Proximate Composition And Organoleptic Properties Of Whole Wheat Biscuit Fortified With Moringa (*Moringa oleifera*) Leaf Powder

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Abstract- Fortification of biscuit was carried out by blending wheat flour with moringa leaf powder on 1:10 (w/w) ratio. The moringa wheat flour biscuit (MWFB) was evaluated for proximate composition and organoleptic appeal against biscuit produced from wheat flour (WFB). Results show that addition of moringa leaf powder marginally ($p>0.05$) increased the moisture content of biscuit from 15.90 to 16.01%, ash from 3.75 to 4.09%, protein from 11.14 to 11.47%, and significantly ($p<0.05$) increased the fiber from 0.71 to 1.28%. There was marginal ($p>0.05$) decrease in carbohydrate from 49.38% in (WFB) to 47.80% in MWFB. Sensory results show that (WFB) was significantly ($p<0.05$) superior in color with 7.95 compared to the 6.70 of MWFB. The MWFB significantly ($p<0.05$) excelled in texture with 7.5 compared to the 7.25 of the WFB, and in taste (7.85) against 7.40. The general acceptability score (8.0) of the MWFB was significantly ($p<0.05$) higher than the 7.50 of WFB. The results suggest that moringa leaf powder can be used to improve nutritional and sensorial qualities of biscuits.

Index Terms- Moringa, wheat, biscuits, sensory, blending, nutrition

I. INTRODUCTION

Biscuits are flour-based snacks usually sweetened to delight of the younger age. However, certain brands with little or no sugar are produced to meet age or health requirements. Biscuits are made with baking soda or powder as a chemical leavening agent rather than yeast (Alan, 2008). Biscuits are ideal for their nutritive value, palatability, compactness and convenience (David, 2003). Since they have low moisture content than cakes and bread, biscuits are generally safer from microbiological spoilage, and hence have long shelf life. Owing to appealing sensorial and textural characteristics, ready-to-eat convenience as well as cost advantage, biscuits have always be one of the most popular snacks across the globe. Biscuits are traditionally baked from wheat flour, though other flour sources have been recently employed.

Composite flours derived from more than one agricultural material, with the intention to improve the functional and nutritional properties are increasingly experimented. Biscuits are fortified to deliberately increase the content of desired macro or micro nutrients such as proteins, fiber, vitamins, minerals (including trace elements), with the expected public health benefits. Plants with high pytochemical reserves such as moringa can be a potential fortifier. Herbal biscuits are made by incorporating *Morina oleifera* leaf powder in a mixture of whole wheat flour, vegetable oil, baking powder, skim milk powder, egg white, salt, water and other approved ingredients.

The moringa leaf powder is rich in protein, vitamins A, B and C, and a whole range of minerals. A 100g portion of fresh moringa leaf has 9.3g protein, 434mg calcium, 404mg potassium, 738µg vitamin A, and 164mg vitamin C (Olson, 2010). Moringa, with its over ninety (90) verifiable nutrients has significant portions of vitamins $B_{1,}$ B_2, B_3, D and E, polyphenols (antioxidants), minerals, fiber, and is one of the highest, naturally occurring sources of chlorophyll (Dada-Mouny, 2009).

Moring plant is totally edible and this presents a great advantage in many poor areas of Africa, where the leaves are important food supplements to fight and prevent malnutrition. Capalakrishnan et al. (2016) reported that leaves of *Moringa oleifera* fresh or dried are known to be excellent source of antioxidants and they have significantly higher antioxidant content comparing to fruits such as strawberries known for high antioxidant content. Saini et al. (2016) found that the relative bioavailability of folate from *M. Oleifera* leaves using rat model was very high (approximately 82%) suggesting that the *M. Oleifera* leaves can be a potential source of dietary folate.

The leaves have bioactive molecules which include carbohydrates, phenolic compounds, oils and fatty acids, proteins and functional peptides and have great potential to be used in several formulations of food products (Saucedo et al., 2018). Abioye and Fumilayo (2015) determined the proximate composition and sensory properties of moringa fortified maize-ogi. Oyeyinka and Oyeyinka (2016) reviewed the application of *Moringa oleifera* in food fortification. Bread fortification has been carried out using moringa seed powder (Bolarinwa et al., 2019). Hayat et al. (2018) reported enrichment of gluten-free bread with *Moringa oleifera* powder. Igbabul et al. (2018) evaluated the proximate, micro nutrient composition, physical and sensory properties of cookies produced with wheat, sweet detar and *moringa* leaf flour blends. Obichili and Ifediba (2019) studied the sensory acceptability of whole wheat bread fortified with moringa leaf powder.

