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Proximate Analysis and Sensory Evaluation of Swallow Produced from Fortified Composite Flour of Millet (*Pennisetum Americanum*), Green Banana (*Musa Acuminate*), Ginger (*Zingier Officianale*) and Selected Vegetables for Elderly

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Abstract

This study analysed the proximate compositions and sensory characteristics of swallow produced from fortified composite flour of millet (Pennisetum americanum), green banana (Musa *acuminate*), moringa (Hyperanthera forssk), ginger (Zingier officianale) and scent leaves (Ocimum gratissimum) for the elderly. The study adopted the experimental design and the Optimal mixture design of Response Surface Methodology (RSM) was used. Flours were produced from green banana, millet, moringa, ginger and scent leaves. The flours were well-blended to produce the swallow. Proximate composition was carried out using Association of Official Analytical Chemists methods to determine the values for moisture, protein, crude fibre, fat and carbohydrate in the composite flour. Sensory evaluations were carried out using the nine-point Hedonic scale. The samples were fed to fifteen judges selected for the study who expressed their opinions on the hedonic scale of from 1 = like extremely to 9 = dislike extremely. Mean and standard deviation were used to analyse the data. The findings revealed the proximate composition of the fortified flour (A) and unfortified flour (B). Percentage for moisture showed 19.51 $^{b}\pm$ 0.160 (A); 20.47 $^{b}\pm$ 0.413 (B); Crude Fibre: 65.56 $^{b}\pm$ 0.000 (A), 21.96 $^{a}\pm$ 0.000 (B); Protein: 3.14 $^{c}\pm$ 0.106 (A); 4.28 $^{a}\pm$ 0.071 (B); Carbohydrate. Among the recommendations is that families should be encouraged to adopt the fortified swallow in order to solve some of the food problems of their aging population.

Keywords: Elderly, Fortified, Ginger, Swallow, Green Banana, Millet, Leafy Vegetables

Introduction

Dietary needs change with aging in several ways. For example, people become less active, their metabolism slows, their energy requirement decreases, all of which mean that they need to eat less or more (Palmore, 2008; Cappelli & Novelli, 2010). Research also shows that as individuals get older, theirabilities to absorb and utilize many nutrients become less efficient. Their nutrient requirements (particularly as a function of body mass) actually increase (Langford and Joshu, 2011). Thus there are positive and negative aspects of aging. Positive aspects include that one

gets more time to relax and enjoy life. Negative aspects are many health challenges, including an increase in digestive health disorders (Mert, 2015; Langford & Joshu, 2011).

Among the health challenges that older individuals face is indigestion (Lauritzen & Carlson, 2011). Problems with digestion can occur at any age, however, nearly about 40% of older adults have one or more age-related digestive symptoms each year in developing countries including Brazil, Nigeria and South Africa (Langley-Evans, 2015). Symptoms include difficult or painful bowel movements, infrequent bowel movements, and hard, dry stool (Bloom & Luca, 2016). There are a number of age-related factors that can cause constipation in older adults.Indigestion is a major concern for the older population (Odaman & Ibiezugbe, 2014). Changes in the digestive system occur more frequently at old age. The digestive system moves food through the body by a series of muscle contractions. Just like squeezing a toothpaste tube, these contractions push food along the digestive tract (Chuku, 2004). As the liver and gallbladder age, a number of structural and microscopic changes occur (Lauritzen & Carlson, 2011). The large intestine does not undergo much change with age (Marangoni, Giovannini & Poli, 2013).

For the purpose of this study, swallow is defined as food that is wholly swallowed without chewing. The foods are not swallowed wholly literally, but in portions. Generally a popular type of food in Africa, and Nigeria in particular, swallows are served with either stew, soup or sauces (Gozie, 2017). Swallows and soups are quite accepted in Nigeria. They could be combined with anyone of the many Nigerian soups as accomplices, and served as dinner or lunch in many parts of the country. It is so described because rather than chewing it, one has to *swallow it in bits called 'balls'*. Swallow is food category which is common among older populations (Olayiwola, Oganah, Ojo & Akande, 2013).

