***Original Research Article***

**Comparative Study on the Proximate Evaluation and Sensory Properties of Bread Produced from Wheat, Acha and Date Fruit Composite Flour with White Bread**

**ABSTRACT**

The study aimed at comparing the proximate and sensory properties of bread produced from wheat, acha and date fruit composite flour with white bread using standard method The results obtained was compared to NAFDAC, 2023 standard for white bread. The composite flour ratios of wheat:acha:date used to produce the bread were 80%:10%:10% (sample B); 70%:20%:10& (sample C) and 60%:30%:10% (sample D). Sample A (white bread) was 100g wheat flour and served as the control. Bread samples produced from Sample B-D had higher values in crude protein (9.90% - 15.42%), ash (1.64% - 1.88%), crude fibre (0.27% - 0.53%) and crude fat (2.47% – 2.71%) than sample A while sample A had higher values in carbohydrate (65.83%) and moisture (19.21%) content. There was significant difference (p<0.05) among the bread samples. When compared to NAFDAC, 2023 standard for white bread, all the bread samples had moisture contents below the maximum (40%) thus better shelf life and storage stability; slightly more crude fat than the maximum (2.0%), more ash and carbohydrate content than the maximum standard of 0.60% and 48.0% respectively while sample D was above maximum standard of 0.50% for crude fibre and sample C and D had more crude protein than the minimum (10%) thus giving us a highly proteinous - fibred bread. The sensory scores showed that there was no significant difference among the bread samples. Thus there is the possibility of producing a highly proteinous-fibre rich bread that is gluten free with improved shelf life, energy densed, can be consumed by everyone and that can curb cases of diabetes, obesity, celiac disease and minerals capable of malnutrition problems

Keywords

Composite Flour, White bread, Proximate, Sensory, Protein Energy Malnutrition

**INTRODUCTION**

Composite flour as defined by NAFDAC (2023) is the combination of wheat flour and one or more non-wheat flour from indigenous cereals, roots, tubers, legumes or oilseeds to produce bread and other baked products. Composite flour has better nutritional value concerning elements of minerals, vitamins, fibres and protein than flour milled from any specific cereal alone (Hasmadi *et al*., 2020).

The Code of Food, Beverage and Shared Objects defines “bread”, as the product prepared by baking in special furnaces and under defined conditions of mass consisting of wheat flour, water, dough and a small amount of salt (Article 111, 2nd Edition, April 2014). Bread is one of the popular daily staple foods in many countries, with refined wheat flour commonly used in most white bread formulations (Issaoui *et al*., 2021). Bread is principally produce from mixture of flour, sugar, hydrogenated edible oil or refined edible oil of suitable type excluding lard, leavening agent, sugar (except for whole wheat bread), food grade salt and portable water (NAFDAC, 2023) fermented and baked.

NAFDAC (2023) defined white bread as a product obtained by baking a yeast-leavened dough made from essential ingredients with or without additional ingredients. This does not include whole wheat bread and bread from composite flour. White bread typically refers to breads made from wheat flour from which the bran and the germ layers have been removed from the whole wheat berry as part of the flour grinding or milling process, producing a light-colored flour (NPCS board, 2012).

Wheat (*Triticum aestivum*) is one of the oldest and most important cereal crops (McGuire, 2015; Akter and Rafigul, 2017) that is one of the major crops of the temperate countries (Dubcousky and Dvorack, 2007; McGuire, 2015; Ajatta *et al*., 2016) that contributes to 30% and 50% of the production and global grain trade respectively (Akter and Rafigul, 2017) and provides 82% of basic calories to the world population (Estrada *et al*., 2013). Wheat bread is high in carbohydrate, hence an energy giving food; however, it is relatively low in quantity and quality in terms of protein content (Seal *et al*., 2021). The production of baked products such as bread, cakes, buns, doughnuts, and biscuit generally use wheat flour due to its elastic gluten protein, gliadins and glutelins (Villarino *et al*., 2014; Barak *et al*., 2013) which when mixed with water produces a relatively large loaf volume with a regular, finely vesiculated crumb structure (Hui, 2006). Despite its remarkable nutritional composition, wheat is linked to metabolic health disorders, such as celiac disorders, diabetes, gluten intolerance, and obesity, due to the presence of higher levels of carbohydrates and low proteins (Rennan Feng *et al*., 2015, Giannou and Tzia 2016, Anania *et al*., 2017, Biesiekierski 2017, Aramburo-Galvez *et al*., 2020 Eunjung *et al*., 2023).