Biscuits are generally eaten as snacks or used to abate hunger prior to main meal, regardless of age. Increasing supply of refined flour has adversely led to the increase in the supply of sugar used in the production of biscuits. As a result consumption of high sugar brands of biscuits is on the increase among the populace. This predisposes the consumer to high incidence of sugar-related diseases, obesity and other sassociated illness. Considering the numerous potentials of *Moringa oleifera*, this study is anticipated to provide a fortified biscuit in order to address the nutritional, sensorial and health inadequacies of some conventional biscuits.

II. MATERIALS AND METHODS

Source of Raw materials

The *Moringa oleifera* leaves were obtained from a commercial farm in Awgbu Town, Orumba Local Government Area of Anambra State in the South East Nigeria. The whole wheat flour and baking ingredients were procured from dealers at Eke Awka Market in Awka the capital city of Anambra State.

Preparation of moringaleaf powder

The moringa leaf powder was produced using the method described by Robert et al. (2008).

Briefly explained, the freshly harvested moringa leaves were detached from the stalks, washed, shade dried in a thin layer under mosquito net, with regular shuffling of the leaves at regular intervals for even and accelerated dehydration. This drying condition will keep away dust, prevent vitamin loss and retain natural color of moringa leaf. The dried leaves were reduced to powder in a motor driven burr mill and sifted through a fine screen to remove extraneous matters. The powder was packaged in cellophane and stored under room temperature until use.

Production of wheat flour biscuit (WFB)

Production was carried out in the Food Laboratory of Anambra State Polytechnic, Mgbakwu.

Equipment: Two chopping boards, two rolling pins, two large stainless steel bowls, two ceramic plates, two stainless trays, variable shape cutters and a triple deck gas oven.

Recipe: Approximately 1kg of whole wheat flour , appropriate volume of potable water, approximately 250g of fat, 2 cans of milk (148ml/can), 4 eggs, and sugar to taste.

Procedure: The whole wheat flour was sieved into the bowl and premixed with water. Fat was added and intimately incorporated to obtain a relatively coarse crumb before adding milk and eggs to bind and emulsify the mix. This was thoroughly knead to obtain a soft and smooth dough, which was rolled out on a chopping board. The rolling pin was employed to further smoothen and flatten the dough prior to cutting to desired shapes with the variable shape cutters. The cut dough were arranged on cookie sheets and moved into a pre-heated gas oven to bake under a close watch at 150±2 ^{o}C for about 22 min. The biscuits were removed from the oven and placed on a tray to cool before packing in cellophane bags and kept under room temperature until use.

Preparation of moringawheat flour biscuit (MWFB)

Equipment: As provided in the Food Laboratory for the production of the wheat flour biscuit.

Recipe: As in the production of the wheat flour biscuit with the exception of the moringa leaf powder added to fortify product.

Procedure: About 100g of the previously prepared moringa leaf powder was reconstituted in water in a mixing bowl into which 1kg of wheat flour and commensurate quantity of sugar were sieved in to premix. Other ingredients were incorporated and homogenized as in the production of the wheat flour biscuits. Dough working, cutting, baking, cooling, packaging and storage followed the same pattern.

III. PROXIMATE ANALYSIS OF SAMPLES

Moisture content determination

Moisture content of the samples was determined according to the gravimetric methods of AOAC (1995). Exactly 5g of test sample was measured into crucibles that have been earlier washed, dried in an oven at a temperature of 70-80°C for 2 h and weighed. The samples were dried in the oven at 105°C for 4 h. This was cooled in desiccators and weighed. It was returned to the oven for further drying, cooling and weighing at 30 min intervals repeatedly until a constant weight is obtained. The weight of the moisture loss was calculated and expressed as percentage weight:

$$\%\ \text{Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \ldots\ \ldots\ldots.\ .\ \ldots\ldots\ldots..\ \ldots\ldots\ldots\ldots.(1)$$

Where:

W_1 = initial weight of empty crucible

W_2 = weight of crucible + sample before drying

W_3 = weight of crucible + sample after drying.

