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SENSORY ACCEPTABILITY STUDIES OF WHOLE WHEAT BREAD FORTIFIED WITH MORINGA LEAF POWDER

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ABSTRACT
Whole wheat flour was produced using whole wheat grain. There was no sifting to ensure retention of bran, germ and endosperm which are essential constituents of whole wheat flour. The shade dried moringa leaves were reduced to powder in an attrition mill. The whole wheat bread (WWB) was produced using 100% whole wheat flour to serve as a control. Moringa wheat bread (MWB) was produced using a blend of moringa leaf powder and wheat flour on a ratio of 1:4 (v/v). The two samples were prepared using similar recipe. The sensory attributes of the two samples were evaluated by thirty-seven (37) panel assessors using a 9-point hedonic rating scale. The data generated were subjected to T-test statistic using SPSS Version 20. The result of the study shows that the Whole wheat bread was superior in colour and texture, while the Moringa wheat bread was superior in flavor, taste and general acceptability. There was no significant ($p>0.05$) difference in all the attributes considered.

INTRODUCTION

Bread is a common staple in developed and emerging economies; cutting across high and low-income earners. Production of bread from whole wheat grain is ageless practice.

Whole grains have all parts of the original kernel bran, germ and endosperm in the original proportions (Keri, 2015). Whole wheat flour is a product in which the endosperm, bran and germ are retained after the grain has been processed and milled. Thus whole wheat bread is a type of bread made using flour that is entirely milled from whole wheat grains (Nutrition facts, 2014). Christensen (2015) opined that whole wheat bread is a wonderful thing; the slices have a chewy texture with a deep nutty flavor. In its natural form wheat is a rich source of vitamins, minerals, carbohydrates, fats and oil and protein (FAO, 2009). However, Longo (2012) pointed out that there is health risks associated with the consumption of wheat because of its gluten content. Gluten is a compound that composes about 80% of the protein found in barley, rye and wheat (Paleoleap, 2013), and is said to upset people with gluten intolerance.

Tennyson (2013) pointed out that wheat contains the protein gluten, which harbors one of the worst prolamine offenders called gliadin. Gliadin has the most powerful toxic effects on the intestinal barrier and severely damages the gut lining in humans. This leads to iron deficiency which causes anemia. There is a compelling need to counteract this deleterious aspect of gluten by fortifying whole wheat bread with iron, of which *Moringa olifera* leaf is a good source.

Danica (2011) described moringa as a genus of trees indigenous to Southern India and Northern Africa. The leaves, flowers, bark, wood and roots of the *moringa* trees are used all over the world for a wide variety of medicinal, pharmacological and nutritional purposes, but it's the leaves of the species called *Moringa oleifera* in particular which have become recognized in recent years as being highly beneficial to the human health. *Moringa oleifera* tree is referred to as a miracle tree due to its rich source of certain macro and micro nutrients of great nutritional importance. *M. oleifera* leaf, seed, and flowers have found numerous applications in food (Oyeyinka and Oyeyinka, 2016). The leaves are typically dried and ground up into a powder that is extremely rich in proteins, vitamins minerals, fatty acids and likely a horde of other undiscovered benefits. O'Byerne (2011) reported that *Moringa oleifera* is the most nutrient-dense plant known to science, with the dried leaves being an incomparable source of vitamin $B_{2,}$ being an essential player in the fight against anemia. It gives more than 100% of the daily value of B_{12}, riboflavin ($B_{2)}$ and thiamin (B_1), which are vital nutrients especially for celiac. The author emphasized that just two teaspoons of the powder provides a little over 100% of one's recommended daily allowance (RDA).

From the foregoing, wheat as a whole grain is amongst the staple food that has lots of benefits apart from the fact that people with gluten intolerance suffer celiac disease; which fortification with moringa leaf powder could mitigate. Moringa plants have an extensive range of bioactive compounds that can be obtained from different vegetative structures, such as leaves, seeds, stems and pod husks, and have great potentials to be used in several formulations of food products (Saucedo-Pompa et al., 2018). As earlier stated dried moringa leaves are incomparable sources of vitamins B_2 which help in fighting anemia, one of the most prevalent symptoms of gluten intolerance. 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.