Most swallows in Nigeria are products of starchy foods such as cassava and cereals. For example, cassava flakes (*garri*) is a popular swallow that is generally accepted in many parts of the country, while *amala* (yam flour) is well-known in the western part of the country. The consumption of starchy or hard foods is major cause of indigestion in the elderly which is easily overlooked by household members (Babagana, 2018). Many older individuals many not be find satisfaction without consuming swallow after a long time, even if the family decides to limit the intake of swallows.

In Rivers State, Gozie (2017) noted that it is common to find individuals who are 60 years and above confronted with severe indigestion among cases in the hospitals, yet their food preference is swallows, hence, leaving families with the task of finding best swallows for this group of family members. While various intervention efforts focus on clinical methods, the role natural and local foodstuffs and herbs can play in providing mechanisms to manage indigestion is usually undermined (Gossard &York, 2019). Millet, native

banana, scent leaves, ginger and moringa possess unique nutrient bases for management of these problems (Bardach & Rowles, 2012). Although earlier studies(Giraud, 2018; Gozie, 2017) have focused on developing new recipes for managing different ailments in different groups of individuals, there is rising need to pay further attention to promotion of digestion amongst the elderly. As a result of this notion, this study focused on the development of fortified flour from local foodstuffs – millet (*Pennisetum americanum*) and green banana (*Musa acuminate*) with herbs – scent leaves (*Ocimum gratissimum*), moringa (*Hyperanthera forssk*) and ginger (*Zingier officianale*) as digestive mechanisms for sustainable health among the older population.

Local food can be defined by the distance between where the food was grown and where it is sold or consumed (Agbaire, 2011). However, the common definition used by the general population considers food "local" if it was grown within 100 miles or within the state (Ilbery, Watts, Simpson and Gilg, 2006). Local food can be defined by the distance between where the food was grown and where it is sold or consumed (Holloway, 2005). It is common knowledge that fiber is beneficial for good digestion. Soluble fiber absorbs water and helps add bulk to your stool. Insoluble fiber acts like a giant toothbrush, helping your digestive tract keep everything moving along (Lauritzen and Carlson, 2011). Soluble fiber is found in oat bran, legumes, nuts and seeds, while vegetables, whole grains and wheat bran are good sources of insoluble fiber. A high-fiber diet has been linked to a reduced risk of digestive conditions, including ulcers, reflux, hemorrhoids, diverticulitis and IBS (Lehmann, 2003). Prebiotics are another type of fiber that feed your healthy gut bacteria. Diets high in this fiber have been shown to reduce the risk of inflammatory bowel conditions (Marangoni, Giovannini & Poli, 2013).

Green Banana (*Musa acuminate*) is a popular fruit worldwide due to its flavor, texture, nutritional value, and convenience of being easy to peel and eat (Long, Martin & Janson-Sand, 2010). It contains a lot of nutrients and minerals that are beneficial to health. Its vitamin C content, which is regarded as a familiar antioxidant, is 15% (Pedersen, 2005). Millets (*Pennisetum americanum*)are a group of highly variable small-seeded grasses, widely grown around the world as cerealcrops or grains for fodder and human food. This millet is known for its umpteen health benefits. Packed with the goodness of iron, protein, fibre, and minerals such as calcium and magnesium; the daily consumption or inclusion of this millet can work wonders. This nutrient dense millet has high fiber content, which can effectively help in losing weight (Agbaire, 2011). In a 100 gram serving, raw millet provides 378 calories and is a rich source (20% or more of the Daily Value (Long, Martin & Janson-Sand, 2010), DV) of protein, dietary fiber, several B vitamins and numerous dietary minerals, especially manganese at 76% DV (Pedersen, 2005). Raw millet is 9% water, 73% carbohydrates, 4% fat and 11% protein (Lehmann, 2003).