Acha *(Digitaria exili*s), grows on poor sandy soil, which often will not support the growth of some of the more popular cereals (Ayo *et al*., 2018). Acha is considered as one of the nutritious grains; its seeds contain 8.79% protein (Ayo *et al*., 2021). Nutrition experts have acknowledged it as exceptional. It has relatively low free sugar and low glycemic content (40%) and this makes it adequate as a suggested diet of diabetic patients (Cruz, 2004, Ayo *et al*., 2010; Agu *et al*., 2014, Ayokunle *et al*., 2024). Acha is known to be easy to digest, and is traditionally recommended for children, old people and for people suffering from diabetes or stomach diseases (Ayo *et al*., 2007). Acha does not contain any glutelin or gliadin proteins which are the constituents of gluten, making it suitable for people with gluten intolerance (Ayo *et al*., 2007; Ayo and Andrew, 2016, Aloisa *et al.*, 2022). Jillian (2020) reported Acha to be rich in fibre. According to Anderson *et al*. (2009) the high fiber content of Acha may be useful for people who wish to lose weight as the fiber itself has no calories, yet provides a "full" feeling because of its water-absorbing ability in addition to the fact that it may help reduce the risk of some cancers, especially colon cancer. This idea is based on the information that insoluble fiber increases the rate at which wastes are removed from the body (Anderson *et al.* 2009).

The date palm fruit (*Phoenix dactylifera*) commonly known as “Debino” by the Hausa tribe is believed to have been introduced into Nigeria in the early 17th century through the trans-Sahara trade made from North Africa and Muslim Pilgrims in Pilgrimage to the Holycities of Mecca and Medina (Omamor *et al*.,2000). Dates when eaten replenish energy, revitalize the body instantly (Sultana *et al*., 2015). For these qualities, they are being served to break the fast during Ramadan month since ancient times. Date fruit contains a considerable amount of moisture (12-14), crude fibre (4.5 -5.0), protein (2.0 – 2.5), fat (1.8 – 2.4) and ash (1.7 – 1.9) which is essential for children’s growth and development (\*Abdul *et al*., 2022). Al-Shahib and Marshall (2003) reported dates to be rich in dietary fibre (Siavoshi *et al*., 2020; Wang *et al*., 2021, Safran *et al*., 2024) and is recommended for pregnant women who are close to delivery and during their lactation period (Chiraz *et al*., 2020). It can be used to replace sugar since it has a lower glycemic index than any sugar alternatives (Conklin and Stilwell, 2007; Pasupuleti, 2008; Shiza *et al*., 2022). Date is also rich in antioxidants and phenolic compounds and also contains antimicrobial properties (Abdul *et al.*, 2022). This will improve the shelf life and storage stability of the bread (Ayo *et al*., 2024).

The local climatic conditions in tropical countries such as Nigeria that is characterized by hot and humid climate and distinct rainy and dry seasons (Reuben *et al*., 2025) and whose soil are generally not naturally suitable for wheat farming due to low organic matter and nutrient deficiency is not suitable for profitable wheat production (Reuben *et al*., 2025), and consequently, Nigeria has been solely dependent on importation of wheat for the production of baked products. This research is aimed at comparing the proximate composition and sensory properties of bread made from wheat, acha and date palm fruit composite flour with white bread and to compare each bread sample with NAFDAC (2023) standard for white bread then finally enlighten consumers on the use of composite flour from our nutritious local crops to replace wheat flour thus supplementing the nutrients lacking in wheat, creating variety in diet, handling cases of celiac disease and gluten intolerance and more importantly, providing a highly nutritious baked bread that can be consumed by everyone and is capable of solving malnutrition problems.