Protein determination

The protein content of the test samples was determined by Kjeldahl method as reported by Onwuka (2005). Exactly 2 g of the test samples was weighed into a micro-kjeldahl flask containing a metallic catalyst and 5 ml of concentrated H_2SO_4 added. The same treatment was given to another 5 ml sample. The sample was digested at red hot temperature in a fume cupboard for 2 h and the digest transferred into a volumetric flask each. A clear solution is an indication of complete digestion after 2 h. Each of the transferred digest was diluted to 50 ml with distilled water. Then, 10 ml of each dilution was pipetted into "markham" apparatus with gradual introduction of 10 ml, 40% NaOH and distilled. Exactly 10ml of 4% Boric acid solution containing 3 drops of mixed indicator was used to collect the distillate and 50 ml of distillate from each duplicate titrated with 0.02N H_2SO_4 to a pink color. Percentage protein is calculated by multiplying percentage Nitrogen by a factor, 6.25.

$$\%\text{N} = \frac{100 \times \text{N} \times 14 \times V_t \times \text{T} - \text{B}}{\text{W}} \times 100 \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2)$$

Where:

T = Titre value of the sample

B = Blank titre value

V_t = Total volume of digest

N = Normality of acid used
W = weight of sample

% crude protein (cp) = % N × 6.25 Note: The total Nitrogen content is calculated using the relationship 1ml H_2SO_4 =14mg of H_2SO_4.

Fat content determination

Fat content of the test samples was determined by the continuous solvent extraction method using a soxhlet extractor as described by James (1995). Clean boiling flask (250 ml) was dried in an oven at 105°C-110°C for 30 min, allowed to cool in desiccators, and weighed. The flask was filled with 300 ml of petroleum ether. Five grams of the test sample was measured into a fat-free extraction thimble which has been dried in an oven and weighed. The extraction thimble was plugged with cotton wool and the weight taken again. The soxhlet apparatus was assembled and allowed to reflux for 6 h. The thimble was removed and the flask kept briefly for escape of petroleum ether before drying at 105°C-110°C for 1 h. The flask was allowed to cool in desiccators and then the weight taken. The fat content was calculated as:

$$\% \text{ Fat} = \frac{W_2 - W_3}{W_1} \times 100 \;\ldots\ldots\ldots\; \ldots\ldots\ldots\ldots(3)$$

Where:
W_3 = weight of empty extraction flask
W_2 = weight of flask and oil extract
W_1 = weight of sample used

Crude fiber determination

The method described by Onwuka (2005) was used for the crude fiber determination. Exactly 2 g of the test sample was measured and defatted with petroleum ether. It was allowed to boil under reflux for 50 min with 200 ml of 1.25% of H2S04 per 100 ml of solution. The hot acid solution was filtered and the residue poured into 200 ml boiling 1.25% NaOH and boiled for 30 min. It was filtered, progressively washed with boiling water, alcohol and petroleum ether after which the drained residue was transferred completely to a porcelain crucible and dried in an oven at 150°C to a constant weight. This was cooled, weighed and incinerated in a muffle furnace at 100°C for 2 h and reweighed after cooling in desiccators. The crude fiber content was calculated gravimetrically as;

$$\% \text{ Crude fiber} = \frac{W_2 - W_3}{\text{Weight of sample}} \times 100 \;\ldots\ldots\ldots\ldots(4)$$

Where:
W_2 = weight of crucible + boiled dried sample
W_3 = Weight of crucible + ash

Ash content determination

Ash content of the test samples was determined by the method described by Onwuka (2005). Exactly 2 g of the test sample was weighed into a previously weighed porcelain crucible and heated in a muffle furnace at 550°C for 2 h during which the sample has completely turned to ash. This was cooled in desiccators and re-weighed.

The percentage ash was calculated as:

$$\% \text{ Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where:
W_1 = weight of empty crucible
W_2 = weight of crucible + sample
W_3 = weight of crucible + ash

Carbohydrate determination

The carbohydrate content of dried test sample was estimated using the arithmetic difference method as described by Onwuka (2005). This means that when other proximate components have been determined as percentage, the sum of these determinations was subtracted from 100 to give the carbohydrate contents.

% Carbohydrate = 100 - (% Moisture + % Protein + % Fat +% Crude fiber+ % Ash).

IV. SENSORY EVALUATION

The samples were accessed in the Food Laboratory facility of Anambra State Polytechnic Mgbakwu using a 20 member sensory panel drawn from staff and students of the institution adjudged to be very familiar with biscuits. The samples which were disguisedly coded as A or B were presented to the panel members in a similar manner and form in a separated booth to maintain privacy and avoid biased judgment. They were provided with glass of potable water to rinse their mouth between samples tasting. Each panelist was requested to score the samples for color, texture, taste and general acceptability on a 9-point Hedonic scale, where 1 = Dislikes extremely and 9 = Like extremely. The scores for sample A which represents the wheat flour biscuit (WFB), and B which represents moringa wheat flour biscuit (MWFB) were collated accordingly.

V. STATISTICAL ANALYSIS

The samples were analyzed using T-Test Statistics for unpaired observations and difference between means determined at level of significance (p<0.05) for two-tailed test.

