Innovations

Physicochemical and Sensory Properties of Bread Produced Using Blends of Wheat and Unripe Palm Nut Kernel Flours

Michael O. Odo[1]; Idam C. Okoh[2] & Lilian C. Hyginus[3]

[1]Department of Food Science and Technology, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki, Nigeria.

[2]Department of Human Nutrition and Dietetics, Faculty of Health and Allied Sciences, Alex Ekwueme Federal University, Ndufu Alike, Abakaliki, Ebonyi State, Nigeria.

[3]Department of Food Science and Technology, Faculty of Agriculture and Natural Resources, Management, Ebonyi State University, Abakaliki, Nigeria.

Corresponding Author: **Idam C. Okoh.**

Abstract: *The study evaluated the nutritional quality of Bread produced using blends of wheat and unripe palm kernel flour. The breads were formulated at varying ratios: 100:0, 90:10, 80:20, 70:30 and 60:40 for wheat and unripe palm kernel flours, respectively. The breads formulated were analyzed for proximate, micronutrient, physical properties and sensory evaluation: The results revealed that protein ranged from 13:15 – 15.34 %, carbohydrate 23:08 – 49.07 % and moisture content 45.25 – 65.24 % respectively. The oven loss of the breads ranged from 13.70 – 20.00, total baking loss 15.00 – 21.00 and loaf volume 175-300. The results equally revealed that vitamin E ranged between 36.77 – 77.00mg/100g and 98.07 – 421.43 mg/100g for zinc, but were significantly different (P<0.05) within the samples. Regarding overall general acceptability, the control (100 % wheat flour) was generally preferred over those of blends; however, among the blends, sample B (90 % wheat flour: 10 % unripe palm kernel flour) was mainly preferred by the panellists. Findings from this work suggest that satisfactory Bread can be produced using blends of wheat and unripe palm kernel flours at a ratio of up to 60:40, and the blends could enhance the nutritional qualities of Bread.*

Keywords: *Wheat flour, palm kernel flour, proximate, micronutrients, loaf volume*

Introduction

Bread is one of the world's most widely consumed food products, and bread production technology is probably one of the oldest known technologies (Selomulyo& Zhou, 2001). The product is basically made of hard wheat flour, yeast, fat, sugar, salt, and water (Badifu*et al*., 2005). It is a cereal product that is naturally low in protein and nutritionally not a balanced diet because it is low in lysine, an essential amino acid (Agu *et al*., 2010). Since Bread is an important food that is generally accepted, it could be an excellent and convenient food item for protein fortification to improve the nutritional well-being and health condition of people and in nutritional programmes, which will enhance the reduction in protein malnutrition that is prevalent in Nigeria and other developing Countries. Fortification of wheat flour with high protein materials from plant sources to improve protein content and the essential amino acids of baked products, such as Bread, has been encouraged (Mepba*et al.,*2009)

Unripe palm kernel seeds are the immature seeds of the oil palm tree (*Elaeisguineensis*). These seeds are typically white and have a relatively low oil content compared to ripe palm kernel seeds. The unripe palm kernel contains about 5.5 % crude protein with a relatively high level of lysine (6.7g/16gN) (Adesehinwa*et al*., 2007). It is a rich source of nutrients and has been shown to have potential for use. It contains a high amount of oil, protein and fibre, vitamins and minerals such as potassium, magnesium and calcium (Adejumo *et al*., 2019). This work aims to enhance Bread's nutritional qualities, thereby reducing nutrition insecurity by blending wheat and unripe palm nut kernel flour for bread production.

Material and Method

Source of raw material

The unripe palm kernel was sourced from Agharoza in Izzi L.G.A.; wheat flour and other ingredients such as milk, sugar, yeast, butter, Dangote salt, and flavour were purchased from International Market, Abakaliki, Ebonyi State.

Sample preparation

The unripe palm fruit collected was separated from the bunch with a cutlass, washed and then cracked to obtain the nut. The nut was oven-dried using a DHG electro-thermal oven and milled into flour using a Yamaha EF5500FW hammer mill machine. The wheat and unripe palm kernel flours were blended in the following weight ratios: 100:0, 90:10, 80:20, 70:30, and 60:40 per cent, represented as A, B, C, D and E, respectively. Sample A, which is wheat flour, served as a control.