**2.0 MATERIALS AND METHODS**

**2.1 Procurement of Materials**

Wheat flour, acha grain, date fruit and the other ingredients like sugar, yeast, baking fat, baking powder, milk flavor and salt were all purchased from North Bank Market in Makurdi Benue State. Procured materials were taken to the food processing laboratory of Food Science and Technology department, Benue State for processing. All chemicals used were of analytical grade

**2.2 Preparation of raw materials**

Standard processing procedures and chemicals were used in the preparation of the flours and bread formulation

**2.2.1 Preparation of Acha Flour**

Acha flour was prepared according to the procedure reported by Olagunju *et al*. (2020) with slight modification. The Acha grains were washed with tap water to separate stones and sand, then, they were dried in the cabinet dryer at 50oC for 6 hours. The resultant dried Acha was milled and sieved into flour using the hammer mill with 0.5 mm screen size.

**2.2.2 Preparation of Date Fruit Flour**

The Date palm fruit flour (powder) was prepared according to Ikechukwu *et al*. (2017) with slight modification. The date palm fruit was de-seeded, sorted and washed. The sorted deseeded broken dates are then oven dried at 80oC for 2hours. The dried dates are milled then sieved to date palm powder. The date flour is then packaged in a sealed plastic and stored at 4oC.

**2.3 Formulation of Composite Flour**

The composite flour with ingredients for bread making was prepared as shown in Table 1. The composite flours were thoroughly mixed at different ratios to obtain a homogenous blend and stored at ambient temperature (30±2oC) in air tight container until required for bread production.

**Table 1: Formulation of the composite flour with ingredients for bread making**

SAMPLE Wheat Acha Date Sugar Salt Yeast Baking Milk Baking

 Flour Flour Flour Powder Flavour Fats

 (g) (g) (g) (g) (g) (g) (g) (g) (g)

A 100 0 0 10 1 2 20 10 5

B 80 10 10 - 1 2 20 10 5

C 70 20 10 - 1 2 20 10 5

D 60 30 10 - 1 2 20 10 5

Source: Ayo *et al*. (2024) – Modified

**KEY**

Sample A: 100% wheat flour

Sample B: 80% wheat flour, 10% acha flour and 10% date flour

Sample C: 70% wheat flour, 20% acha flour and 10% date flour

Sample D: 60% wheat flour, 30% acha flour and 10% date flour

**2.4 Production of bread**

Bread was produced using the straight dough (direct dough) method involving bulk fermentation as reported by Olaoye and Obidegwe (2018). A quantity (100g) each of the flour samples were weighed and an addition of required amount of water and other ingredients was done to obtain dough and kneaded on a pastry-board to smoothen. The dough was initially fermented for 1 hour at 30oC before subsequently kneaded to expel carbon dioxide and then, it was tightened-up to ensure improvement in the textural properties of the bread. The dough was sized and molded into the baking pans for final proofing at 30oC for 2 hours. Baking of the dough was carried out in a forced air convection electric oven (380V, ROHS Deck Baking Oven, Hangzhou 311121, China) at 230oC for 30 minutes

**2.5 ANALYSIS**

The research used a combination of quantitative approach to determine the proximate composition (AOAC, 2015) of the bread and a qualitative approach to evaluate the sensory properties of the bread made from wheat, acha and date fruit composite flour.

**2.5.1 Determination of proximate composition of the white bread and the bread produced from wheat, acha and date palm fruits composite flour**

The moisture, protein, fat, ash, and crude fiber contents were determined following the procedure outline by AOAC (2015), while carbohydrate was calculated by difference (Ihekoronye and Ngoddy, 1985).

