COST EVALUATION OF BREAD PRODUCTION FROM COMPOSITE OF WHEAT FLOUR AND CORN FLOUR

ABSTRACT

Composite bread is a baked product that incorporates a mixture of flours containing high starch and protein content, such as wheat and corn flour, to enhance its nutritional value. This study aimed to develop and assess composite bread using various ratios of wheat and corn flour, following standard proportions. Four formulations of composite bread were created, substituting different levels of corn flour, while a 100% wheat bread was used as a control sample. Proximate composition analysis of the wheat and corn flour was performed in the laboratory. The bread was prepared using the straight dough method, and sensory evaluation was conducted to determine consumer acceptability.Results indicated that the sample with a ratio of 90% wheat flour and 10% corn flour (sample B) exhibited the highest overall acceptability, closely resembling the 100% whole wheat bread. Furthermore, sample C, with a ratio of 80% wheat flour and 20% corn flour, could be more acceptable if supplemented with additional ingredients such as fats, natural and chemical improvers, emulsifiers, and flavors. Incorporating 20% corn flour in the bread formulation proved to be cost-effective, leading to a 20% reduction in wheat importation, equivalent to 1.2 million metric tonnes of imported wheat.

Keywords:*Composite Bread, Corn flour, Sensory evaluation, Wheat Flour*

1.0 INTRODUCTION

Bread, biscuit, cake, doughnut, noodles and otherwheat flour based products are popular in Nigeriaand indeed all parts of the world. Bread is the mostpopular among all the wheat-based products. Bread is a fermented confectionary product primarily made from wheat flour, water, yeast, andsalt through a series of processes involving mixing, kneading, proofing, shaping, and baking (Abdullahi et al., 2018) (Dewettinck et al., 2008). It serves as a staple food, and its consumption is steadily increasing in Nigeria due to its convenience as a ready-to-eat food product(Iyayosa Andrea et al., 2023) (David, 2006). The rising popularity of bread consumption has been observed not only in Nigeria but also in other African countries (Andrea et al., 2023) (Shittu et al., 2007), driven by factors such as nutritional value, population increase, urbanization, changing food preferences, and increased wealth (Abdulsalam, AlhajiYaro, et al., 2023) (Seibel, 2006). To ensure the production of high-quality bread, the dough must possess specific characteristics. It should be extensible enough to relax and expand during rising, elastic enough to retain the gases produced, and stable enough to maintain its shape and cell structure. Several conditions contribute to the production of large, well-textured loaves of bread. These conditions include having sufficient initial sugar content in the flour with adequate diastatic activity for fermentation, satisfactory protein quality and quantity for gas retention, and optimal dough ripeness at the time of baking. Composite flour, which combines locally available crops with wheat flour, has gained attention in developing countries due to its advantages, including reduced wheat flour importation and promotion of locally grown crops (Abdulsalam, Ibrahim, et al., 2023) (Hugo et al., 2000; Hasmadi et al., 2014). The main objective of composite flour is to enhance the nutritional value of wheat flour by addressing its deficient components, such as essential amino acids and minerals, through the addition of other cereal flours. Shittu et al. (2007) also emphasized the use of composite flours, which consist of binary or ternary mixtures of flours from various crops, with or without wheat flour, offering advantages such as saving hard currency, supporting native plant species, improving protein supply for human nutrition, and optimizing domestic agricultural production (Berghofer, 2000; Bugusu et al., 2001).Cereal grains, while sharing similar proximate compositions, differ in their ability to retain gas during proofing and baking. Wheat flour dough, characterized by gluten protein, forms a typical aerated foam structure that produces bread (Bello et al., 2021) (Dobraszcyk, 2001). Other cereals, although containing similar protein groups to gluten, have limited gas-holding capacity, making them less suitable for producing aerated baked products (Alhassan et al., 2016) (Dobraszcyk, 2001). Corn, an important crop used in both human nutrition and animal feed, exhibits superior nutritional qualities compared to other cereals, except for its protein content. It is rich in fat, iron, fiber, vitamins (provitamin A, niacin, vitamin E, and vitamin C), and is widely cultivatedalongside rice and wheat worldwide.this study focuses on the development and evaluation of composite bread using wheat and corn flour, aiming to enhance the nutritional profile of bread by leveraging the unique properties of wheat gluten and the nutritional advantages of corn.

2.0 MATERIALS AND METHODS

Flour, the primary ingredient in bread production, is influenced by the properties of the grains used. The degree of milling affects the chemical composition of the flour, with increased milling reducing starch content and increasing the presence of inorganic ingredients, insoluble fiber, and vitamins found in the bran. In this study, wheat flour known as "Dangote Flour" was obtained from Olam Flour Mill in Ilorin, Kwara State, and is commonly used as a general-purpose flour by the Nigerian Bakers Association. Corn flour was obtained from Mandate Market in Ilorinand was chosen due to its widespread availability in the research region. The flour was milled, and ground into fine particles using a small-scale flour milling plant. STK Royal instant Dry Yeast was selected as the yeast variety used in the project, while pulverized sugar and iodized common salt were acquired from the local market in Ilorin to enhance flavor. Water at room temperature was used as the liquid component in the bread-making process.Wheat flour, maize grains, and various baking ingredients were obtained from Oja Oba in Kwara State, Nigeria. The bakery equipment used for the project, including an industrial oven, dough mixer, dough sheeter, baking trays, weighing scales, proofing cabinets, and cooling racks, were sourced from a reputable bakery that adheres to industry standards. The maize grains underwent a process of sorting, cleaning, and proper sun drying before being milled using a locally fabricated attrition mill. Subsequently, composite flours were prepared by combining different ratios of wheat and maize, specifically 100:0, 90:10, 80:20, 70:30, and 60:40. These mixing ratios were selected in accordance with the Nigeria Wheat Policy, which recommends a 40% inclusion of agro-based composite material in wheat.