GAIN (2015) listed out fortified foods which include vegetable oil with vitamin A and D, wheat and maize flour with iron, folic acid and other B vitamins and zinc; sauces and condiments such as soy sauce with iron and salt with iodine. The combination of these nutrients in food helps to solve public health problems. However, it is important to determine the organoleptic attributes of fortified foods since the acceptability of a product is of utmost importance in product development.

Organoleptic attributes of food is a scientific discipline that applies principles of experimental design and statistical analysis to the use of human senses (sight, smell, taste, touch and hearing) for the purpose of evaluating consumer products (Walker, 2004; Eze and Mberekpe, 2010). Anozie et al. (2014) noted that assessing human responses using sensory acceptability test in new product development is an inevitable activity besides looking for the nutritional safety and convenience of a given product. Sensory quality such as colour, taste and aroma is essential parameter that determines to a great extent the acceptability of a product. Olivera (2011) pointed out that appearance of food evokes initial response and that flavor determines the final acceptance or rejection by the consumer.

Oyeyinka and Oyeyinka (2016) also stated that sensory evaluation provides an index of overall acceptability of food stuffs, which depends on its appearance, flavour, taste and after taste.

Several studies on the fortification of food with *moringa* have been published in literature.

Duchana et al. (2013) investigated the effect of dried moringa leaves on rheological, micro structural, nutritional, textural and organoleptic characteristics of cookies. Abioye and Aka (2015) determined the proximate composition and sensory properties of moringa fortified maize-ogi. Kolawole et al. (2013) evaluated the nutritional and sensory qualities of wheat-moringa cake.

The results of the above studies corroborated earlier report that *Moringa oleifera* is the most nutrient-dense plant known to science. The authors further showed that the organoleptic and acceptability of foods so much depends on the evaluation theory and the theory of consumer's choice. They propounded that food nutrients are very essential in the body as they help in keeping the body in good state, while human feelings over a particular product help in decision making as to accept the food or not.

For the purpose of this study, the organoleptic attributes that will be evaluated include colour, taste, flavor, texture and general acceptability. Therefore this study is intended to investigate the sensorial acceptability of whole wheat bread fortified with moringa leaf powder, considering the attested nutritional and health benefits.

Thus far, empirical studies of nutritional and sensorial attributes of some foods fortified with *Moringa oliefera* lend credence to the viability of the present study.

Moringa leaf and powder

MATERIALS AND METHOD

Source of raw materials

The whole wheat grains, margarine, sugar, egg, yeast, flavor, and milk were purchased from Eke Awka Market, Anambra State, Nigeria. The *Moringa olifera* leaves were plucked from the researchers' vegetable garden at the Demonstration Farm of School of Agricultural Technology, Anambra State Polytechnic, Mgbakwu, Anambra State, Nigeria. The experimental tools which include electric oven, electric kneading machine, mixing bowls, bread tins, burner, sieve, measuring spoons, and baking trays were obtained from the Foods and Nutrition Laboratory, Department of Home Economics and Hospitality Management Education, Vocational and Technical Education (VTE) Faculty, University of Nigeria, Nsukka.

Preparation of raw materials

Approximately 10.2 kg of the whole wheat grains were sorted to remove any extraneous matter before

milling in industrial hammer mill. There was no sifting to ensure retention of bran, germ and endosperm which are essential constituents of whole wheat flour.

The moringa leaves were washed, shade dried and grounded to powder in an attrition mill.

Sample preparation

The samples were produced after the preparation of the raw materials using the recipe and method described below.

Recipe for whole wheat bread

The whole wheat bread was prepared using the recipe prescribed by Donna (1991). The recipe is as follows: $1^{1}/^{3}$ cups of whole wheat flour, 1/4 cup of margarine, $2^{1}/^{2}$ tablespoons of sugar, 2 teaspoons of powdered milk, 1whole fresh egg, 2 tablespoons of vanilla flavor, 2 teaspoons of yeast, $1^{1/3}$ teaspoons of salt and $1^{1/4}$ cups of water. The given recipe was scaled up to obtain a dough weight of approximately 5.8 kg.

Recipe for moringa wheat bread

The recipe described by Donna (1991) was slightly modified to include the moringa leaf powder as follows: $1^{1}/^{3}$ cups of whole wheat flour, 1/4 cup of margarine, $2^{1}/^{2}$ tablespoons of sugar, teaspoons of powdered milk, 1 whole fresh egg, 2 tablespoons of vanilla flavor, 2 teaspoons of yeast, $1^{1/3}$ teaspoons of salt, $1^{1/4}$ cups of water, 1/3 cup of moringa leaf flour.