 **(a) Determination of moisture content**

The moisture content was determined using the method of AOAC, (2015). A clean dish with a lid was dried in an oven at 100oC, it was cooled in a desiccator and weighed. Five grams of the sample was weighed into the dish. The dish with its content was put in the oven at 105oC and dried to a constant weight. The moisture content was calculated as:

**(b) Determination of ash content**

The ash content was determined by the standard method of AOAC, (2015). Two grams of the sample was weighed into a dried pre-weighed porcelain crucible. The sample was transferred into a preheated Muffle furnace (carbolite, Bamford S30AU) and heated at 550oC for 2 hours. The ash was then removed, cooled in a desiccator and weighed. The percentage ash was calculated as:

**(c) Determination of crude protein content**

The protein content was evaluated using Kjedahl method as described by AOAC (2015) as reported by Czubaszek et al. (2021). Two grams of samples was put into kjeldahl flask and sodium sulphate (7.68g), copper sulphate (0.28g), Selenium dioxide (SeO4) (0.04g) and 25ml of concentrated H2SO4 were added. The flask was heated on a heating mantle, until the solution became clear. The digest was transferred into distillation flask, 100ml water and 15ml NaOH was added. The 3 drops of methyl red indicator were put into the distilling flask. They were boiled in the distillation apparatus to liberate ammonia into the receiving flask containing 50ml of 2% boric acid. This was titrated against 0.01N Hydrochloric acid (HCl). The protein was calculated as:

**(d) Determination of crude fiber content**

The fiber content of the sample was determined according to the method of AOAC (2015). Two (2) gram of the prepared samples were extracted using diethyl ether. This was digested and filtered through the California Buckner system. The resulting residue was dried at 103±2oC in an oven (uniscope 5m 9053 laboratory oven) for about two hours and cooled in desiccators. The weighed residues was then transferred into a muffle furnace and ignited at 600 ± 100oC at 30 minutes, cooled in desiccators and reweighed. The percentage crude fiber was calculated as:

Mdry = sample weight after drying

Mash = sample weight after ashing

Msample = sample weight

**(d) Determination of total fat content**

The soxhlet solvent extraction method was used to determine fat content according to AOAC (2015). Two (2) grams of the sample were weighed into the extraction thimble and fixed into extraction flask of known weight. Extraction was carried out using diethyl ether in electro thermal model extractor for 5 hours. At the completion of the extraction, the ethyl ether was removed and the remaining fat in the flask was dried at 60oC for 30 minutes in the oven cooled for 15 minutes and weighed. The percentage fat was calculated as follows:

Where:

W1 = Weight of sample before extraction

W2 = Weight of sample after extraction

W3 = Original weight of sample

**(e) Determination of carbohydrate content**

The carbohydrate content was calculated by difference as described by Ihekoronye and Ngoddy (1985) as:

**2.5.2 Determination of Sensory properties of the bread samples**

The samples were analyzed based on crumb, colour, crust, aroma, taste and general acceptability using a 9-point hedonic scale by fifteen-member panel who are familiar with bread. The rating of the samples ranged from 1 (extremely dislike) to 9 (like extremely) (Ihekoronye and Ngoddy, 1985).

**2.6 Statistical Analysis**

Triplicate data obtained were subjected to statistical analysis using the Statistical Package for the Social Science (SPSS), version 28. The analysis of variance (ANOVA) were used to determine significance difference between the mean (P<0.05) while the means was separated using Duncan Multiple Range Test (DMRT).