Fig 1: milling of corn flour

Fig 2: Composition before mixing

2.1 FORMULATION OF RECIPE

The recipe formulation for wheat and maize flour incorporated bread was carried out in table 1.

Table 1. Recipe formulation for bread

	A(g)	B(g)	C(g)	D(g)	E(g)
Wheat Flour	2000	1800	1600	1400	1200
Corn Flour	0	200	400	600	800
Salt	33.4	33.4	33.4	33.4	33.4
Sugar	200	200	200	200	200
Yeast	10	10	10	10	10
Water	1000	1000	1000	1000	1000

2.2 PREPARATION OF MATERIAL

2.2.1 corn flour

The whole-corn grain was sent to a small-scale flour milling facility. Before being processed (milled) into finer flour particle sizes, the maize was first crushed into smaller sizes. The flour was stored in a plastic container and kept in a suitable environment.

2.2.2 composite bread

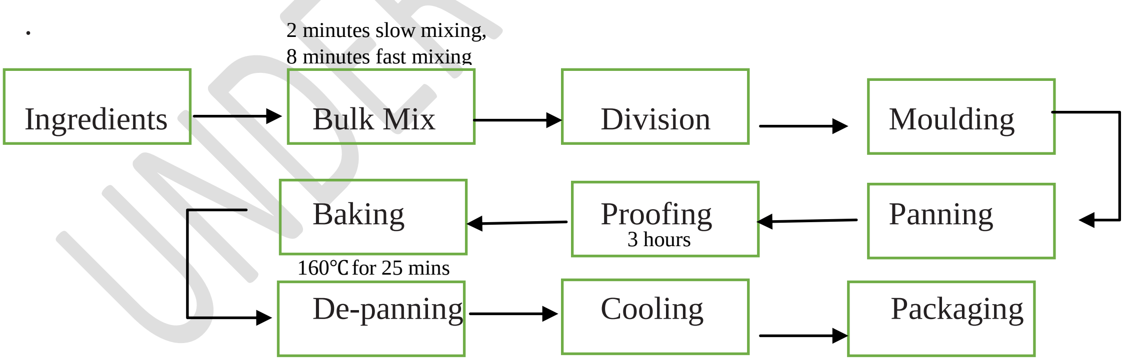
A composite bread was created by combining wheat and maize flour with salt, sugar, yeast, and water. The flour samples were measured based on the predetermined mixing ratios, and the other ingredients were proportionally measured and added into the spiral mixing machine gradually. The mixing process commenced slowly for 2 minutes, followed by fast mixing for 8 minutes. Once the dough sponge formed, it was shaped through kneading and then placed into pans. The pans were then transferred to a proofing box, where they remained for a maximum of 3 hours. Subsequently, the bread was baked in an oven set at 160℃ for 25 minutes. After baking, the loaves were removed from the pans, allowed to cool, and then packaged accordingly.

Fig 3: Moulded Dough after mixing

Fig 4: Panning of Moulded dough

2.3 BREAD MAKING BLOCK DIAGRAM FLOW CHART

Chart 1. Bread making block diagram chart.



2.4 ANALYSIS OF RAW MATERIALS AND PRODUCTS

2.4.1 Determination of physical properties of product

2.4.1.1 Weight

Weight analysis is an important aspect of the physical analysis of bread. It involves measuring the mass or heaviness of the bread loaf or individual units. This measurement provides insights into the bread's density, size, and consistency. By monitoring the weight during production, bakers can ensure uniform portion sizes, adjust ingredient ratios, and maintain product quality. Weight analysis aids in assessing bread characteristics and meeting quality standards in the baking industry. The weight of bread was determined by standard rule of thumb.

2.4.1.2 Volume

Volume analysis is a significant aspect of the physical analysis of bread. It involves measuring the amount of space occupied by the bread loaf or individual units. This measurement provides insights into the bread's texture, structure, and overall quality. Various methods, such as displacement techniques, are used to measure the volume. Evaluating the volume helps assess leavening effectiveness, crumb texture, and overall appearance of the bread. Volume of bread was determined by rapeseed displacement method as mentioned in whitebread (AACC, 2016).

2.4.1.3 Specific loaf volume of the bread

The specific loaf volume is a physical measurement that indicates the volume of a bread loaf in relation to its weight. The specific loaf volume provides insights into the bread's texture, crumb structure, and overall density. Higher values indicate a lighter and more aerated bread, while lower values suggest a denser texture. Monitoring the specific loaf volume helps bakers assess formulation changes, adjust ingredients and processes, and maintain consistent quality in bread production. Loaf volume was measured after baking by rapeseed displacement method. Specific volume was calculated as loaf volume (cm^3)/loaf weight (g)

2.4.2 Proximate analysis

The proximate analysis consisting of the moisture content, fat, ash, protein fibre and carbohydrate content of the flour samples are to be taken by the proximate analysis machine.These proximate analysis measurements provide essential information about the nutritional composition of food, aiding in dietary assessments, product development, and quality control in the food industry

2.4.2.1 Moisture

The moisture content refers to the quantity of water found within the sample, impacting its texture, stability, and shelf life. To determine the moisture percentage in the bread, the gravimetric method was employed. A 1g sample was initially weighed (W1) in a petri plate and subsequently placed in a hot air oven (model NSW 144) at 105°C for a period of 24 hours. Following the oven treatment, the sample was carefully taken out, allowed to cool in a desiccator, and then reweighed (W2).