Analysis of Samples

Moisture content, protein, Ash, Fat, and crude fibre were determined according to AOAC official methods (AOAC, 2010). Carbohydrate was analyzed by weight difference (Ihekoronye&Ngoddy, 1985). Minerals such as calcium, magnesium, and zinc were determined according to the method described by James (1995), while iron was determined according to AOAC official analysis methods (AOAC, 2010). Vitamins A and E were determined spectrophotometrically. Oven loss was determined by taking the weight of the dough before baking and immediately after baking. Total Baking Loss was taken after the Bread had been cooled for one hour. Total moisture content was determined by calculating the moisture loss in air drying and the moisture loss in oven drying. The loaf volume was determined by the rapeseed displacement method (Sahin &Gulum, 2006).

Sensory Evaluation.

Twenty (20) panellists were selected from the Department of Food Science and Technology, Ebonyi State University, Abakaliki. The panellists evaluated the samples' appearance, texture, taste, aroma, crust, colour, and general acceptability on the 9-point Hedonic scale (Ihekoronye&Ngoddy, 1985).

Statistical Analysis

Data from chemical analyses and sensory evaluation were analyzed using SPSS (version 15.0). Mean separation was done using Duncan's multiple range test, and analysis of variance was used to determine significant differences between samples at 5 % level of significance.

Results and Discussion

The proximate compositions of Bread produced with wheat flour and unripe palm kernel flour are shown in Table 1.

The moisture content of the Bread increased as the level of unripe palm kernel flour substitutions increased. The moisture content was higher than 17.00 – 20.95 %, as Yusufu and Ejeh (2018) reported on the moisture content of Bambara Groundnut substituted whole wheat bread. The high moisture content of the bread sample is disadvantageous because it will make the Bread vulnerable to microbial inversion. The presence of moisture in Food is crucial for microbial growth, and its control is essential to prevent spoilage and deterioration. High moisture content creates a favourable environment for bacteria, mould and yeast growth, leading to microbial spoilage and potential health risks. Therefore, accurately determining and controlling moisture content is vital in maintaining the microbiological stability and overall quality of food products (Mozuraityte*et al.*, 2016). Bread is a food product with intermediate moisture; whole wheat bread's recommended acceptable range of moisture is 18 – 28 %, while composite Bread is 25 – 42 % (Mozuraityte et al. 2016).Although the moisture contents of the composite Bread are high (24.10 – 40.07 %). It follows that the moisture content is in agreement with the findings of (Mozuraityte*et al.*, 2016) for composite breads and is statistically different ($p<0.05$) depending on the level of substitution. Commercially baked breads can be stored at room temperature for 2 to 4 days or 7 to 14 days in the refrigerator, but this may depend on ingredients, types of bread and storage method.

Table 1: Proximate Composition of Bread

Parameters (%)	**A**	**B**	**C**	**D**	**E**
Moisture	$25.03^{d} \pm$ 0.15	$24.10^{e} \pm$ 0.10	$28.81^{c} \pm$ 0.02	$31.70^{b} \pm$ 0.10	$40.07^{a} \pm$ 0.12
Protein	$15.34^{a} \pm$	$14.72^{b} \pm$	$14.24^{c} \pm$	$13.94^{d} \pm$	$13.15^{e} \pm$

	0.30	0.07	0.01	0.04	0.04
Ash	3.07^{a}± 0.12	2.73^{b}± 0.06	2.60^{c}± 0.01	2.41^{d}± 0.01	2.10^{e}± 0.10
Fibre	2.48^{e}± 0.10	3.5^{d}± 0.11	4.07^{c}± 0.10	5.23^{b}± 0.15	6.03^{a}± 0.55
Fat	4.77^{e}± 0.06	6.87^{d}± 023	8.90^{c}± 0.10	12.90^{b}± 0.10	14.87^{a}± 0.12
CHO	49.07^{a}± 0.06	47.47^{b}± 0.59	41.47^{c}± 0.16	34.37^{d}± 0.39	23.80^{e}± 0.03

Values are mean ± standard deviations of triplicate determinations. Means with different superscripts along the same row were significantly different (P < 0.05).