Preparation of bread samples

The whole-wheat bread and moringa wheat bread were prepared using rubbing in method, and all materials were scaled up from the recipe obtained from Donna (1991), as previously described.

A 4-Cabinet electric oven was preheated to 300^{o}F (180^{o}C) and forty (40) bread tins of 25cmx10cm ring mould were greased with margarine and lined up for use. Approximately 30 cups of whole wheat flour was sieved into the mixing bowl and a commensurate measure of margarine was rubbed in. Warm water was poured into a deep plate and appropriate measures of yeast and little part of sugar were added to prove the yeast. The proven yeast, remaining sugar and other ingredients were added to the mixing bowl and thoroughly mixed, with an intermittent run in of water until desired consistency was obtained, before kneading with electric kneading machine. The well-kneaded dough was left to rise at warm temperature for 30 min, knocked off and thoroughly kneaded once more before moulding to desired shape, placed in the previously greased tins and left to stand for 15 min. The bread tins were moved into the electric oven and the temperature further increased to 450^{o}F (232^{o}C) and left to bake for 45min. The loaves were allowed to stand for 5 min before they were taken out of the tins and transferred to cooling rack to set.

Design of the Study

The study adopted the experimental research design method of Anaekwe (2007), which are mainly concerned with identifying cause and effects relationship. This occurs where the researcher manipulates one variable and controls the rest of the variables. It has a control group which will not receive any treatment. The design is considered suitable for this study which is intended to investigate the sensory attributes and acceptability of whole wheat bread fortified with moringa leaf flour.

Controlling of extraneous variables:

The extraneous variables have a carryover effect on the consumers' mouth, hands, eyes etc. They alter the results of the experiment if not controlled. These variables include: previous food consumed by the evaluator, time of food consumption and evaluation environment. These variables were controlled by conducting the evaluation in a well-ventilated centre that is odour-free in a day light (for ample visibility). The evaluators were provided with potable water to wash their hands and clean their

mouth before tasting the products, and rinsed their mouth with water before going over to the next sample.

Study population

The study population consists of thirty-seven (37) evaluators categorized into two groups of 7 lecturers and 30 registered postgraduate students in the Department of Home Economics, University of Nigeria Nsukka. The rationale for the selection was based on the assumption that lecturers and postgraduate students in Department of Home Economics are experienced and capable of determining organoleptic attributes of food samples. The whole wheat bread and moringa wheat bread were evaluated on a 9 –point hedonic scale where 9 is like extremely, 8 like very much, 7 like moderately, 6 like slightly, 5 neither like nor dislike, 4 dislikes slightly, 3 dislikes moderately, 2 dislikes very much, 1 dislikes extremely. The hedonic scale is a standard instrument that required no validation. The samples which were simply coded A, B to mask identity were assessed for colour, taste, aroma, texture and general acceptability. The coded products were further defined as Sample A = WWB (whole wheat bread), Sample B = MWB (moringa wheat bread), for data verification and discussion.

Method of Data Collection

The data collection involved the use of rating scale to record the scores of each evaluated food sample. The panelists were required to rate the sensory attributes of each sample in the following order of colour, taste, texture, aroma and general acceptability on the rating scale provided. Only one characteristic of a sample was evaluated at a time to avoid “halo effect” and potable water which was maintained at room temperature was used to rinse the mouth after each rating, to promote sensitivity. The completed rating forms were retrieved from the panelists and the scores were collated accordingly.

Method of Data Analysis

The mean ratings and standard deviation of the scores for each attribute were then determinedand using T-test Statistics performed to test the Null hypothesis at 0.05 level of significance using SPSS Version 20.

RESULTS AND DISCUSSION

Table 1: Sensory attributes of whole wheat bread and moringa wheat bread.