Scent leaves (*Ocimum gratissimum*) are essential type of vegetables that support digestion. Scent leaves contain appreciable quantities of fiber (5.16-15.86%), β-carotene (6,666.67-21,833.33RE), ascorbate (18.64-40.09mg), potassium (97.03-325.90mg), phosphorus (99.36-409.75mg) and calcium (234.30-279.71mg) (Lehmann, 2003), calcium, flavonoids, alkaloids and phytosterols, which have health promoting benefits. Scent leaf can help relief bloating and also help digest meals on time. It can also help with bowel evacuation.More so, ginger (*Zingier officianale*) is a popular ingredient in cooking, and especially in Asian and Indian cuisine. It has also been used for thousands of years for medicinal purposes (Idris, Ibrahim, Sufiyan & Oladipo, 2012). Consuming fruits and vegetables of all kinds has long been associated with a reduced risk of many lifestyle-related health conditions. At the same time, ginger also appears to have beneficial effects on the enzymes trypsin and pancreatic lipase, and to increase motility through the digestive tract. This suggests ginger could help preventcolon cancer and constipation (Pedersen, 2005).

Furthermore, Moringa (*Hyperanthera forssk*) offers a powerhouse of nutrients—it is high in fiber, protein, magnesium and potassium (Long, Martin & Janson-Sand, 2010). It contains more calcium than milk, more iron than spinach and more vitamin C than oranges. While the leaves contain most of the nutrition, the pods themselves are an excellent source of vitamin C, boasting 157% of the RDA (Lehmann, 2003).

Purpose of the Study

The main purpose of the study was to carry out proximate analysis and sensory evaluation of swallow produced from fortified composite flour of millet, native banana, moringa, ginger and scent leaves for the elderly. Specifically, the study:

1. analyzed proximate composition ofswallow produced from fortified composite flour of millet, native banana, moringa, ginger and scent leaves for the elderly
2. determined sensory characteristics of the swallow produced from fortified composite flour of millet, native banana, moringa, ginger and scent leaves for the elderly.

Research Questions

The study was guided by the following research questions:

1. What are proximate compositions of swallow produced from fortified composite flour of millet,native banana, moringa, ginger and scent leaves for the elderly?
2. What are the sensory characteristics of the swallow produced from fortified composite flour of millet, native banana, moringa, ginger and scent leaves for the elderly?

Materials and Methods

***Design of the Study*:** The study adopted the experimental design to analyse the proximate composition of the swallow. Optimal mixture design of Response Surface Methodology (RSM) was used for the experimental design.RSM explores the relationships between several explanatory variables and one

or more response variables (*Atkinson, Donev & Tobias, 2017*).The purpose of mixture experiments is to explore the optimum blends of mixture components, which will provide desirable response characteristics in finished products.

Materials: The raw materials – Native banana, millet, moringa, ginger and scent leaves were purchased from the popular Mile III market in Port Harcourt, and taken to the Department of Home Economics Laboratory in Ignatius Ajuru University of Education.

Preparation of Materials (Flours): The method of Rita and Sophia (2010) was used. The Native banana, millet was washed in salt water to remove dirt, and microbes. After washing, they were sliced into pieces, sun-dried and thereafter ground into flour. Millet grains were thoroughly picked to remove dirt, insect, dust, excretal, feathers, stones and admixture of other food grains. The cleaned mill were then ground into fine flour.

Ginger, moringa and scent leaves were washed in salt water to remove dirt and sliced into pieces. Subsequently, all the materials were freeze-dried (general purpose freeze dryer, FD-1C-55, Boyikang experimental instrument Co., Ltd, Beijing).

Preparation of the Samples (Composite Swallow Flours)

Recipe: Native banana flour (100g); Millet flour (130g); ginger flour (20g); moring flour (20g) and scent leaves flour (20g).

Procedure for Preparation: Composite flour comprising native banana flour, millet flour, ginger, moringa and scent leaves flours was prepared by mixing the flours thoroughly until they were properly blended and a very smooth texture was obtained. This was done with the use of the Classic Mixing Machine.

Packaging*:* The flour was packagedusing density polyethylene (LDpt), aluminum foil, plastic plates were purchased from the popular Mile III market in Port Harcourt and used to properly package the swallow.

Chemicals/Proximate composition: This was carried out using Association of Official Analytical Chemists (AOAC, 2005) methods in order to determine the percentages of moisture contents, protein, crude fibre, fat and carbohydrate in the composite flour.

Bulk density (BD): Bulk density was estimated by method described by Maninder *et al.*, (2007). The flour samples were gently filled into 10 ml graduated cylinders. The bottom of each cylinder was tapped gently on a laboratory bench several times until diminution of the sample level ceases after filling to the 10 ml mark.