2.4.2.2 Crude Protein

Crude protein is one of the components analyzed in proximate analysis. It represents the total protein content in a food sample. The term "crude" refers to the estimation of protein content based on the measurement of total nitrogen, as proteins contain nitrogen. The nitrogen content is determined using the Kjeldahl method, and the crude protein content is calculated by multiplying the nitrogen content by a conversion factor, typically 6.25. The crude protein content provides valuable information about the nutritional quality and potential protein contribution of a food product. It is an essential parameter for assessing the protein content of various food sources and is used for labeling purposes, dietary assessments, and formulation of balanced diets.

2.4.2.3 Crude Fat, Crude Fibre and Ash Content:

In proximate analysis, several components are assessed to determine the nutritional composition of a food sample. These components include crude fat, crude fiber, and ash content. Crude fat represents the total lipid content and provides insights into the energy density and sensory attributes of the food. Crude fiber represents the indigestible carbohydrates and offers information about the dietary fiber content and its impact on digestion. Ash content indicates the inorganic mineral residue after combustion, providing details about the mineral composition and potential contaminants. These parameters collectively contribute to assessing the nutritional quality, functional properties, and safety of food products.Determination of the crude fat, crude fibre and the ash content in the bread samples wascarried out using the standard methods described by AOAC2000.

2.4.2.4 Carbohydrate

The carbohydrate content is significant in assessing the energy value of a food product and its impact on blood sugar levels. It also plays a crucial role in dietary planning, particularly for individuals with specific carbohydrate requirements or following certain diets, such as low-carb or high-fiber diets. Carbohydrate was determined using estimation by difference (AACC,2016). The crude fibre, crude protein, and the fat content were subtracted from organic matter; the remainder accounted for carbohydrates:% carbohydrate = 100 - protein (%) + fat (%) + ash (%).

2.5 Sensory analysis

Sensory analysis evaluates and understands the sensory characteristics of food and other products. It involves assessing attributes such as taste, smell, appearance, texture, and sound. Trained panellists or consumers participate in standardized tests to describe sensory properties or provide feedback on overall liking. Sensory analysis helps in optimizing product formulation, detecting quality issues, assessing stability, and making informed decisions in product development and marketing. Its goal is to understand consumer preferences and create appealing products that meet their expectations. Statistical analysis of the sensory scores was obtained from 12 semi-trained panelists using9-point hedonic rating scale (9=like extremely, 1= dislike extremely) for composite breadformulations. The parameters for sensory evaluation were crumbappearance, colour, texture, flavour and overall acceptability.

2.6 Statistical Analysis

Statistical analysis involves using statistical techniques to analyse and interpret data. It includes collecting and preparing data, summarizing and describing it, making inferences and predictions, visualizing data through graphs and charts, and drawing meaningful conclusions. The statistical analysis of the results of this project was carried out, computed and plotted using Microsoft excel software

3.0 RESULTS AND DISCUSSION

This work was carried out for the preparation of different bread formulation with varying proportion of wheat flour and corn flour. Five formulations incorporating different proportion of wheat flour along with corn flour in varying samples namely A (100% wheat flour), B (90% wheat flour and 10% corn flour), C (80% wheat flour and 20% corn flour), D (70% wheat flour and 30% corn flour), E (60% wheat flour and 40% corn flour) were prepared. As bread is the product widely consumed by general population, wheat flour and corn flour incorporated bread adds value to the nutritional profile along with price compatibility. At first, the major raw materials were subjected to physio-chemical proximate analysis.

3.1 Proximate composition of wheat flour and corn flour

Table 2.Proximate composition of wheat flour, oats flour and maize flour

Parameters	Wheat Flour	Corn Flour
Moisture (%)	13.09±0.14	12.15±0.21
Crude Protein (%)	12.56±0.22	9.08±0.19
Crude Fat (%)	0.85±0.04	1.15±0.10
Crude Fibre (%)	0.68±0.17	1.25±0.13
Ash Content (%)	0.62±0.2	1.60±0.25
Gluten Content (%)	12.11	0

*Values are the means of triplicates ± standard deviation.

3.2 Physical parameters of composite bread

Physical parameters of bread such as loaf volume, weight and specific loaf volume wereaffected by the substitution increment of the level of wheat flour as maize flour which is presented in the Table 3. The data shows changes in physical parameters such asweight and loaf volume of bread with incorporation of corn flour in bread. Weight was found to behighest in sample E (3500 g) and lowest in sample A (control) (3000g). It might be dueto high water absorption capacity of increased fiber content which is as outlined by rule of thumb.

There was decrease in loaf volume of bread from 5801 to 2456cm^3 and specific loaf volume from 1.93 to 0.70 cm^3/g with increase in level of maize flour.The decrease in loaf volume is may be due to the dilution effect of non-wheat flour on glutencontent of wheat flour and has been expressed as decrease in loaf volume when usingcomposite flours for bread preparation.