ATTRIBUTES	WWB (N)	X1	SD1	MWB (N)	X2	SD2	DF	t-test	sig 2-tailed	Remarks
COLOUR	37	7.57	1.19	37	7.16	1.46	72	1.307	0.195	NS
TASTE	37	7.23	1.32	37	7.51	1.17	72	-1.027	0.308	NS
FLAVOR	37	6.73	1.47	37	7.16	1.24	72	-1.372	0.174	NS
TEXTURE	37	7.43	0.96	37	6.86	1.65	72	1.807	0.075	NS

Table 2: General acceptability of whole wheat bread and moringa wheat bread

ATTRIBUTES	WWB (N)	X1	SD1	MWB (N)	X2	SD2	DF	t-test	sig 2-tailed	Remarks
GENERAL ACCEPTABILITY	37	17.46	28.79	37	12.54	20.98	72	0.840	0.404	NS

Table 3: t-test table for the sensory attributes of the two bread products

ATTRIBUTES	t-test	DF	SIG 2-TAILED
COLOUR	1.307	72	0.195
TASTE	-1.027	72	0.308
FLAVOR	-1.372	72	0.174
TEXTURE	1.807	72	*0.075*

Table 4: t-test table for level of acceptability of the two bread products

Attributes tailed	WWB (N)	X1	SD1	MWB (N)	X2	SD2	df	t-test	sig 2-
GENERAL ACCEPTABILITY	37	17.46	28.79	37	12.54	20.98	72	0.840	0.404

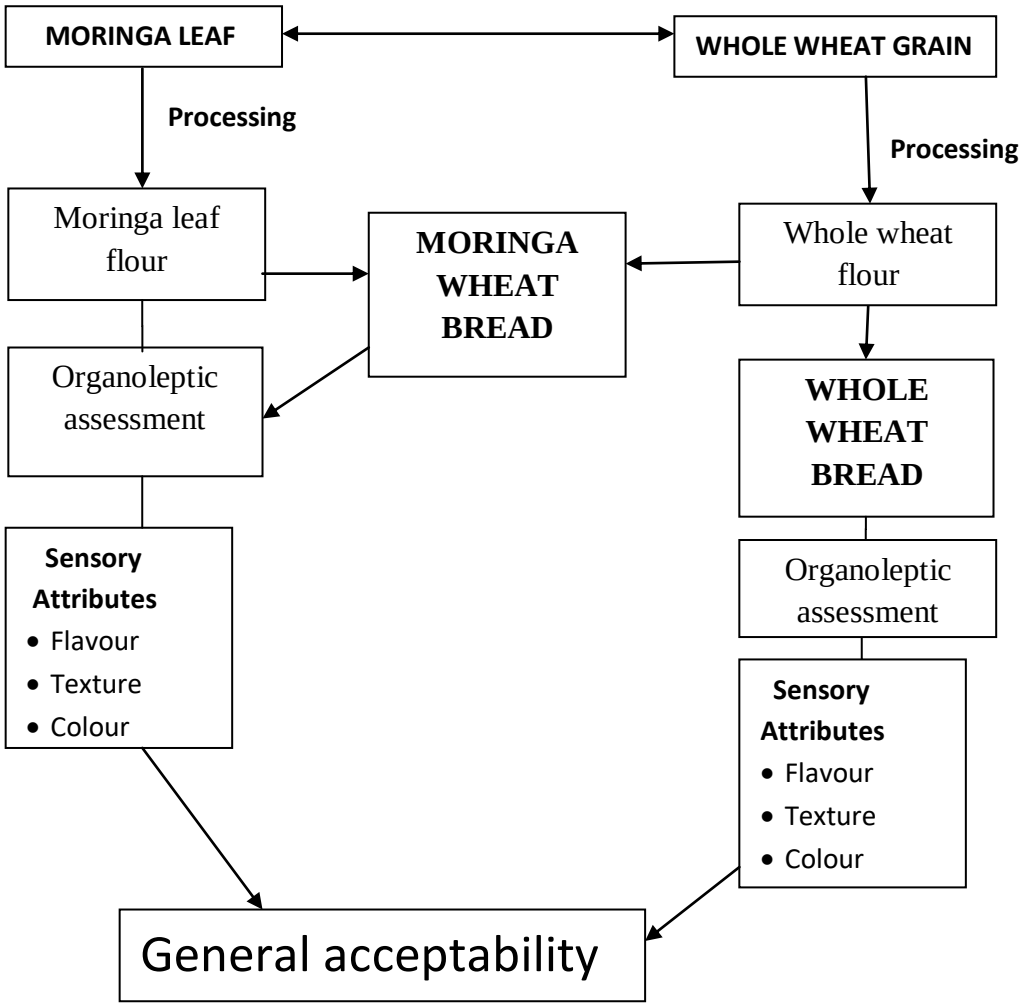
Key: N= Number of respondents;X1= Mean of WWB respondents for each of the attributes; X2= Mean of MWB respondents for each of the attributes;SD1=Standard deviation of X1; SD2=Standard deviation for X2; **NS**= Not significant; S = Significant; t-test = Calculated values of t-test with SPSS; Level of significance = 0.05