The crude protein decreases with an increase in unripe palm kernel flour substitution. This decrease could be attributed to the lower protein content of palm nut kernel flour that was incorporated in the composite flour formulation. The protein content of the samples was significantly different (P < 0.05) from one another. Other functional ingredients could have probably affected the wheat content's gluten network and thereby increased the loaf volume (Adeyeye *et al*., 2019). The result of this study is similar to 8.65 – 18.41 % reported by Yusufu and Ejeh (2018) on protein content of Bambara Groundnut-substituted whole wheat Bread. Determining and optimizing crude protein levels in food formulations are essential for meeting the nutritional requirements of both humans and animals, ultimately contributing to the overall well-being of individuals and populations, accordingto the National Research Council (2012).

The Ash contents were significantly different (p < 0.05), and the formulated samples were all lower than the control. The ash content of the bread samples was higher than the range (0.56 – 2.02 %) reported for Bread produced from wheat, sweet potatoes, and cashew nut flours (Tanko *et al*., 2023). The ash contents of the samples were within the limits of not more than 5 %, indicating that the blending of wheat flour and unripe palm kernel flour would be appropriate for bread making. They had appreciable amounts of ash, suggesting high mineral elements in the product, FAO/WHO/UNICEF/PAG (2007).

The fibre content of the samples increased with an increase in unripe palm kernel flour substitution, indicating high fibre content in unripe palm nut kernel flour. The range of this study was higher than 0.2 – 0.99 %, as Adeniran (2019) reported, on the fibre content of 30 % Defatted coconut flour of supplemented Bread. Thus, it can probably be stated that this increase in fibre content also caused the increase in loaf volume. The fibre content of the bread samples was significantly different (P <0.05) from one another. Consumption of high-fibre food products has been linked to a reduction in haemorrhoids, diabetes, high blood pressure, and obesity. Consuming this Bread will provide essential dietary bulk, aid in maintaining digestive health, and promote regular bowel movement, thereby aiding in the prevention of constipation.

The fat content of wheat flour bread was 4.77 %, and that of composite flour bread was 6.87 – 14.87 %. The difference in numerical values of fat contents of composite bread variations was statistically significant ($p < 0.05$) when compared to the control. It was observed from the results that the increase in fat content for the composite flour bread variations was due to the percentage incorporation of high-fat palm nut kernel flour. It could probably be stated that the increase in fat content for composite flour breads occurred due to the presence of unripe palm nut kernel flour. The range was higher than 2.37 – 3.66 % (Bibiana *et al.*, 2019). The high-fat content of the composite flour formulations would explain the ability to prepare Bread with unripe palm nut kernel flour without the addition of any shortening. This feature also highlights the possibility of using high-fat seed flour, like palm nut kernels, as sources of natural fat replacers in bread baking.

The carbohydrate content, as presented in Table 1, was statistically significant ($p<0.05$) when the composite flour breads were compared with the control and decreased in values with an increase in palm kernel flour, indicating a low content of carbohydrates in unripe palm nut kernel flour. The results were lower than 53.05 – 69.85 %, as reported by Yusufu and Ejeh (2018). This suggests that composite Bread may have a lower glycemic index, leading to a slower and steadier increase in blood sugar levels after consumption because of low carbohydrate content. This may be beneficial for individuals with diabetes or those aiming to manage their blood sugar levels.

The micronutrient compositions of Bread using wheat and unripe palm kernel flour blends.