Table 3. Physical parameters of composite bread

Samples	Loaf Volume (cm^3)	Weight (g)	Specific Volume (cm^3/g)
A	5801	3000	1.93
B	4702.5	3100	1.52
C	4258.4	3200	1.33
D	2860	3400	0.84
E	2456	3500	0.70

Fig 5: Sample A -100% whole

Fig 6: Sample B – 90% WF : 10% CF

Fig 7: Sample C – 80%WF : 20% CF

Fig 8: Sample D – 70%WF : 30% CF

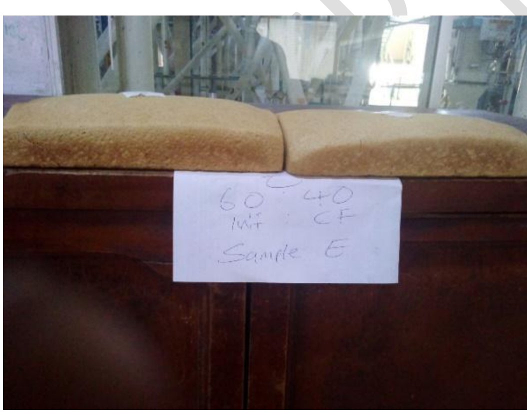


Fig 9: Sample E – 60% WF : 40% CF

Fig 10: Collected baked samples

3.3 SENSORY PROPERTIES OF BREAD

Statistical analysis of the sensory scores was obtained from 12 semi-trained panelists using9-point hedonic rating scale (9=like extremely, 1= dislike extremely) for composite breadformulations. Sensory analysis was performed with the aid of different panelists evaluatingcrumb appearance, color, texture, taste, flavor and overall acceptability of wheat flour and cornflour incorporated bread against the blank.

3.3.1 Effect of formulation on aroma

The mean sensory score for aroma of bread samples of different formulations are shown in Fig.11. The statistical analysis showed that the partial substitution of wheat flour with corn flour had significant effect on the aroma of the different bread formulation. Product B got highest score which was significantly different from other formulation. Product E got lowest score. The aroma of the 10% wheat flour incorporated breadwas found to be significantly superior. Also the product C was appreciated as the control product A.

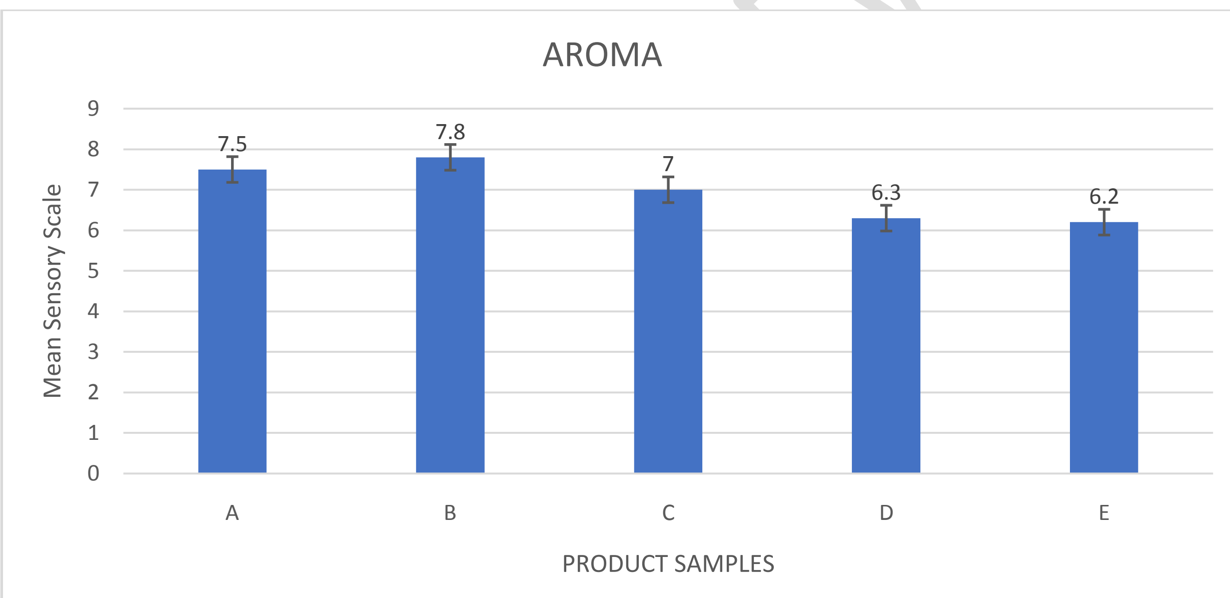


Fig. 11.Mean sensory scores for aroma of bread of different formulations.

3.3.2 Effect of formulation on Taste

The mean sensory scores for taste of bread samples of different formulations are shown in Fig. 12. The mean sensory score of product B was highest compared to all other composite products but was not significantly differentfrom product A and C. Product E is the lowest scoring formulations of all which indicatesthat higher amount of corn flour in the formulations could lower the score and acceptabilityof the product.Formulation containing

10% corn flour got high score which may be due to optimumamount of corn flour. The taste of the 10% and 20% corn flour incorporated bread was found to be significantlysuperior as judged by panelist.