Water absorption capacity (WAC): Water absorption capacity was determined using the procedure of Sathe (2002a). One gram of the sample was mixed with 10 ml distilled water for 5 min on a magnetic stirrer. The mixture was centrifuged at 3500 rpm for 30 min and the volume of the supernatant noted.

Oil absorption capacity (OAC): One gram of sample was weighed, 10 ml of vegetable oil of a known density (0.99 mg/ml) was added to the sample and the mixture stirred on a magnetic stirrer at 1000 rpm for 5 min. The mixture was centrifuged at 3500 rpm for 30 min and

the supernatant removed and measured with 10 ml measuring cylinder (Sathe and Salunkhe, 2002).

Gelation properties: Gelation properties of composite flour were evaluated using the method of Sathe, (2002b).

Swelling index: This was determined as the ratio of the swollen volume to the ordinary volume of a unit weight of the flour. The method of Abbey and Ibeh (1988) was used.

Sensory evaluation*:* Sensory evaluation was carried out on the samples. A nine-point Hedonic scale andAnalysis of variance (ANOVA) was used.

***Selection of panel of judges*:** The nine lecturers in the Department of Home Economics and six elderly non-academic staff (retired staff who were on contract appointments) of the Ignatius Ajuru University of Education, Port Harcourt were used as the judges for the evaluation.

***Instrument for Data collection*:** Instrument for data collection was a9-point hedonic scale. It is standard tool for sensory evaluation with ratings from 1 = like extremely to 9 = dislike extremely.

***Method of Data Collection*:** Data for this study was collected using direct contact approach. The samples were fed to the participants, and they were expected to express their opinions on the hedonic scale of from 1 = like extremely to 9 = dislike extremely.

Method of Data Analysis: Mean and standard deviation values were used to analyze the data.

Findings

Research Question 1: What are proximate composition of swallow produced from fortified composite flour of millet, native banana, moringa, ginger and scent leaves for the elderly?

Table 1: Proximate composition of the fortified flour developed

Sample	Moisture	Fat	Ash	Crude Fibre	Protein	Carbohydrate
	(%)	(%)	(%)	(%)	(%)	(%)
A	19.51 $^{b}\pm$ 0.160	3.48 $^{b}\pm$ 0.085	21.26 $^{ab}\pm$ 0.049	65.56 $^{b}\pm$ 0.000	3.14 $^{c}\pm$ 0.106	12.07 $^{a}\pm$ 0.120
B	20.47 $^{b}\pm$ 0.413	23.37$^{b}\pm$ 0.028	2.02 $^{b}\pm$ 0.092	21.96 $^{a}\pm$ 0.000	4.28 $^{a}\pm$ 0.071	17.91 $^{b}\pm$ 0.318

Values are means + standard deviation of three determinations. Values on the same row with different superscripts are significantly different ($p < 0.05$). Key: A = Fortified; B = Unfortified

Table 1 reveals the proximate composition of the fortified flour (A) and unfortified flour (B). Percentage for moisture showed 19.51 $^{b}\pm$ 0.160 (A); 20.47 $^{b}\pm$ 0.413 (B); Fat: 3.48 $^{b}\pm$ 0.085 (A); 23.37 $^{b}\pm$ 0.028 (B); Ash**:** 21.26 $^{ab}\pm$ 0.049 (A); 2.02 $^{b}\pm$ 0.092; Crude Fibre**:** 65.56 $^{b}\pm$ 0.000 (A), 21.96 $^{a}\pm$ 0.000 (B); Protein: 3.14 $^{c}\pm$ 0.106 (A); 4.28 $^{a}\pm$ 0.071 (B); Carbohydrate: The crude fibre and protein contents of the sample were significantly ($p < 0.05$) different, 12.07 $^{a}\pm$ 0.120 (A), 17.91 $^{b}\pm$ 0.318 (B). The proximate content of the fortified and unfortified samples were significantly ($p < 0.05$).

