$

where: N.F. = nitrogen factor (0.014)

M = morality of HCl (0.01)

V_1 = final volume of digest (50ml)

V_2 = volume of digest used (10ml)

T = titre volume of distillate

W = weight of sample used

PF = protein multiplication factor (6.25)

5. Carbohydrate Determination

The total carbohydrate content of each sample was estimated by "difference". The sum of the percentage concentrations of each parameter of the other proximate compositions were subtracted from 100 i.e.

Total carbohydrate = 100 – (% moisture + % ash + % fat + % protein + % crude fibre).

Procedures for Determination of Minerals

The mineral content were analysed from the solutions obtained by first dry-ashing the sample. The ash in 10% (vol/vol) HCl, filtered and made up to the mark in a 100ml volumetric flask using distilled de-ionised water. Sodium and potassium were determined by flame photometry while calcium, magnesium and iron were determined by atomic absorption spectrophotometer (AAS) (AOAC, 2008).

1. Calcium and Magnesium Determination

Calcium and magnesium contents of the test sample were determined by the EDTA complexometric titration. 20ml of each extract was dispersed into a conical flask and 2ml of the masking agents, hydroxylamine and potassium cyanide solution were added followed by 20ml of ammonia buffer (pH 10.0). A pinch of the indicator salt of Eriochrome Black T was added and the mixture was swirled. It was titrated against 0.01M EDTA solution. A permanent blue colour was observed and the reading taken. Blank titration consisting of 20ml distilled water was also treated as described above.

Titration for calcium alone was repeated of the previous one with slight change, 10% NaOH solution as a pH 12.00 was used in a place of ammonia buffer while murexide was used as an indicator. The calcium and magnesium content was calculated using the formula below:

$$\text{Cal or Mg (mg/100g)} = \frac{100 \text{ X Ew X N X Vt X T}}{\text{W X 100 X Va}}$$

where: W = weight of sample used

Ew = equivalent weight of the sample

Vt = volume of extract titrated

N = normality of EDTA

T = titre value of blank solution

2. Potassium and Sodium Determination

The potassium and sodium of the sample was determined by flame photometric method. The instrument was set up according to the manufacture's instruction. The equipment was switched on and allowed to stay for about 10 minutes. The gas and air inlets were opened as the start knob was turned on. The equipment being self-igniting, the flame was adjusted to a non-luminous level until a blue colour was obtained. Meanwhile standard K and Na solutions were prepared separately and each was diluted to concentrations of 2, 4, 6, 8, 10 ppm. Starting with the least concentration of 2ppm, all the standard solution were sucked into an instrument and caused to spray over the non-luminous flame. The reading was recorded and later plotted into a standard curve and used to extrapolate to K level in the sample. After the standard, the beverage solutions were siphoned in turns into the instrument with their readings recorded. The samples were repeated in sodium standard. The concentration of the test mineral in the sample was calculated with reference to the curve and obtained as follows:

$$\text{K or Na (mg/100g)} = \frac{100 \times Vt \times X \times D}{W \times 10^3}$$

where: W = weight of sample used
Vt = total extract volume
X = concentration K/Na from the graph
D = dilution factor

3. Iron Determination

AOAC (2008) method was used to determine the iron content. 2ml of the test samples was weighed and first digested with 20ml of acid mixture (650ml conc HNO_3, 80ml perchloric acid (PCA) and 20ml conc. H_2SO_4) and aliquot of diluted clear

digest was diluted clear digest was used for atomic absorption spectrophotometer. The solution was heated until a clear digest was obtained. The digest was diluted with distil water to the 100ml mark, which now served as sample solution for atomic absorption spectrophotometer reading. A standard solution of iron was prepared to plot the calibration curve. The concentration of iron was calculated by extrapolation using the standard curve.

Fe (mg/100g) = $\frac{\text{Vt x X x 100 x D}}{\text{Va x } 10^3 \text{ x W}}$

where: Vt = total extract volume

Va = volume of digest used

X = concentration iron

W = weight of sample

D = dilution factor

Sensory Evaluation

Sensory quality was evaluated by fifty (50) panelist in Ondo West Local Government Area of Ondo State. The panelists were serve with gruels prepared from each of the samples and were asked to score the samples on a 7-point hedonic scale, where 1 represent dislike extremely and 7 represent like extremely respectively. Each sample was assessed for appearance, texture, aroma, taste and overall acceptability with the aid of questionnaire (Ihekoronye and Ngoddy, 2010).