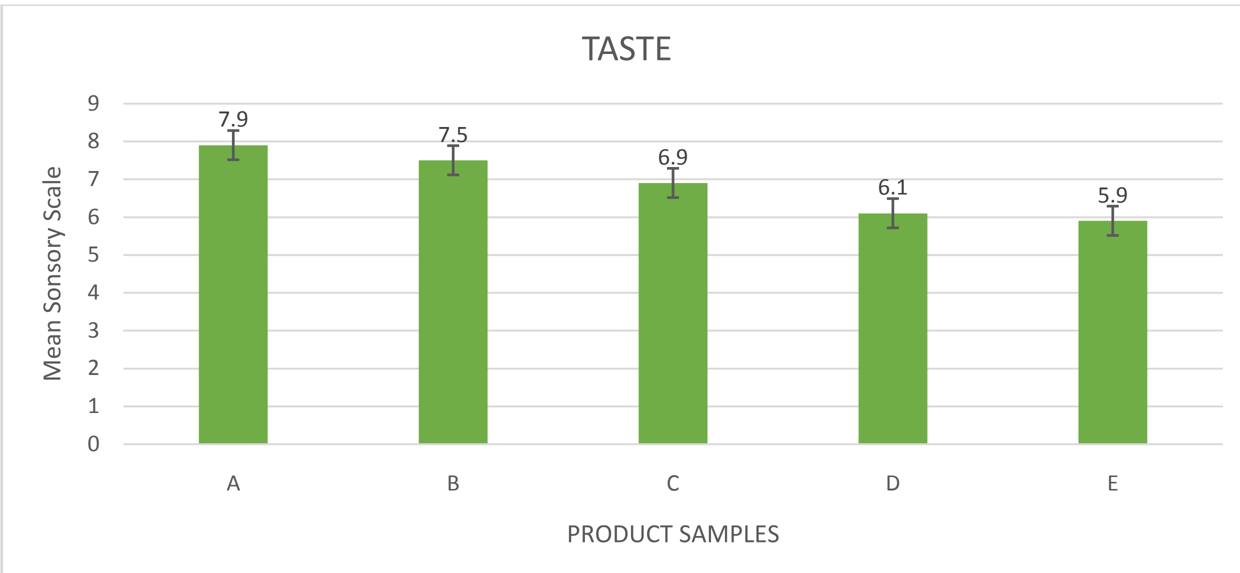


Fig. 12.Mean sensory scores for taste of bread of different formulations.

3.3.3 Effect of formulation on colour

The mean sensory score for colour of bread samples of different formulation are shown in Fig. 13. Statistical analysis showed that the partial substitution of wheat flour along with constant maize flour had significant effect on the colour of thedifferent bread formulation. Product B got highest score may be due to the appropriateamount of corn flour (10%). There is no significant difference in the colour of product B andproduct A. reduced sensory acceptability of composite flour bread for colour with increase inpercentage of other flour has been reported. With additional comment made on product sample C as also having an acceptable colour.

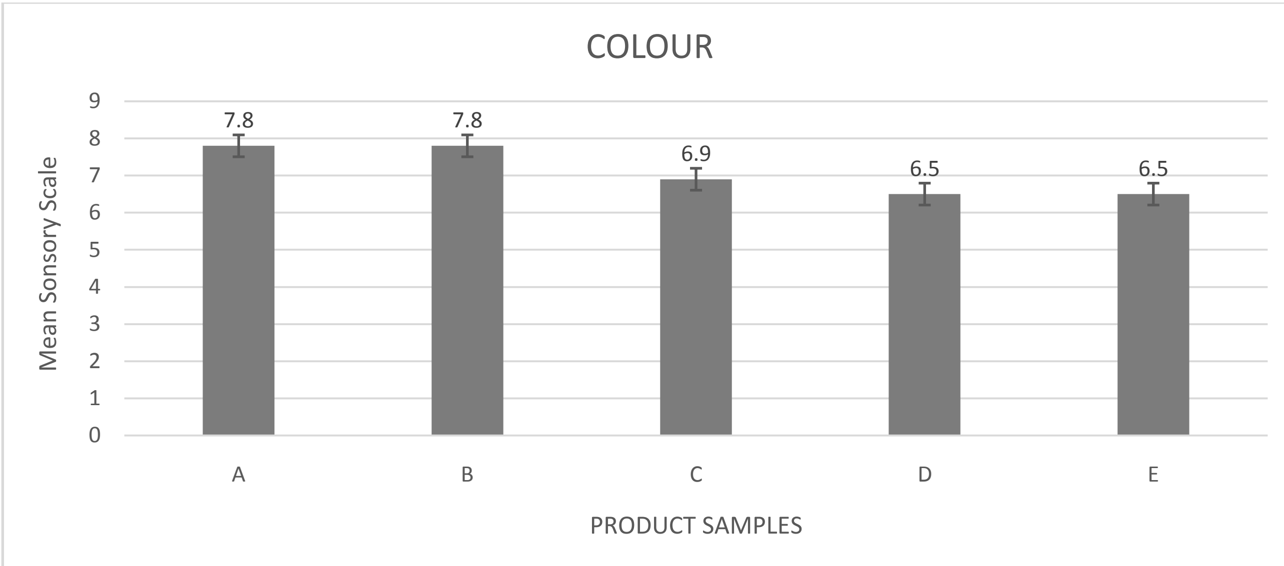


Fig. 13.Mean sensory scores for colour of bread of different formulations.

3.3.4 Effect of formulation on Texture

The mean sensory score for texture of bread samples of different formulations are shown in Fig. 14. The mean score was found to be highest for product B which was significantly different with other formulation with little significant difference with product sample C. As proportion of corn flour increases texture score decreases which may be due to increase in firmness of bread. Fresh corn bread was firmer (stiffer) than fresh wheat bread. This may be attributed to the lack of gluten network formation and smaller air cell structure ofbread after corn flour addition as confirmed by the higher density of the cornbread. A perfect texture should be free from lump and hardness and should present a smoothsilky surface.