Table 2: Vitamins composition of the fortified flour developed

Samples	Vitamin A	Vitamin B1	Vitamin B2	Vitamin C	Vitamin E
A	7.71^{c}±0.01	2.04^{a}±0.00	4.11^{a}±0.14	18.94^{d}±0.01	13.07^{e}±0.01
B	2.04^{a}±0.01	0.05^{a}±0.01	1.16^{a}±0.20	5.51^{c}±0.01	4.17^{b}±0.01

Table 2 revealsthe Vitamins composition of the fortified and non-fortified swallows. According to the table, it was revealed that the fortified (A) flour vitamins content ranged between 7.71^{c}±0.01 and 18.94^{d}±0.01, while the unfortified (B) sample ranged between 0.05^{a}±0.01 and 5.51^{c}±0.01.It shows that the sample is richest in Vitamin E while the least was Vitamin B1.

Table 3: Mineral compositions of the fortified flour

Samples	Calcium (100g)	Magnesium (100g)	Iron (100g)
A	4.25^{b}± 0.002	4.00 ^{a}± 0.001	4.48^{b}± 0.003
B	1.50^{a}± 0.002	3.50^{c}± 0.001	3.36^{c}± 0.002

Values are means ± standard deviation of triplicate samples. Mean values bearing different superscripts in the same column differ significantly ($p < 0.05$).

Table 3 reveals the mineral composition of the fortified swallow sample. According to the results, the fortified (A) flour contained higher minerals than the unfortified (B). The scores ranged from 4.00 ^{a}± 0.001 (magnesium 100g) to 4.48^{b}± 0.003 (iron 100g), while the non-fortified had between 1.50^{a}± 0.002 to 3.50^{c}± 0.001 respectively.

Research Question 2: What are the sensory characteristics of the swallow produced from fortified composite flour of millet, native banana, moringa, ginger and scent leaves for the elderly?

Table 4: Sensory Evaluation the fortified flour developed

Sample	Colour	Appearance	Texture	Taste	Flavour Overall	Acceptability
A	7.00 ^{a}± 1.690	7.00 ^{a}± 1.558	7.73 ^{a}± 1.163	8.07 ^{a}± 0.884	9.27 ^{a}± 1.280	11.40 ^{a}± 1.454
B	1.33 ^{a}± 1.543	2.27 ^{a}± 1.163	7.67 ^{a}± 0.976	2.13 ^{a}± 0.743	4.00 ^{a}±1.000	2.40 ^{a}± 1.242

Values are means + standard deviation of three determinations. Values on the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 4 reveals the sensory evaluation of the fortified and unfortified samples of the flour. The results showed that the fortified flour (A) had higher level of overall acceptability (11.40 ^{a}± 1.454) while the unfortified had(2.40 ^{a}± 1.242). However, the flavour had the highest score at 9.27 ^{a}± 1.280 (fortified) and 4.00 ^{a}±1.000 (unfortified), while appearance had the lowest score at 7.00 ^{a}± 1.558 (fortified).

Discussion of the Findings

Table 1 above revealed the proximate composition of the fortified flour (A) and unfortified flour (B). Percentage for moisture showed 19.51 ^{b}± 0.160 (A); 20.47 ^{b}± 0.413 (B); Fat: 3.48 ^{b}± 0.085 (A); 23.37 ^{b}± 0.028 (B); Ash**:** 21.26 ^{ab}± 0.049 (A); 2.02 ^{b}± 0.092; Crude Fibre**:** 65.56 ^{b}± 0.000 (A), 21.96 ^{a}± 0.000 (B); Protein: 3.14 ^{c}± 0.106 (A); 4.28 ^{a}± 0.071 (B); Carbohydrate: The crude fibre and protein contents of the sample were significantly ($p < 0.05$) different, 12.07 ^{a}± 0.120 (A), 17.91 ^{b}± 0.318 (B). The crude fibre content of scent leaves and moringa are generally high hence the high content in the fortified swallow. The consumption of these leaves could aid digestion, absorption of water from the body, bulk stool and prevents constipation (Herro, 2006). The leaves may therefore be very useful in the control of body weight, reduction of serum cholesterol level, hyperten-sion, diabetes, breast cancer, constipation and protection against colon cancer (WHO, 2009).These findings are supported Sathe's (2002a) report which identified moringa, scent leaves and unripe banana as combinations that are ideal for the aging populations.