RESULT AND DISCUSSION

1. Nutritional Composition (Proximate and Mineral) of yellow maize gruel fortified with moringa leaf

Table 1: Proximate Composition of Yellow Maize and Moringa Leaf Flour Blends

Sample	Ash	Moisture	Fat	Crude Fibre	Protein	Carbohydrate
A	1.95±0.037[a]	12.93±0.034[b]	3.10±0.006[c]	4.45±0.038[d]	16.21±0.006[a]	61.37±0.023[b]
B	2.54±0.034[b]	12.89±0.003[a]	3.29±0.009[d]	3.73±0.001[c]	19.02±0.004[b]	58.54±0.052[a]
C	3.47±0.007[c]	11.71±0.002[d]	3.45±0.007[a]	3.29±0.001[b]	20.26±0.006[c]	57.84±0.013[d]
D	1.54±0.007[d]	9.51±0.006[c]	3.93±0.003[b]	4.92±0.007[a]	12.91±0.009[d]	69.19±0.032[c]

Sample codes: -

A. 90% Yellow maize flour + 10% moringa leaf
B. 80% Yellow maize flour + 20% moringa leaf
C. 70% Yellow maize flour + 30% moringa leaf
D. 100% Yellow maize flour

Instant breakfast meals are breakfast manufactured in powdered form. They provide an easy way out of taking a long time in preparing breakfast and skipping meals in the morning. Breakfast, being one of the important meals in the day must be a nutritious one that will provide the body the required strength and mental alertness. The proximate composition of yellow maize gruel fortified with *moringa oleifera* leaves and control sample are presented in Table 1. As the level of substitution of *moringa oleifera* leaves increased in the blend, the ash content of the gruel increased. The ash content at 30% was highest (3.47±0.007 mg/kg) while that of 100% yellow maize (1.54±0.007 mg/kg) was lowest. The ash constituents include potassium, sodium, calcium and magnesium, which are present in larger amounts as well as

smaller quantities of aluminum, iron, copper, manganese or zinc, arsenic, iodine, fluorine and other elements present in traces. Ash content represents the total mineral content in foods. Although minerals represent a small proportion of dry matter, often less than 7% of the total, they play an important role from a physicochemical, technological and nutritional point of view.

Moisture content at 10% level of substitution of *moringa oleifera* leaves was highest (12.93±0.034 mg/kg). Compared to the control (100% yellow maize) the moisture content increased when *moringa oleifera* leaves was substituted at 10% then it gradually reduced to 11.71±0.002 mg/kg at 30% level of substitution. Low moisture content in complementary foods is very important to prevent nutrient losses and ensure adequate shelf life of the product as the removal of moisture generally increases concentrations of nutrients and make some nutrients more available (Amankwah, Barimah, Acheampong, Addai and Nnaji 2009). Increase in the moisture content of the blend as *moringa oleifera* increase could mean decrease in the shelf life. Studies have shown that moisture content in food products facilitate the growth of microorganisms, which in turns causes spoilage and low nutritional qualities of the food products (Udensi, Odom, Nwaorgu, Emecheta & Ihemanma, 2012; Oyarekua, 2013). The moisture contents were higher than the ones observed by Adeoti and Osundahunsi (2017) in *ogi*-fermented moringa seed flour. The higher moisture content observed may be due to the processing technique used (fermentation).

Substitution of *moringa oleifera* leaves in yellow maize gruel would not necessary improve the fat content of the gruel. The

fat content of the control (3.93±0.003 mg/kg) was highest followed by the fat content at 30% level of substitution. It was observed that, *moringa oleifera* leaves significantly reduced the fat content of the blend compared to the control. However, increasing the *moringa oleifera* leaves content from 10% to 20% and to 30% significantly increased the fat content. Similarly observations were made by Abioye (2015) and Ijarotimi and Oluwalana (2013). Although, high fat content is nutritionally advantageous because it can increase the energy level of a diet, however, it can reduce the shelf life and stability of the food product during storage since unsaturated oils are vulnerable to oxidative rancidity (Adebayo, Olatodoye, Ogundipe, Akande and Isiah, 2012).