The vitamin A contents were statistically significant ($p<0.05$) from one another. They increased with the substitution of unripe palm nut kernel flour, indicating that palm nut kernel flour is a good source of vitamin A, and consumption of this Bread will support good sight. The results align with the 550 µg (0.5 mg/100g) Recommended Dietary intake of WHO/FAO (2004). The range of vitamin A in this study (4.13 mg/100g – 8.98 mg/100g) was higher than 1.75 – 1.97 mg/100g reported by Bibiana *et al*. (2019) on the vitamin A content of composite Bread produced from wheat, water yam, and brown hamburger bean flours and lower than 14.18 – 47. 56 mg/100g was reported by Ndirika*et al*. (2015) for the vitamin A content of Bread produced from composite flours of wheat and beans (composites of fermented ground bean and wheat flours).

The Bread's vitamin E content was statistically significant ($p < 0.05$) and increased with the substitution of unripe palm kernel flour. This implies that palm kernel is a good source of antioxidanttocopherol. The range of this study is higher than the RDA for vitamin E for persons aged 14 and older, which is 15 mg or 22.4 international units (IU) per day, as α – tocopherol equivalents by the National Institute of Health (2021). Vitamin E is a fat-soluble antioxidant that plays a significant role in protecting cells from oxidative damage. Consuming this Bread with elevated vitamin E provides increased protection against oxidative damage, reducing the risk of chronic diseases like cardiovascular diseases and certain cancers.

The calcium content of the bread samples ranged from 3.02 to 14.16 mg/100g; they were statistically significant ($p<0.05$). The calcium content increased with the inclusion of unripe palm kernel flour. It was lower than 16.34 – 21.02 mg/100g, as Bibiana et al. (2019) reported on the calcium content of composite Bread produced from wheat, water yam, and brown hamburger bean flour. The calcium content observed in the formulated bread samples was lower than 1000 mg/100g, which is recommended by the US dietary allowance (RDA) for calcium, implying that palm nut kernel is not a good source of calcium. It is necessary for teeth and bone health development.

Table 2: Micronutrient Composition of Bread

Parameters (%)	**A**	**B**	**C**	**D**	**E**
VIT.A (μg/100g)	412.67^{e}± 5.51	445.67^{d}± 3.06	625.33^{c}± 2.52	719.67^{b}± 3.21	897.67^{a}± 20.50
VIT.E (mg/100g)	36.77^{e}± 0.03	64.42^{d} ± 1.14	68.43^{c} ± 0.51	72.77^{b}± 0.64	77.00^{a}± 1.00
Calcium (mg/100g)	3.02^{d}± 0.52	6.93^{c}± 1.01	8.87b^{c}± 1.19	11.01^{b}± 2.24	14.76^{a}± 2.27
Iron (mg/100g)	2.15^{e}± 0.19	2.62^{d}± 0.04	3.15^{c}± 1.12	3.68^{b}± 0.09	4.58^{a}± 0.41
Zinc (mg/100g)	89.07^{d}± 0.00	127.34^{c}± 1.02	138.84^{c}± 13.98	207.29^{b}± 7.99	421.43^{a}± 3.69
Mg (mg/100g)	3.85^{e} ± 0.53	6.82^{d}± 1.18	17.64^{c}± 0.81	21.93^{b}± 0.28	25.46^{a}± 0.43

Values are mean ± standard deviations of triplicate determinations. Means with different superscripts along the same row were significantly different ($P < 0.05$).

The Iron content of the bread samples showed significant differences ($p<0.05$) and ranged from 2.15 to 4.58 mg / 100g. The results showed that iron content increased with the addition of unripe palm kernel flour, indicating high iron content in palm kernel flour. These values are lower than the US RDA (10-15 mg/100g). Consumption of this composite Bread may not provide sufficient daily iron intake, thereby improving the role of iron in diets. The result of the present study was higher than 0.35 – 0.52 mg/100g, as reported by Ndirika*et al*. (2015) for Bread produced from composite flours of wheat and bean composites of fermented ground bean and wheat flours. Iron is a vital mineral with significant importance in the human diet due to its essential role in various physical functions. Iron is crucial for forming haemoglobin and plays an important role in the different metabolic processes.