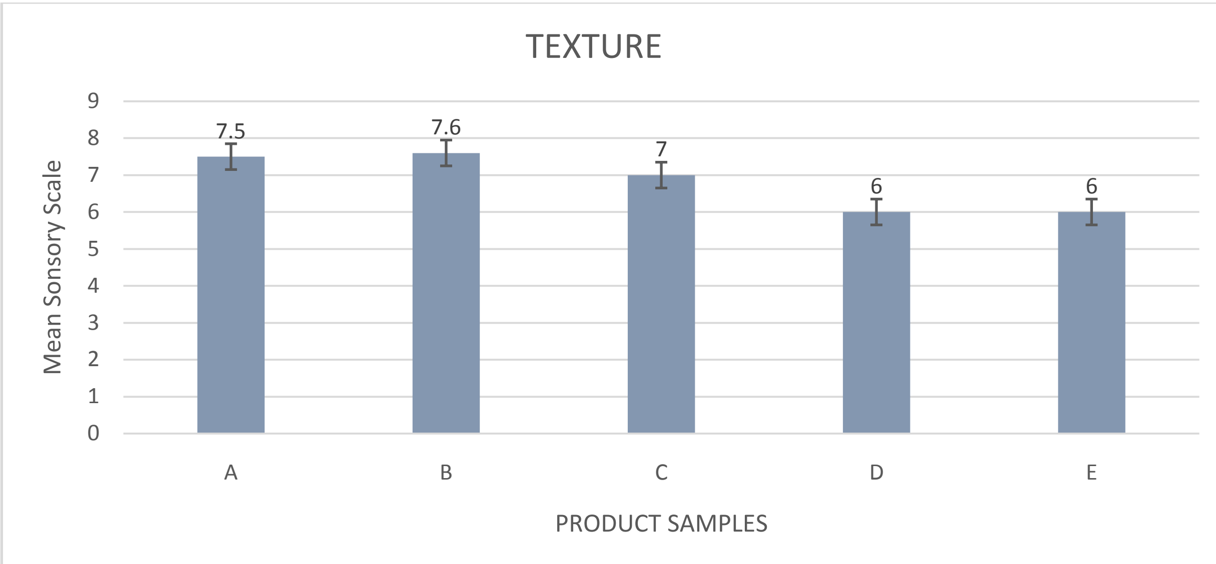


Fig. 14. Mean sensory scores for texture of bread of different formulations.

3.3.5 Effect of formulation on Crumb Appearance

The average mean scores of crumb appearance are shown in Fig. 15. The product B got highest score while D and E ranked lowest score because incorporating high levels of corn flour protein depresses loaf volume, gives poor crumb characteristics and decreases acceptability.

Upon hydration and during processing, gliadin and glutenin interact to a unique viscoelastic gluten network, for holding the gases and for producing light porous crumb textured bread. An appropriate balance in the amount of these two major protein components of wheat gluten is required for achieving the desired bread quality. Fat coats the proteins to interfere with gluten development, which creates a tender product. Sugar also interferes with gluten development, but too much fat or sugar will retard the development. Corn flour weakened wheat flour dough by increasing ash concentration. Substitution of gluten proteins by non-gluten-forming proteins causes a dilution effect and consequently weakens the dough. Corn flour proteins interfere with gluten formation in both a direct and an indirect way, the direct effect is related to an interaction between corn proteins and gluten proteins and the indirect effect is related to water availability of wheat proteins (Maforimbo et al., 2008).

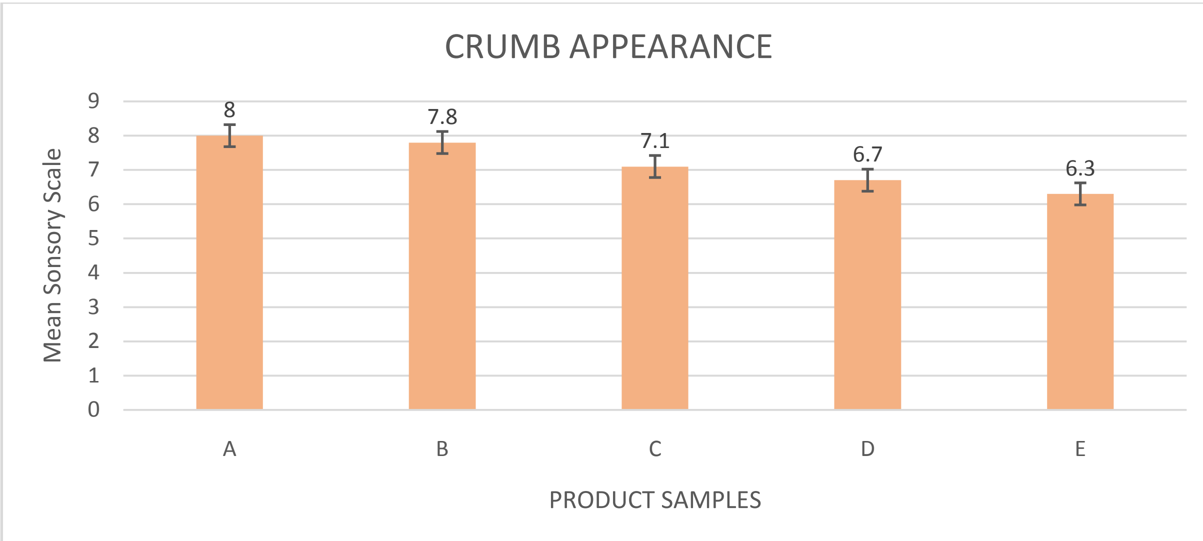


Fig. 15. Mean sensory scores for crumb appearance of bread of different formulations.