VI. RESULTS AND DISCUSSION

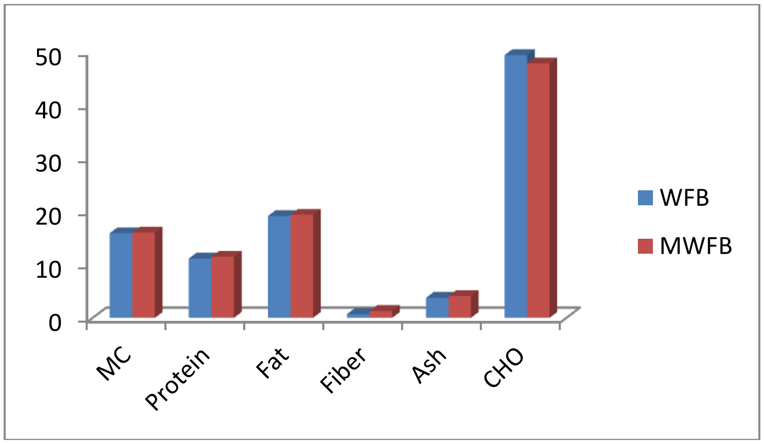

Figure 1: Chart for proximate values of biscuit samples
Key: WFB = Wheat flour biscuit, MWFB = Moringa wheat flour biscuit

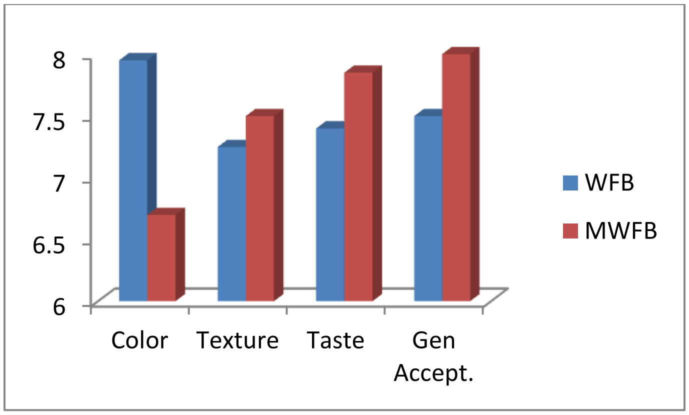

Figure 2: Chart for sensory scores of biscuit samples
Key: WFB = Wheat flour biscuit, MWFB = Moringa wheat flour biscuit

Table 1: Proximate composition of biscuit samples

Parameters	WFB	MWFB
Moisture content	15.90±0.25^{ns}	16.41±0.26^{ns}
Protein	11.42±0.10^{ns}	11.47±0.09^{ns}
Fat	19.13±0.51^{ns}	19.35±0.56^{ns}
Crude fiber	0.70±0.01^{b}	1.28±0.03^{a}
Ash	3.75±0.12^{ns}	4.09±0.11^{ns}
Carbohydrate	49.38±1.00^{ns}	47.80±1.11^{ns}

Means of triplicate samples and their standard deviation within a row followed by different superscripts are significantly ($p<0.025$) different, ns = no significant difference, WFB (wheat flour biscuit), MWFB (moringa wheat flour biscuit).

Table 2: Sensory scores of biscuit samples

Attributes	WFB	MWFB
Color	7.95±0.87^{a}	6.70±1.92^{b}
Texture	7.25±1.19^{b}	7.50±1.02^{a}
Taste	7.40±0.86^{b}	7.85±1.06^{a}
General acceptability	7.50±0.97^{b}	8.00±1.14^{a}

Means of triplicate samples and their standard deviation within a row followed by different superscripts are significantly ($p<0.025$) different, ns = no significant difference, WFB (wheat flour biscuit), MWFB (moringa wheat flour biscuit).

The proximate result in Table 1 shows that there was no significant ($p>0.05$) difference in the 15.90% moisture content of WFB and 16.01% of MWFB. This agrees with Igbabul et al. (2018) who reported increase in moisture content of cookies produced from fermented sweet detar, moringa leaf powder and wheat flour blends. It however varied from the report of Bolarinwa et al. (2019) that the moisture content of moringa seed powder fortified bread dropped from 22.90 to 20.20%. The difference in moisture behavior may be attributed to the higher moisture retention in the moringa leaf powder compared to the seed powder. Moreover the higher surface volume of bread may contribute to higher rate of moisture escape during baking. The higher fat ration in ingredients for biscuits may also retard moisture elimination during baking. There was marginal ($p>0.05$) increase in protein from 11.42% in the wheat flour biscuit to 11.47% in the moringa wheat flour biscuit. The increase in protein corroborates the reported increase in protein in the moringa fortified cookies (Igbabul et al., 2018) and moringa fortified bread (Bolarinwa et al., 2019). The increase in the protein content may be attributed to the dense nutrient content of *Moringa oleifera* plant, particularly high quality proteins. In this regard the margin of difference may depend on the level of replacement of the wheat flour with the moringa powder. The 19.13% fat content of the wheat flour biscuit was marginally ($p>0.05$) different from the 19.35% of moringa wheat flour biscuit. The increase is in agreement with the findings of Igbabul et al. (2018) and Bolarinwa et al. (2019). The increase in fat is understandable since fresh moringa leaf has measurable fat deposits which appreciates substantially when dried and converted to powder.