The zinc content of the composite Bread was statistically significant ($p < 0.05$) from one another. The zinc content increased as the unripe palm nut kernel flour

addition increased, indicating high zinc content in palm kernel flour. The zinc content of the present study was higher than 0.58 - 0.68mg/100g, as reported by Onoja (2011) on the zinc content of wheat-based Bread supplemented with legume, root tuber, and plantain flour. The values obtained in this study were higher than the recommended values: (15 mg/100g) for men and (12 mg/100g) for women, indicating that consuming this Bread would contribute significantly to meeting daily requirements for individuals. Zinc aids in tissue growth and repair, boosts the immune system, and plays an essential role in sperm survival.
The magnesium content of this study ranged from 3.85 to 25.46 mg/100g. It was statistically different ($p < 0.05$) from one another and increased with the substitution of unripe palm nut kernel flour, indicating a high content of magnesium in palm nut kernel flour. The magnesium content was lower than 25.46 – 142.57 mg/100g, as Henry-Unaeze (2022) reported for Bread made from African yam bean and corn seed flour blends. The magnesium content obtained in this study was lower than the values recommended by the US RDA for magnesium (280 mg/100g) and 350 mg/100g for women and men. This shows that consuming this Bread may not significantly contribute to meeting individuals' daily magnesium requirements. However, since magnesium could be sourced from other foods, consumption of this Bread will contribute immensely to the magnesium needs of individuals. Magnesium is one of the essential elements required for proper metabolism and bone mineral density.

Physical Properties of Bread Produced Using Wheat Blends and Unripe Palm Kernel Flours.

The oven loss of wheat flour was 13.70, and the study revealed that the inclusion of unripe palm kernel increased the value of oven loss of the composite flour bread, indicating that palm nut kernel flour has a high content of moisture. Thus, it can probably be stated that this high moisture content of palm nut kernel flour also caused the increase in moisture content of the composite Bread produced. Oven loss in bread baking is a significant phenomenon that involves the reduction in weight as moisture evaporates during the baking process, directly impacting the final moisture content, texture, and quality of the Bread (Scheiner, 2009).

Table 3: Physical Properties of the Bread Samples

Parameters	A	B	C	D	E
Oven loss (%)	13.7	16.0	17.1	17.7	20.0
TBL (%)	15.0	17.0	18.0	18.8	21.0
TMC (%)	45.25	43.83	50.16	55.60	65.24
Loaf vol. (m^3)	175m^3	200 m^3	225 m^3	295 m^3	300 m^3

The total baking loss of the wheat flour was 15 %, and the result revealed that the addition of unripe palm kernel flour increased the total baking loss of the composite Bread; this could be due to the less compactness of the crumb and decreased starch content of the composite flour bread. Total baking loss in bread production is a critical parameter that directly affects the final product's quality, texture, and shelf life. It refers to the weight loss experienced by Bread during the baking process, primarily due to moisture evaporation (Lazaridou *et al*., 2007). Losses in moisture during baking will result in the firming of the crumbs. This will negatively affect the freshness of the Bread as an increase in substitution increases the baking loss.

The total moisture content of the wheat flour was 45.25 % and increased in composite Bread with the substitution of unripe palm kernel flour, indicating a high moisture content of the composite flour and the Bread produced compared to wheat flour bread. This suggests that the Bread produced from wheat flour will have a longer storage life than the composite Bread. Since total moisture content is a critical parameter in food processing and storage, particularly in bread production, it directly influences the texture and overall quality of the final bread product. It enhances its storage stability by minimizing mould growth and other biochemical reactions (Owens *et al*., 2016).

The loaf volume of the wheat flour bread was 175 m^3 and increased in composite Bread with the addition of unripe palm kernel flour. It could be stated that the increase in loaf volume indicates the high fibre content in palm nut kernel flour. Thus, it was observed that a higher level of composite flour substitution had a positive effect on the volume of the Bread. A larger loaf volume typically indicates a well-risen, aerated crumb with a desirable light and airy texture, while a smaller loaf volume may suggest denser, less appealing Bread (Nwachukwu *et al*., 2020).

The Sensory Attributes of Bread Produced Using Blends of Wheat and Unripe Palm Kernel Flours.