3.3.6 Effect of formulation on overall acceptability

The mean scores of overall acceptability of breads of different formulations are shown in Fig. 16 which shows the significant effect ($p<0.005$) on overall acceptability of the different bread formulations with partial substitution of wheat flour with corn flour. Product B got higher score which was significant different to all bread formulation. Color, crumb appearance, texture, taste and aroma of product B was very much liked similarly product C. Therefore,product B and product C got high score in terms of overall acceptability. The overall acceptability of the10% corn flour along with 20% corn flour incorporated composite bread was foundto be significantly superior, generally edible and acceptable.

It's generally estimated that the 90:10 (wheat flour: corn flour) sample B is best and most edible for consumption in a simple mixture of flour, yeast, sugar, salt and water resulting in no significant difference with the 100% whole wheat. And the 80:20 (wheat flour: corn flour) sample C would be more edible if other ingredients such as fats, natural improvers (eggs, milk), chemical improvers (ascorbic acid, lactic acid), emulsifiers, flavours which will all be provided by the Nigerian government according to the wheat policy act.

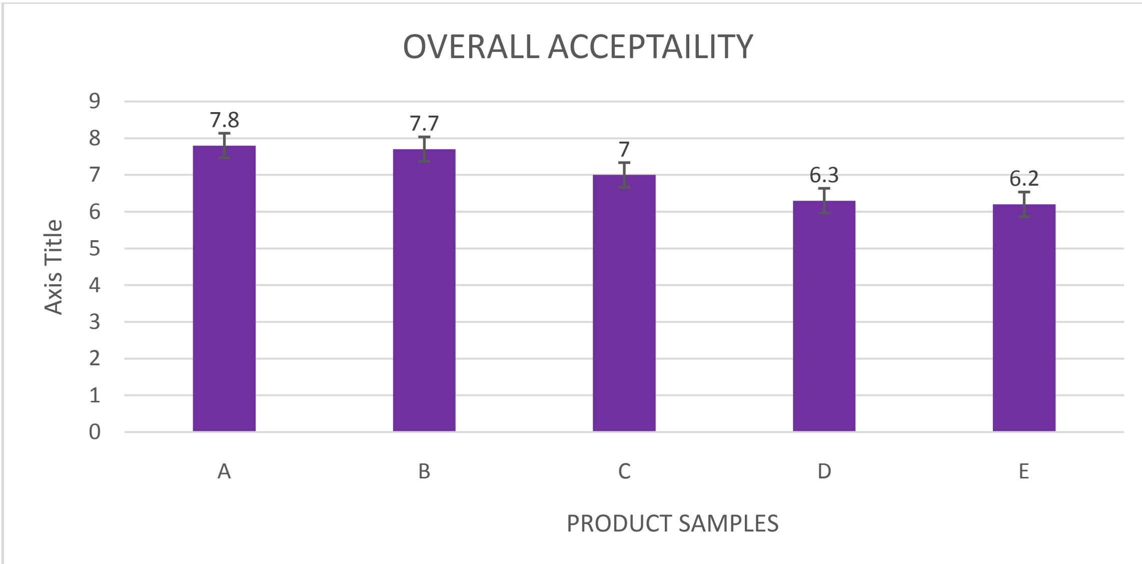


Fig. 16.Mean sensory scores for overall acceptability of bread of different formulations.

3.4 COSTING

Nigeria can only produce 1% - 3% of it's annual wheat consumption which is about 63,000 metric tonnes per year out of about 5-6 million metric tonnes per year which is needed for daily consumption throughout a year.

After the Corona virus (COVID-19), in the 2021/2022 planting year in Nigeria it was estimated that a 6000 area by 1000 Hectare produces 12,745 by 1000 tons of corn. Meaning that corn was planted in a 6,000,000 hectare of farmland to produce 12,745,000 tons of corn and 1 ton = 1000kg approximately. Therefore, averagely in a Hectare of farmland it's possible to produce 2.1 tons of corn. This this an average estimation for farmland with low soil fertility. With a good quality corn seeds, fertile soil and enough fertilizers and manure 1 hectare of farmland can produce 5-10 tons of corn yield.

Taking basis of 20% corn substitution to wheat bread means that the total number of imported wheat metric per tonnes will reduce by 20% resulting to 4.8 million metric per tonnes from the initial basis of 6 million metric per tonnes, making it 1,200,000 metric per tonnes less than the original value to be imported. Taking basis of annually produced corn at 12,745,000 metric per tonnes and subtracting the 20% at 1,200,000 metric per tonnes of needed corn. Therefore less than 10% of the annually produced metric per tonnes corn would be needed for a successful and edible composite bread.

If the corn wheat substitution is taken even up to 20% its said that Savings of the Nigeria's foreign exchange earning of N 260 billion per annum as at July 2022. Also the fertilizers, pesticides and all other farming materials will be provided according to the Nigerian Wheat Policy as well as training for farmers too. Its estimated from various research work both local and internationally that the incorporation and substitution of wheat flour with agro-based composite materials of any country is more cheaper, economical than using wheat for the complete production of bread.