**3.0 RESULT AND DISCUSSION**

**Proximate Composition of the White Bread and the Bread Produced from the Composite Flour of Wheat, Acha and Date palm fruit**

The proximate composition of white bread and the bread produced from the composite flour of wheat, acha and date palm fruit are presented in Table 2. The moisture content (21.80%) and carbohydrate content (65.83%) of the white bread (Sample A) was higher than any of the composite flour bread samples (B-D) but with respect to crude fibre, crude protein, crude fat and ash content, the composite flour bread samples (B-D) had higher values with each substitution of wheat flour with acha and date palm fruit flour. Sample D (60% Wheat flour,30% Acha flour, 10% Date flour) had the highest value for crude fibre (0.53%), crude protein (15.42%), crude fat (2.71%) and ash content (1.88%). There was no significant difference between sample A (control) and sample B (80% Wheat flour,10% Acha flour, 10% Date flour) for carbohydrate content.

From the result, it was observed that the moisture and carbohydrate content of the composite flour (sample B-D) were lower than that of the white bread while the crude protein, crude fat, crude fibre and ash content of the composite flour (sample B – D) were higher than that of the white bread. This result is in agreement with Dabel *et al* (2016) who reported a decrease in moisture content and carbohydrate content but an increase in crude protein, crude fibre, crude fat and ash content as wheat flour was substituted with acha and mungbeans flour to produce bread. Dabel *et al*. (2016) reported that the high protein, low carbohydrate composite flour bread samples has nutritional advantage over the bread made with only wheat flour especially for individuals with health problems that may require protein – rich and low – carbohydrate foods such as diabetics. This result is also in agreement with Ijemi *et al*. (2025) who reported an increase in ash, crude fibre, crude protein and crude fat as wheat flour was substituted with acha and date flour to produce composite flour that could be used in the baking industry. Ijemi *et a*l. (2025) also surmised that if the composite flour of wheat, acha and date flour was used to bake, then the product baked should be rich in crude protein, crude fibre and ash content. Ayo *et al*. (2024) also reported an increase in crude protein, crude fibre, ash and crude fat as wheat flour was substituted with acha flour complemented with defatted bambara and groundnut flour. Seal *et al*. (2021) reported that bread made from wheat flour is high in carbohydrate, hence is an energy giving food. This will explain why the white bread (sample A) had the highest value in carbohydrate content and also why when wheat flour was substituted with acha and date palm flour, the lesser the carbohydrate content observed in the bread samples made from the composite flour (B – D). The highest value of carbohydrate obtained in white bread (sample A) suggest that it will contribute more in maintenance of the plasma glucose level, sparing the body protein from being easily digested (Onimawo et al., 2019). Several researchers had also reported dates to be a rich source of dietary fibre (Ghmini *et a*l., 2015, Ghmini *et al*., 2017 Al-Shahib and Marshall 2003, Siavoshi *et al*. 2020, Wang et al. 2021, Safran et al. 2024, Ijemi et al. 2025) which adds bulk to diet and helps in bowel movement (Peter – Ikechukwu *et al*. 2020) and also, acha seed and date fruit to contain protein in varying percentages” (Ayo *et al*. 2018, Temple and Bassa 1991, Al-Shahib and Marshall 2003, Siavoshi et al. 2020, Wang *et a*l. 2021, Safran *et al*. 2024, Ayo et al. 2021). The ash content of any food is a measure of the total amount of minerals within food produce (Ojinnaka and Nnorom 2015, Hamza *et a*l. 2014, Akubor and Ishiwu, 2013). Some of these minerals that make up the ash content of a food aid in the metabolism of other organic compounds such as fat and carbohydrate” (Akinola *et al*.2015), therefore bread with higher fat will provide vital and beneficial minerals needed for the development of human bones and body metabolism (Onwuka, 2018). Chinma *et al.* (2012) reported that the increase in ash content is an indication of increased mineral content capable of solving malnutrition problems.