Sensory evaluation results are shown in Table 4. The mean scores for acceptability of appearance, texture, taste, aroma, and crust colour were significantly higher for sample A (100 % wheat flour bread) than for the composite flour bread. Among the blends, sample B (90:10) had the highest appearance, texture, taste, aroma, and crust colour rating, and the 60:40 blend (sample E) had the lowest rating in all the parameters. In terms of overall general acceptability, the control was generally preferred over that of composite flour. However, among the blends, the panellists mainly preferred sample B (90:10) and sample E (60:40), which were rated lower. This indicates that a 10 % substitution of palm kernel will result in a bread of highly acceptable quality.

Table 4: Sensory Attributes of Bread

Parameters	**A**	**B**	**C**	**D**	**E**
Appearance	$8.10^{a} \pm 0.79$	$6.55^{b} \pm 0.51$	$6.15^{b} \pm 0.59$	$5.20^{c} \pm 0.89$	$3.9^{d} \pm 0.91$
Texture	$7.95^{a} \pm 0.51$	$6.80^{b} \pm 0.52$	$6.35^{c} \pm 0.49$	$4.90^{d} \pm 0.72$	$4.00^{e} \pm 0.92$
Taste	$7.80^{a} \pm 0.89$	$6.85^{b} \pm 0.67$	$6.05^{c} \pm 0.69$	$5.00^{d} \pm 0.65$	$3.90^{e} \pm 1.12$

Aroma	7.55[a]± 0.83	6.80[b]± 0.62	6.20[c]± 0.62	4.90[d]± 0.79	3.85[c]± 1.18
CC	7.65[a]± 0.93	6.65[b]± 0.67	6.15[b]± 0.67	4.75[c]± 0.71	3.80[d]± 1.15
GA	8.0[a]± 0.65	6.80[b]± 0.52	6.25[c]± 0.55	5.00[d]± 0.73	4.00[e]± 1.03

Values are means ± standard deviations of triplicate determinations. Means with different superscripts along the same row were significantly different (P < 0.05).

Conclusion

Blending wheat and unripe palm kernel flours for bread production will improve the nutritional value of Bread, especially the micronutrients, thereby addressing the under-nutrition prevalent in developing Countries. The composite Bread produced from 90 % wheat and 10 % unripe palm nut kernel, 80 % wheat and 20 % unripe palm nut kernel significantly increased moisture, fibre, fat, and micronutrients, and decreased protein, ash, and carbohydrate. The sensory attributes of the blends revealed that the panellists preferred sample B (90 % wheat and 10 % unripe palm nut kernel), followed by sample C (80 % wheat and 20 % unripe palm nut kernel). Findings from this work suggest that blending wheat flour with up to 20 % unripe palm kernel flour could be an effective and economical means by which to improve the nutritional content of Bread.

References:

1. *Selomulyo V. O. and W. Zhou (2001). Frozen bread dough: Effects of freezing storage and dough improvers. Journal of Cereal Science, 45: 1-17.*
2. *Badifu, S. O, C. E. Chima, Y.I. Ajayi and A. E. Ogori (2005). Influence of Mango Mesocarpflour supplement to micronutrients; physical and organoeptic qualities of wheat-based Bread. Nigerian Food Journal, 23: 59-68.*
3. *Agu, H. O, Ukonze, J. A., and Paul, K. A. (2010). Quality Characteristics of Bread made fromwheat and fluted pumpkin seed flour. Nigerian food journal, 28, 188-198.*
4. *Mepba, H. D., Eboh, L., Aron, A., and Ukpabi, U. J. (2009). Rheological, baking, and sensorycharacteristics of fermented cassava starch, wheat cowpea blends.Nigerian food journal, 27:172-186.*
5. *Adesehinwa, A.O.K., Oke, D.B., and Oyewole, O.B. (2007). Performance and Nutrient Digestibility by West African Dwarf Goats Fed Palm Kernel cake – based diets Supplemented with Leaves of Leucaena Leucocephala and Gliricidiasepium. Pakistani Journal of Nutrition 6(4), 322 – 327.*
6. *Adejumo, B. A., Omoniyi, S. A., and Adebayo, A. O. (2019). Chemical Composition and functional properties of unripe palm kernel flour. Journal of Food Processing and Preservation, 43(12), e14138.*