The lower content of moisture in the fortified swallow shows that the food has a long shelf life; that is it will be better preserved. Gregor (2008) noted that low moisture increases longevity of food products. The crude protein value of the swallow revealed that the formulated samples had higher protein content than the unfortified. This is arguably because of the presence of millet which has good amount of protein (Hero, 2006). Protein is an essential macronutrient for proper development of persons, Sathe (2002a) recommended minimal amounts of protein for the elderly. It plays a vital role such a tissue replacement and deposition of lean body mass. The high ash content of the fortified sampleindicates that it is good source of mineral (Lehmann, 2003). Minerals are important to the proper functioning of many body processes especially in adulthood. They are necessary players in nervous system functioning, easy digestion, other cellular processes, water balance, and structural (e.g. skeletal) systems (Langley-Evans, 2015). These increases in protein, fibre and ash (minerals) therefore, agree with the suggestions made by Lehmann (2003) and Hero (2006) that protein and micronutrient malnutrition in Nigeria could be resolved with cheap locally available raw materials.

Table 2 above revealed that the fortified (A) flour vitamins content ranged between 7.71^{c}±0.01 and 18.94^{d}±0.01, while the unfortified (B) sample ranged between 0.05^{a}±0.01 and 5.51^{c}±0.01. These findings are significant for healthy living among the elderly. The vitamin compositions of scent

leaves, moringa, native banana are essential normal functioning. Since vitamin C (ascorbic acid) promotes the health of teeth and gums, lungs and bronchia, and joints, aids the purification of blood (Gregor, 2008), its (ascorbic acid) presence in the leafy vegetables more especially in moringa leaf with the highest vitamin C content suggests that its consumption and use in herbal medicine can prevent common cold and other diseases like prostate cancer (Herro, 2006).Moringa has almost every important mineral and vitamin for healthy digestion. It is loaded with Vitamin A, C, & D, and it contains several B-vitamins as well (Moore, 2006).In addition, Moringa contains over 40 anti-inflammatory compounds that reduce bloating, gas, and constipation (WHO, 2009).

Table 3 above revealed that the fortified (A) flour contained higher minerals than the unfortified (B). The scores ranged from $4.00^{a}\pm 0.001$ to $4.48^{b}\pm 0.003$ (A) and $1.50^{a}\pm 0.002$ to $3.50^{c}\pm 0.001$ respectively. It contains a lot of nutrients and minerals that are beneficial to health. Its vitamin C content, which is regarded as a familiar antioxidant, is 15% (Pedersen, 2005). Native bananas are usually harvested before being fully mature for domestic consumption. It is found that this *Musa acuminate* contains high fiber, protein and acid insoluble ash when compared to other variety of bananas (Lehmann, 2003).

From the sensory evaluation of the fortified and unfortified samples of the flour, the results showed that the fortified flour (A) had high level of acceptability. The high level of acceptability could be as a result of the lack of additives comprising chemical agents. The preparation was purely natural, and had a natural taste that is appealing. This observation could also be attributed to the result of the smooth blending of the composite flours. Since the fortified samples compared better than the unfortified and were liked slightly and moderately too by the panellists, then feeding aged persons with the food from this study from cheap locally raw materials could cause improvement in their development and digestion challenges (Langley-Evans, 2015).

Conclusion

This study has revealed the proximate compositions and sensory characteristics of swallow produced from fortified composite flour of millet, native banana, moringa, ginger and scent leaves for the elderly with digestion challenges. The high content of crude fiber, vitamins and minerals, as well as low protein and carbohydrates makes the fortified flour ideal for consumption among the elderly for sustainable health. The study also revealed that families can save money from expensive flours which may not be readily affordable. The utilization of local foodstuffs such as millet, native banana, scent leaves, moringa leaves and ginger has proven to be significant to achieving family food objectives.

Recommendations

Based on the findings of the study, the following recommendations were made.

1. The production of the fortified flour from local food crops and spices should be encouraged by stakeholders and government.
2. The elderly and general population should be sensitized on the nutritious significance of the fortified flour.
3. Families should be encouraged to adopt the fortified swallow in order to solve some of the food problems of their aging population.

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