**Table 2: Proximate Composition of the White bread and the bread produced from the composite flour of Wheat, Acha and Date Palm Fruit**

Samples Moisture C/Protein Crude Fibre Crude Fat Ash Carbohydrate (%) (%) (%) (%) (%) (%)

A 21.80a±0.21 9.20 d±0.04 0.23c±0.01 2.25d±0.02 0.69d±0.06 65.83a±0.31

B 20.78b±0.07 9.90c±0.02 0.27c±0.02 2.47c±0.02 1.64c±0.04 64.95a±0.15

C 19.68c±0.25 13.20b±0.01 0.32b±0.03 2.56b±0.08 1.70b±0.02 62.53b±0.42

D 19.21d±0.13 15.42a±0.05 0.53a±0.03 2.71a±0.03 1.88a±0.02 60.25c±0.25

Values are Means ± Standard Deviation of Triplicate Determination. Values followed by thesame subscript (s) within the same column are not significantly different at 5% probability level.

**KEY**

Sample A: 100% wheat flour

Sample B: 80% wheat flour, 10% acha flour and 10% date flour

Sample C: 70% wheat flour, 20% acha flour and 10% date flour

Sample D: 60% wheat flour, 30% acha flour and 10% date flour

**Comparison of Chemical Properties of Bread Samples with Specification of Standard of National Agency of Food and Drugs, Administration and Control (NAFDAC, 2023) for White Bread**

The values for the comparison of chemical properties of the bread samples with specification of standard of National Agency of Food and Drugs, Administration and Control (NAFDAC, 2023) for white bread are presented in Table 3.

**Table 3:** **Comparison of Chemical Properties of Bread Samples with Specification of Standard of National Agency of Food and Drugs, Administration and Control (NAFDAC, 2023) for White Bread**

Parameters NAFDAC Sample A Sample B Sample C Sample D

Ash (%) Max. 0.6 0.69 1.64 1.70 1.88

Crude Fat (%) Max. 2.0 2.25 2.47 2.56 2.71

Crude Fibre (%) Max. 0.5 0.23 0.27 0.32 0.53

Protein (%) Min. 10 9.20 9.90 13.20 15.42

Moisture (%) Max. 40 21.80 20.78 19.68 19.21

Carbohydrate (%)Min. 48 65.83 64.95 62.53 60.25

**KEY**

Sample A: 100% wheat flour

Sample B: 80% wheat flour, 10% acha flour and 10% date flour

Sample C: 70% wheat flour, 20% acha flour and 10% date flour

Sample D: 60% wheat flour, 30% acha flour and 10% date flour

**Moisture content**

The average moisture content of the composite flour bread samples (B-D) ranged from 19.21% - 20.78% while sample A was 21.80%. All the bread samples had moisture contents below the maximum required standard levels of 40%. This is an indication that the bread samples cannot spoil easily as a result of their moisture content which may bring about changes in their aesthetic qualities. Higher moisture content in bread provides for suitable condition for microbial growth and activities thereby affecting the shelf life and causing spoilage (Herz, 1960, Barak *et al*. 2013) of the product. This is one of the reason why bread is not packaged while it is still hot to prevent the condensing of steam on the bread. The lower moisture content in all the bread samples (A – D) proves that the bread produced has longer shelf life and also increased storage stability. According to Ayah and Heba (2024), Zilpah (2023), UNEP (2021), Hussah (2019), Lourenco (2019) and WebMD (2023) date powder contain natural antioxidants that can delay the oxidative rancidity of fats of stored foods thereby maintaining the products appeal and shelf life. These characteristics of dates and the lower moisture content of the bread samples which were all below the maximum standard of NAFDAC (2023) is certainly an advantage in the bakery industry as we all need products that are highly nutritious with longer shelf life or storage stability.

 **Crude protein**

The average crude protein content of the composite flour bread samples (B-D) ranged from 9.90% - 15.42% while sample A was 9.20%. Sample B (80% Wheat flour, 10% Acha flour and 10% Date fruit flour) coincidentally had approximately almost thesame value with the minimum standard requirement for white bread which is 10% while sample C – D had higher values for protein content than the minimum standard. Protein is needed for growth, repairs of worn out tissues (Onwuka, 2018), regulation and maintenance of the body (Ayo et al. 2024). Deficiency of protein (in quantity and quality) could lead to Protein Energy Malnutrition (Abuengmoh *et a*l.2024, Hasmadi, 2020, Peter – Ikechukwu, 2020, Biersiekieski, 2017). Protein rich diet as reported by Dabel *et al* (2016) is also necessary for people suffering from diabetes. Thus the fact that sample C –D had crude protein values higher than the minimum value of white bread given NAFDAC (2023) is an excellent advantage when it comes to the health and well- being of humanity.