7. *AOAC (2010). Official method of analysis (18th ed.), Washington DC; Association of Official Analytical Chemists.*
8. *Ihekoronye, A. I. and Ngoddy, P. O(1985). Integrated Food Science and Technology for the Tropics. Macmillan Publishers, New York, pp 296 – 301.*
9. *James, C. S. (1995). Analytical Chemistry of Food. Blackie Academic and professional.*
10. *Yusufu, M. I. and Ejeh, D. D. (2018). Production of Bambara Groundnut substituted whole wheat Bread: Functional properties and Quality Characteristics. Journal of Nutritional Food Science, 8: 731.*
11. *Tanko, O.O., Hussaina T. O., and Donaldben N.S. (2023). Evaluation, physicochemical, and sensory properties of composite Bread produced from Wheat, Sweet Potatoes and Cashew nut flour. Asian Food Science Journal, 22(9), 74-87.*
12. *Adeniran, A. A. (2019). Physico-chemical properties of deflated Coconut flour supplemented Bread.*
13. *Bibiana, I. Grace, N. and Julius, K.U. (2019). Moisture contents of composite Bread producedfrom wheat, water yam and brown hamburger bean flours. Journal of Food Research, 8(5), 45 – 55.*
14. *Ndirika, V. I., Okoye, J.I. and Ezeama, C.F. (2015). Vitamin A content of Bread produced from composite flours of wheat and beans (composites of fermented ground bean and wheat flours). African Journal of Food Science and Technology, 6(2), 98 – 105.*
15. *National Institutes of Health (2021). Office of Dietary Supplements – Mineral fact sheets retrieved from ods.nih.gov*
16. *Onoja, U. S. (2011). Bread as a major dietary constituent in Nigeria. How much do we know? Journal of Food Science and Engineering, 1(1), 1 – 10.*
17. *Henry – Unaeze, H. N. (2022). Proximate, vitamins, minerals and ant-nutrients composition of breads made from African yam bean (Sphenostylisstenocarpa) and corn (Zea mays) seeds flours blends. Greener Journal Agricultural Sciences, 12(1), 456 - 459.*
18. *Scheiner M. (2009). Bread baking: An Artisan's perspective. John Wiley and Sons.*
19. *Lazaridou, A; Duta, D; Papageor-giou, M; Belc, N. and Biliaderis, C. G. (2007). Effects ofhydrocolloids on dough rheology and bread quality parameters in gluten-free formulations. Journal of Food Engineering, 79(3), 1033 – 1047.*
20. *Nwachukwu, I. D; Ndife, J; Ezeama, C. F. and Uzodinma, E. O. (2020). Loaf volume as a quality parameter in bread baking. Journal of food science and technology, 57(8), 2956 – 2963.*
21. *Mozuraityte, R., Rustad, T., and Storro, I. (2016). Oxidation of fish lipids and its inhibition with tocopherols. Journal of the American Oil Chemists' Society, 83(7), 647-656.*
22. *Adeyeye, S. A. O., Boleyi, O. J., Abegeunde, T. A., Adebayo-Oyetoro, A. O., Tiamiyu, H. K., and Idowu-Adebayo, F. (2019). Quality Characteristics and*

Consumer acceptance of Bread from wheat and composite flour. Accessed 11th December 2024.

23. *National Research Council (2012). Nutrient Requirements of Swine: Eleventh Revised Edition. The National Academics Press.*
24. *FAO/WHO/UNICEF/PAG (2007). Human vitamin and mineral requirements. Food and Agriculture Organization of the United Nations, World Health Organization, United Nations Children's Fund, Protein Advisory Group.*
25. *WHO/FAO (2004). Human vitamin and Mineral requirements. Report of a joint FAO/WHO Expert Consultation. Food and Agriculture Organization of the United Nations and World Health Organization.*
26. *Owens, G; Ponte, J. G; Terry, I. and Yaghoubi, M. (2016). Bread and Its Fortification: Nutrition and Health Benefits. CRC Press.*