Adding *moringa oleifera* leaves to yellow maize reduced the crude fibre content. The crude fibre content reduced by about 10% when *moringa oleifera* leaves was substituted (4.92±0.007 to 4.45±0.038 mg/kg). At 30% level of substitution, the crude fibre content of the blend had reduced by over 33% (4.92±0.007 to 3.29±0.001 mg/kg). Protein content in the gruel increased significant as the level of substitution of *moringa oleifera* leaves increased. The protein content was highest at 30% level of substitution in the blend (20.26±0.006 mg/kg). As infant food, the protein content of all the blends is within the range of 15% recommended by World Health Organisation (2001) for complementary food. One factor that could be responsible for the increase in protein content is fermentation. Fermentation improves the protein content and quality of food products (Fasasi, 2009). Increase in the protein content during fermentation of the seeds may be attributed to the net synthesis of enzymic protein by the germinating and

fermenting seeds (Inyang and Zakari, 2008).The protein content in the blends is comparable to 15% – 17% reported by Adeoti and Osundahunsi (2017) and 13% to 18% reported by Abioye (2015). The increase in the protein content of the blend on moringa leaf substitution is also a reflection of the report that moringa leaf is high in protein content.

A significant decrease was observed in the carbohydrate content of the blend as the *moringa oleifera* leaves content increased (61.37±0.023 mg/kg at 10%; 58.54±0.052 mg/kg at 20%; and 57.84±0.013 mg/kg at 30%). Carbohydrate is required in instant breakfast meals. It contributes to the bulk of energy of the meal and makes it high energy food and ideal for the growth (Agu & Aluyah, 2004). The carbohydrate content observed in the blends are comparable to that reported by Adeoti and Osundahunsi (2017) and Abioye (2015).

Table 2: Mineral Composition of Yellow Maize and Moringa Leaf Flour Blends

Sample	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Iron (Fe)
A	52.01±0.014^{b}	36.00±0.001^{a}	19.60±0.002^{d}	194.00±0.001^{c}	11.30±0.002^{b}
B	66.00±0.002^{a}	39.30±0.424^{b}	21.10±0.004^{c}	198.01±0.002^{d}	12.00±0.001^{a}
C	92.00±0.005^{d}	43.20±0.001^{c}	24.00±0.001^{b}	206.00±0.001^{a}	17.40±0.000^{d}
D	43.55±0.000^{c}	31.58±0.035^{d}	54.92±0.021^{a}	33.65±0.071^{b}	5.67±0.014^{c}

The calcium, magnesium, potassium and iron contents increased significantly as the *moringa oleifera* content of the flour blends increased. The calcium content of the flour blend with the highest percentage of *moringa oleifera* leaves (92.00±0.005) was highest. The same applied to all other mineral contents apart from sodium. The sodium in 100%

yellow maize was the highest. This finding is similar to that of Abioye (2015) that observed an increase in mineral content with increase in moringa leaves powder substitution in yellow-maize *ogi*.

Table 3: Evaluation of the sensory properties of moringa fortified yellow maize-*ogi* samples

Test	Sample A	Sample B	Sample C
Appearance	3.20	3.48	3.12
Colour	3.30	5.12	2.88
Texture	4.78	3.22	5.04
Aroma	4.96	3.28	4.74
Taste	5.18	5.04	5.22
Overall Acceptability	5.60	4.72	5.60

The result of the sensory evaluation of the yellow-maize and moringa leaves *ogi* samples is as shown in Table 3 revealed that the colour of the ogi sample with 20% *moringa oleifera* leaves was preferred. The texture and taste of *ogi* sample with 30% *moringa oleifera* leaves was preferred. Overall, *ogi* samples with 10% and 20% *moringa oleifera* leaves were preferred.

CONCLUSION

Given the world food crisis, the use of local resources like moringa is critical to reduce the dependence of developing countries on imported goods, and to improve nutrition among poor households. Moringa leaf is an extremely valuable source of nutrition for people of all ages. Addition of small amounts of moringa leaf powder will have no discernible effect on the taste, texture and overall acceptability of *ogi*. In this way,

moringa leaves will be readily available to improve nutritional intake on a daily basis. Fortification of yellow maize with moringa leaves to produce maize gruel (*ogi*) is possible and this will also enhance the nutritional content of the gruel.

REFERENCES

Abioye, V. F. (2015). Proximate composition and Sensory Properties of moringa Fortified yellow maize-ogi. *African Journal of Food Science Research, 3*(1), 155-159.

Adebayo, A. O., Olatodoye, O. P., Ogundipe, O. O., Akande, E., & Isiah, C. G. (2012). Production and quality evaluation of complementary foods formulated from fermented sorghum, walnut and ginger. *J Appl Biosci. 54,* 3901-3910.