**Crude fat**

The average value for crude fat content of the composite flour bread samples (B-D) ranged from 2.47% - 2.71% while sample A was 2.25%. The maximum standard value for crude fat is 2.0% of which 0.5% saturated fat. Almost all the bread samples were slightly above standard. Greasing of the pan with baking fat before baking could have contributed to the slight increase in the samples from the standard. Fat acts as flavor retainers and help to improve the sensory properties of baked products (Peter – Ikechukwu et al. 2020). “However, diets high in fat predispose consumers to different illnesses such as obesity and coronary heart diseases” (Akinola et al.2015). High levels of fats in food product should be less than 25% (<25%), since this could lead to rancidity in foods and development of unpleasant and odorous compounds (Ikumola *et al*., 2017). Though the difference of the fat contents of the bread samples and that off NAFDAC (2023) standard may look insignificant, it is advisable to reduce the fats used to grease the pan or in the bread formulation so that the bread produced would all be within standard and healthy in all ramification.

**Crude fibre**

The average value for the crude fibre content of the composite bread samples (B-D) ranged from 0.27% - 0.53% while the control sample A was 0.23%. The maximum standard requirement of fibre for white bread is 0.50%. Sample D (60g Wheat flour, 30g Acha flour and 10g Date flour) was slightly above standard which isn’t a problem but a health benefit since fibre improves digestion in the body (Ayo and Andrew, 2016). The increase in fibre content is also an improvement in the nutrient status of the bread since they are agents in food which aids absorption during the absorption process (Ubbor *et al.*, 2022) and is beneficial for digestive health (Arukwe *et al*. 2021).

**Ash content**

The average ash content of the composite flour bread samples (B-D) ranged from 1.64% - 1.88% while sample A was 0.69%. The control stabilized within the limit of the maximum standard requirement of 0.60%. The ash content of any food is a measure of the total amount of minerals within food produce (Ojinnaka and Nnorom 2015, Hamza *et al*. 2014, Akubor and Ishiwu, 2013) and these minerals are capable of solving malnutrition problems (Chinma *et al.* 2012).

**Carbohydrate content**

The average carbohydrate content for the composite flour bread samples (B-D) ranged from 60.25% - 64.95% while sample A was 65.83%. The minimum standard requirement approved for white bread was 48.0%. Carbohydrate contribute more in maintenance of the plasma glucose level, sparing the body protein from being easily digested (Onimawo et al., 2019) and they are the principal and indispensable source of energy (Khan et al., 2013). Energy is an essential property of food and the energy required by humans for daily activities is supplied by food (Ubbor *et al*., 2022).

**Sensory Properties of White Bread Compared with that of the Composite Flour Bread Samples**

The sensory evaluation result of the white bread and that of the bread produced from the composite flour of Wheat, Acha and Date Palm Fruit are presented in Table 4. The mean scores for each of the quality attributes (Crumb, Colour, Crust, Aroma, Taste and General Acceptability) ranged from 6.00 – 7.47 for Crumb, 6.67 – 7.67 for colour, 7.20 – 8.13 for crust, 6.47 – 7.13 for aroma, 6.60 – 7.67 for Taste and 7.60 – 8.20 for General Acceptability. The mean score for crumb, colour and crust decreased with increasing acha and date flour thus making sample A (white bread), to have the highest value while sample B (80% Wheat flour, 10% Acha flour, 10% Date flour) had the least value for crumb and sample D (60% Wheat flour, 30% Acha flour, 10% Date flour) had the least value for colour and crust. The colour of the bread and it crust changed from creamy to dark brown as the substitution of wheat flour with acha flour and date flour. The dark brown colour may be due to maillard reaction between the reducing sugar and amino acids (Raidi and Klein, 1983; Dingra and Jood, 2005) contained in acha and date fruit flour and also due to the dactyliferic acid and its isomers that are enzymic browning substrates found in dates (Maier *et al*.,2001).