From Table 1 the mean rating (7.57) for colour of the whole wheat bread was marginally ($p>0.05$) higher than the 7.16 of the moringa wheat bread. The higher colour value of the whole wheat bread may be due to the natural chocolate color of wheat flour which was altered by the dulling effect of the moringa leaf powder, thus changing the colour of the wheat bread from brownish white to greenish brown. This might be attributed to the high chlorophyll content of *Moringa oliefera* leaf with resultant deep green powder most likely to mask the colour of most foods when added in substantial quantities. As reported by Karim et al. (2015), moringa leaf powder had a deep green colour related to high chlorophyll content, and thus green colour of moringa leaf powder changes the colour of bread. Hayat et al. (2018) reported that the total colour difference of crumb and crust increase significantly with moringa leaf powder addition.

The higher taste score (7.51) of moringa wheat bread differed marginally with the 7.23 of the whole wheat bread. The higher taste rating of the moringa wheat bread may be attributed to the additional pleasant natural taste of moringa leaf powder in the product.

The higher texture value (7.43) of whole wheat bread had no significant difference from the 6.86 of moringa wheat bread at $p<0.05$ level of significance. Hayat et al. (2018) reported that enhancement with 2.5 and 5% moringa leaf powder had little influence on bread taste and no significant difference on texture. They however added that substitution of gluten-free bread with moringa leaf powder at levels above 2.5% adversely affected volume, hardness and chewiness of bread. This may be due to particulate distribution of the moringa leaf powder with resultant coarse network. This corroborates the report of Duchana et al (2013) that the use of dried moringa leaf increases dough hardness and decreases cohesiveness and spread ratio of cookies. It also conforms with the findings of Abioye and Aka (2015) that lower texture rating of *ogi* fortified with moringa leaf powder mixtures may be attributed to the lower viscosities of the mixtures as revealed by the pasting properties.

Schematic representation of the conceptual framework



The higher flavor rating (7.16) of the moringa wheat bread had no significant ($p>0.05$) difference from the 6.73 of whole wheat bread. This maybe as a result of the sweet appealing flavor attribute of moringa leaves. This is more so as flavor development is often accelerated by thermal processes.

The result in Table 2 indicated no significant ($p>0.05$) difference in the general acceptability rating of the whole wheat bread and that of the moringa wheat bread.

The higher general acceptability of the whole wheat bread might be attributed to the combined effect of higher appearance and texture ratings. This partly complies with Olivera (2011) who posited that the appearance of food evokes initial response and that flavor determines the final acceptance or rejection by the consumer. It however contradicted the report of Anozie (2014) that flavor plays a major role in a consumer's judgment of a product as acceptable, since the moringa leaf bread had higher flavor rating. It can thus be inferred that general acceptability is a product of interplay of two or more sensorial attributes. This suggest that introduction of moringa leaf flour had no cumulative effect in the sensorial quality of bread products. This is in agreement with Bolarinwa et al. (2019) who reported that 5% moringa fortified bread was not significantly different from the bread produced from 100% wheat flour in terms of most of the quality attributes evaluated. They were also of the view that

apart from increase in micro and macronutrients of conventional bread, the moringa fortified bread was acceptable to consumer at 5% fortification level. Hayat et al. (2018) however remarked that although the control bread had significantly highest scores for taste, aroma, and appearance, the most acceptable gluten-free bread was obtained for control bread and bread with 2.5% moringa leaf powder. The result of this study corroborates the report of Ighabul et al. (2018) that the sensory scores for appearance, aroma, crispiness, taste, texture and general acceptability of product from fermented sweet detar, moringa leaf and wheat composite flour show that moringa leaf could be used in the production of nutritious and acceptable cookies.

CONCLUSION

This study shows that good quality bread can be produced from whole wheat moringa leaf powder blend. *Moringa oliefera* leaves which are commonly consumed as vegetable and as food supplements are rich in macro and micronutrients required for proper growth and good health. Wheat bread fortified with moringa leaf flour had good taste, flavor and general acceptability, baring the superior colour and texture of the whole wheat bread. Perhaps improved processing method for the moringa leaf powder might lead to product with better color and texture.

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