Adeoti, O. A., & Osundahunsi, O. F. (2017). Nutritional characteristics of maize-based complementary food enriched with fermented and germinated *Moringa oleifera* seed flour. *International Journal of Food Science, Nutrition and Dietetics, 6*(2), 350-357.

Agu, H. O., & Aluyah, E. (2004). Production and chemical analysis of weaning food from maize, soybean and fluted pumpkin seed flour. *Nigeria Food J., 22*(1), 171-177.

Amankwah, E. A., Barimah, J., Acheampong, R., Addai, L. O., & Nnaji, C. O. (2009). Effect of fermentation and malting on the viscosity of maize-soyabean weaning blends. *Pakistan Journal of Nutrition, 8*(10), 1671-1675.

AOAC (2008). Official methods of analysis of the association of official analytical chemist. Official Methods of

Analysis. Washington, D.C: Association of Analytical Chemistry.

Beth, D., & Lindsay, C. (2005). Moringa leaf powder. http://www.echonet.org

Bonavia, D. (2013). Maize: Origin, domestication and its role in the development of culture. Cambridge: Cambridge University Press.

Fahey, J. W. (2005). Moringa oleifera: A review of the medicinal evidence for its nutritional, therapeutic and prophylactic properties. *Trees of Life Journal, 1* (2),

Fasasi, O. S. (2009). Proximate, antinutritional factors and functional properties of processed pearl millet (*Pennisetum glaucum*). *Journal of Food Technology, 73*(3), 92-97.

Fuglier, E. R. (2004). Nutritive composition of *ogi* fortified with moringa leaf powder. *Journal of Applied Sciences and Environmental Management, 8* (2), 23-28.

IITA (2009). The incorporation of nutritional goals in agricultural research in developing countries. *Benson Inst. Rev., 10*, 18-28.

Ijarotimi, O. S., & Oluwalana, I. B. (2013). Chemical compositions and nutritional properties of popcorn-based complementary foods supplemented with *Moringa oleifera* leaves flour. *Journal of Food Research, 2*(6), 117-132.

Inyang, C. U., & Zakari, K. K. (2008). Effect of germination and fermentation of pearl millet on the proximate,

chemical and sensory properties of instant *fura* a Nigerian cereal food. *Pakistan Journal of Nutrition, 7*(1), 9-12.

Kalp, K. (2000). Handbook of cereal science and technology. Corn hardness determination. *Cereal Chem., 6*(1), 147-150.

Karl, J. (2010). Maize: Day neutral plant. Relationship between protein content of corn and concentration of amino acids and nicotinic acid. *Cereal Chem., 31,* 217-228.

Makkar, A. D. (2007). Effects of dietary protein concentration on lactating cows. *Journal of Dairy Science, 24,* 235-245.

Okafor, K., & Usman, O. L. (2014). Production, chemical and sensory properties of *ogi* from different pearl millet varieties. *Journal of Biological Science, 3* (1), 103-106.

Otunola, O. K. (2007). The potential of upgrading traditional fermented foods through biotechnology. *African Journal of Biotechnology, 4*(5), 375-380.

Oyarekua, M. A. (2013). Comparative studies of co-fermented maize/pigeon pea and maize/mucuna as infants complementary foods. *Wudpecker Journal of Food Technology, 1*(1), 1-8.

Sophie, D. C. (2006). America's first cuisines. Austin: University of Texas press.

Udensi, E. A., Odom, T. C., Nwaorgu, O. J., Emecheta, R. O., & Ihemanma, C. A. (2012). Production and evaluation of the nutritional quality of weaning food formulation from

roasted millet and *Mucuna cochinchinesis. Sky Journal of Food Science, 1*(1), 1-5.

William, R. (2004). Amino acid supplementation of cereal grain flours tested in children. In N. S. Schrimshaw & A. M. Altschul (eds). *Amino Acid Fortification of Protein Foods* (pp. 184-204). Cambridge: Mass, USA, MIT Press.

World Health Organisation (WHO) (2001). Guiding principles for complementary feeding of the breastfed child. Washington DC.: Pan American Health Organization.

Reference to this paper should be made as follows: Akintoye Mopelola O. and Adeyanju Bridget E. (2018), Nutritional Value of Instant Breakfast Cereal from Yellow Maize fortified with *Moringa Leaf. J. of Biological Science and Bioconservation,* Vol. 10, No. 2, Pp. 86-108