Sample B (80% Wheat flour, 10% Acha flour, 10% Date flour) had the highest value while sample D (60% Wheat flour, 30% Acha flour, 10% Date flour) had the lowest value for aroma respectively. For taste, sample A (White bread) had the highest value while sample C (70% Wheat flour, 20% Acha flour, 10% Date flour) had the lowest value. In overall acceptability, sample A had the highest value while sample D (60% Wheat flour, 30% Acha flour, 10% Date flour) had the least value. There was no significant difference between all the bread samples in crumb, colour, aroma, taste and overall acceptability. This result goes in agreement with the work published by Dabel *et al. (*2016) where it was discovered that the taste of the bread made from 80% Wheat flour, 10% Acha flour, 10% Mung bean could be compared with bread made from 100% Wheat flour.

With this result, we can say that healthy and nutritious bread can be baked from composite flour of Wheat, Acha and Date fruits flour up to 40% substitution of wheat flour with acha (30%) and date flour (10%) and the composite flour bread when compared with white bread were all acceptable.

**Table 4: Sensory Properties of White Bread Compared with that of the Composite Flour Bread Samples**

Samples Crumb Colour Crust Aroma Taste Overall

 Acceptability

A 7.47a±0.61 7.67a±0.33 8.13a±0.22 6.67a±0.61 7.67a±0.46 8.20a±0.17

B 6.00a±0.71 7.47a±0.46 7.20a±0.47 7.13a±0.43 7.60a±0.32 8.07a±0.47

C 6.93a±0.43 7.00a±0.40 7.53a±0.32 6.53a±0.42 6.60a±0.58 7.80a±0.28

D 6.60a±0.62 6.67a±0.53 7.33a±0.46 6.47a±0.59 7.00a±0.53 7.60a±0.58

Values are Means ± Standard Deviation of Triplicate Determination. Values followed by thesame subscript (s) within the same column are not significantly different at 5% probability level.

**KEY**

Sample A: 100% wheat flour

Sample B: 80% wheat flour, 10% acha flour and 10% date flour

Sample C: 70% wheat flour, 20% acha flour and 10% date flour

Sample D: 60% wheat flour, 30% acha flour and 10% date flour

**Conclusion and Recommendation**

The study compared the proximate and sensory properties of bread produced from wheat, acha and date fruit composite flour with white bread and the result of the proximate properties were then compared with standard of NAFDAC (2023) for white bread. The study concluded that highly nutritious and organoleptic acceptable bread can be produced from the composite flour of wheat, acha and date fruit using an optimum level of 60% wheat flour 30% acha flour and 10% date fruit flour (Sample D) which was higher in the protein, fibre, ash and fat contents than white bread. Comparing with NAFDAC (2023) for white bread, all the bread samples had lower moisture content thus better shelf life and storage stability while the bread made from the composite flour especially sample D had more fiber, ash, protein which are also of benefits to the health of humanity. All the bread samples were all of acceptable quality on a 9 – point hedonic scale. Based on the result, instead of the bakery industry, hotels and eateries to be focused on baking with only wheat flour, composite flour of wheat, acha and date fruit should be advocated for commercialization thus flooding the food market with highly proteinous-fibre rich bread that is gluten free with improved shelf life, energy densed, can be consumed by everyone and that can curb cases of diabetes, obesity, celiac disease and minerals capable of malnutrition problems. Sample D is highly recommended for commencialization.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author (s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text –to – image generators have been used during the writing or editing of the manuscripts.

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