4.0 CONCLUSION

Based on this findings, it can be concluded that composite bread can be successfully prepared using a combination of wheat flour and corn flour. The statistical analysis indicated that the formulation with a ratio of 90% wheat flour and 10% corn flour exhibited superior characteristics in terms of color, crumb, flavor, texture, taste, and overall acceptability compared to other formulations. The inclusion of both 10% and 20% corn flour in the bread was found to be acceptable for consumption. Furthermore, the production of composite bread offers cost advantages, as it is relatively cheaper, more economically viable, and helps save foreign exchange in the Naira market.

REFERENCES

Abdullahi, A., Alhassan, M., Isah, A. G., Sani, K. A., &Olalekan, O. A. (2018). Comparative studies on the kinetics of biogas purification using activated Carbon and Zeolite. *IOP Conference Series: Earth and Environmental Science*, *173*(1). https://doi.org/10.1088/1755-1315/173/1/012046

Abdulsalam, A., AlhajiYaro, N., Mohammed, A., Saleh Ibrahim, Y., Mustapha Yakasai, K., Iyayosa Andrea, D., &Alhassan, B. (2023). Kinetic Studies of Emerging Contaminants Removal from Wastewater using Organo Modified Activated Carbon. In *International Journal of Innovative Science and Research Technology* (Vol. 8, Issue 10). www.ijisrt.com

Abdulsalam, A., Ibrahim, Y. S., Yaro, N. A., Olanrewaju, O. A., Alhassan, B., Iyayosa, D. A., &Lawal, K. (2023). Emerging Contaminants Removal from Wastewater Using Organo-Modified Bentonite Clay. *Journal of Engineering Research and Reports*, *25*(10), 121–144. https://doi.org/10.9734/jerr/2023/v25i101006

Alhassan, M., Auta, M., Sabo, J., Umaru, M., & Kovo, A. (2016). CO2 Capture Using Amine-impregnated Activated Carbon from Jatropha curcas Shell. *British Journal of Applied Science & Technology*, *14*(4). https://doi.org/10.9734/bjast/2016/24253

Andrea, D. I., Abdulsalam, A., Aboje, A. A., &Azeez, O. S. (2023). Application of Activated Rice Husk for Adsorptive Bleaching of Groundnut Oil: Kinetic, Equilibrium and Thermodynamic Study. *International Research Journal of Pure and Applied Chemistry*, *24*(6), 52–72. https://doi.org/10.9734/irjpac/2023/v24i6840

AOAC (2000) Association of Official Analytical Chemists. Official Methods of Analysis. Vol. II, 17th Edition, AOAC, Washington DC.

Bello, A., Mohammed, A., Manase, A., &Abdullahi, A. (2021). Ascertaining Optimum Pyrolysis Conditions for Biochar Production from Maple Sawdust. *Current Journal of Applied Science and Technology*. https://doi.org/10.9734/cjast/2021/v40i4031597

Berghofer, E. 2000. Brot als funktionales Lebensmittel. GetreideMehlBrot 54(3):175-179.

Bugusu, B. A., Campanella, O. and Hamaker, B. R. 2001. Improvement of sorghum-wheat composite dough rheological properties and breadmaking quality through zein addition. Cereal Chemistry 78(1): 31- 35.

David MO (2006). Nigeria No. 1 Market for U.S. wheat: Potential forother grains and seeds. Foreign Agric. Serv. Bull. pp. 1 – 2.

Dewettinck, K., Van, Bockstaele, F., Kuhne, B., Van de Walle, Courtens, T., Gellynck, X. 2008. Nutritional value of bread: Influenceof processing, food interaction and consumer perception. Rev. J. Cereal Sci., 48:243-257.

Dobraszcyk, B.J. (2001). Wheat flour. In: Dendy, D.A.V. andDobraszcyk, B.J. (eds.). Cereals and Cereals Products Chemistryand Technology. Aspen Publishers Inc. New Delhi India, pp.100 – 124

Hasmadi, M., SitiFaridah, A., Salwa, I., Matanjun, P., Abdul Hamid, M. and Rameli, A. S. 2014. The effect of seaweed composite flour on the textural properties of dough and bread. Journal of Applied Phycology 26:1057–1062.

Hugo, L. F., Rooney, L. W. and Taylor, J. R. N. 2000. Malted sorghum as a functional ingredient in composite bread. Cereal Science 79(4): 428-432

Iyayosa Andrea, D., Abdulsalam, A., Uthman, H., & Sarafa Azeez, O. (2023). Article no.JMSRR.110513 Original Research Article Andrea et al. In *Journal of Materials Science Research and Reviews* (Vol. 6, Issue 4). https://www.sdiarticle5.com/review-history/110513

Maforimbo E, Skurray G, Uthayakumaran S, Wrigley C. Incorporation of soy proteins into the wheat–gluten matrix during dough mixing. *J Cereal Sci.* 2008;47:380–385. doi: 10.1016/j.jcs.2007.01.003.

Seibel, W. (2006). Composite flours. In Future ofFlour: A Compendium of Flour Improvement.Popper, L (ed). VerlagAgriMedia, pp. 193-198

Shittu, T.A., Raji, A.O., Sanni, L.O., 2007. Bread fromcomposite cassava-wheat flour: I. Effect of bakingtime and temperature on some physical propertiesof bread loaf. Food Res. Inter. 40, 280 – 290.