The moringa wheat flour biscuit recorded significant ($p<0.05$) increase in fiber from 0.70% of the wheat flour biscuit to 1.28%. The increase is concurrent with Bolarinwa et al. (2019) who reported an increase in fiber from 0.08% in conventional wheat bread to 1.76% in moringa fortified sample. It also conforms to the reported increase in fiber of moringa fortified cookies from 2.05 to 3.96% (Igbabul et al., 2018). The increase in fiber can be attributed to the characteristic fibrous network of leaves with expected concentration in the dry powdery form.

There was marginal ($p>0.05$) increase in ash content of wheat flour biscuit from 3.75 to 4.09% of the fortified sample. Again, the increase is in accord with the reports of Igbabul et al. (2018) and Bolarinwa et al. (2019). The increase in ash might be due to abundance of minerals in moringa leaf, since sufficient ash is indicative of rich mineral elements in a food sample (Ekeh et al., 2007; Olaoye et al., 2007). This was corroborated by Obasi and Ifediba (2018) who reported significant ash increase in biscuit fortified with African breadfruit seeds flour, giving that African breadfruit seed has higher mineral deposits than wheat grain.

There was no significant ($p<0.05$) difference in carbohydrate decrease from 49.38% in wheat flour biscuit to 47.84% in moringa fortified sample. This is consistent with the reported decrease in carbohydrate of substituted wheat flour baked products (Obasi and ifediba, 2018; Igbabul et al., 2018; Bolarinwa et al., 2019). The decrease can be attributed to substitution of wheat flour with materials lower in carbohydrate. However, since snacks are to provide temporary relief from hunger, flour composition must not compromise energy requirement of end product.

VII. SENSORY EVALUATION

The result in Table 2 shows significant ($p<0.05$) difference in the 7.95 color rating of wheat flour biscuit from the 6.70 of moringa wheat flour biscuit. Fortification with moringa leaf powder similarly led to decrease in color of gluten-free bread (Hayat et al., 2018) and whole wheat biscuit (Obichili and Ifediba, 2019). The inferior color of fortified sample might be due to dulling effect of moringa leaf powder (obichili and Ifediba, 2019) which is attributable to deep green color which is related to the high chlorophyll content of moringa leaves (Dadamouny, 2009; Karim et al., 2015).

The 7.5 texture rating of moringa wheat flour biscuit was significantly ($p<0.05$) superior to the7.25 of the wheat flour biscuit. Igbabul et al. (2018) reported similar improvement in texture of cookies made from sweet detar, moringa leaf powder and wheat composite flour. The grainy matrix of imbedded moringa leaf powder might have resulted in crispy bake, and crispiness can be complementary to desirable textural property of biscuit.

There was significant ($p<0.05$) difference in the taste of the two biscuit samples with the moringa wheat flour biscuit recording higher score of 7.85 compare to the 7.40 of the wheat flour biscuit. Igbabul et al. (2018) reported a wider increase in taste of cookies from 4.40 of the ordinary sample to 7.60 0f sample fortified with moringa leaf powder. The improved taste of moringa substituted sample may be due to versed phenolic and bioactive compounds in moringa leaf which combine with other substances in the recipe to form aromatic complex with pleasant taste.

The moringa wheat flour biscuit was significantly ($p<0.05$) higher with general acceptability score of 8.0 than the 7.50 of the wheat flour biscuit. Igbabul et al. (2018) similarly reported higher general acceptability of cookies fortified with moringa leaf powder from 4.66 to 8.13. The higher general acceptability of the moringa wheat flour biscuit is expected since it excelled in three out of other attributes considered. It may be surmised that interplay of texture and taste play greater role than color in organoleptic choice of most snacks.

VIII. CONCLUSION

This work reveals that biscuit derived from moringa wheat flour blend compared favorably with the conventional brand in proximate composition and sensory appeal. There is however need to explore different substitution levels in order to attain significant increase in nutrients without compromising consumer acceptance.

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