OriginalResearchArticle

QUALITY CHARACTERISTICS AND SENSORY PROPERTIES OF BREADELLABORATEDWITHFLOURBLENDSOFWHEATAND AFRICANYAMBEAN`

Abstract

Keywords:F

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sensoryproperties

Thisstudyevaluatedqualitycharacteristicsandsensorypropertiesofbreadelaborated with flour blends of wheatand African yam bean. The wheat flour wasprocured,whilethepurchasedAfricanyambeanseedswerecleaned,sorted,washeda ndsteepedin2.5litresofcleanwaterfor12hwithintermittentchangingofsoakingwaterat3 hintervals,drained,sprayedonmoistenedjutebagspreadonmaltingtableand covered with moistened jute bag. The seeds were germinated for 72 h withoccasional sprinkling of water. Thereafter,harvested imbibed seeds weredried in ahotairovenat60°Cfor12handconvertedintoflourwithattritionmill.WheatflourandAfri canYamBeanflourweresievedindividuallywith500mmmeshsizesieve.Theflourswere blendedinthepercentageratios(W:W)of100:0,90:10,80:20and70:30forsamplesA,B,C andD,respectively.Threegramsofyeast(Saccharomycescerevisiae, FoshanCeng Goa Food Co. Ltd, De Rich Instant Dry)weredissolvedin clean bowlwith 30 ml of water and 10 g sugar of the stipulated receipe and leftfor 1 h to activate at ambient temperature (29 ± 1°C). The flour blends wereevaluatedforproximatecomposition,functionalpropertiesandconsumeracceptabilit y.Preferencerankingtestswereconductedtodescribeandevaluatetheacceptabilityofthebreadloave saccordingtohedonicscaleontexture,flavour,colourandoverall acceptability using a 9-point, where1 = dislike extremely and 9 = extremelylike.Thedatageneratedwereanalyzedstatistically usingone wayanalysisofvariance and means separated by Tukey test at 5 % level of Significance. The resultsshowedthatsampleD–30%substitutedAfricanyambeanflourhadhigherswellingindex (1.81g/g), water absorption capacity (160.00 %), protein content (14.89 %),fat content (2.80 %), panelists textural scores (6.55) and the least flavour scores(4.05),colourscores(5.70)andoverallacceptabilityscores(3.85)comparedtoothe rsamples. There were no statistically significant differences ($p < 0.05$) in overallacceptabilityscoresofsamplesB,CandD.Theoverallacceptabilityscoresshowed thatsamplesacceptancedecreasedwithincreasedlevelsofsubstitutionwithAfricanyam beanseedflour.
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1. Introduction

Many household especially those with children prefer their breakfast to be bread which is afermented product. Bread is made mostly from wheat flour an imported product (Okoye andOkaka, 2009) andit isimportant staple whose consumption has increasedgreatly inbothdeveloped and developing Countries. Breadis the most consumed cereal based product andthesecondwidelyconsumednon–indigenousfoodafterrice.Duringbreadproductionmanyingredientsareaddedtowheatflourtoincreaseitspalabilityandimprovesitsflavourdevelopment.

Hence, bread could serve as vehicle for supply of important nutrients which emanate from thesubsidiary products. An addition ofwater to flour results to paste or dough. Waternot onlydissolve soluble protein groups in flour (albumin, globulin and proteoses) but also leave theundissolved glutenin and gliadin to form bread structure. The quantity ofliquid added to flouraffectsthetextureandcrumbofbread,hencegoodloavesaremadebyadoptingpercentagerecipeof dry ingredients to the stated quantity of liquid(Edema, 2004). Calcium propionate is also anessential ingredients, which are added to retard growth of moulds and extend the shelf-life of thebread. Breadmay lack good volume probably due to insufficient kneading to enable good glutenstretch. “The rising of dough during fermentation is as a result of network of reaction complexestakingplaceinwhichtheglutenretainsCO_2,bindingwatertemporarily,activatingthegelatinization of starch and the formation of foam – raising structures of the bread” (Lagrain*et al.,*2013). Bread is known to undergo high economic loss caused by staling and microbial spoilage(moulds and rope spoilage) as reported Gobbetti et al. (2019) and Ripari et al. (2016). Wheat flouris an ideal flour for bread production, but its costly nature andnon-availability resulted inapplicationof compositeflourinproduction ofbaked products.

Compositeflourhasbeendefinedby Seibel(2006)as“amixtureofflours obtainedfromtubersrich in starch (cassava, potatoes or yam), legume flours rich in protein (cowpea. Soybean andBambara Groundnut) and cereals (maize, rice, millet and sorghum) with or without wheat flour.Starches are mostly biodegrablepolymer that play active roles in raising action and differentsourcesofstarchesgiveanenhancedinteractionduetoassociationofstarchandglutein”.“Association of starchand glutein providesa more malleable and stable network with adequateCO_2 retention that makes structure of the bread to resist collapse during fermentation and cooling”(Delcour&Hoseney, 2009). Makowska *et al.* (2023) stated that “bread consumption increases theincidence of civilization diseases, therefore the application of raw materials with proven anti-diabeticandhypertension-loweringpropertieswillincreaseitsattractiveness anddesirability”.

African yam bean (*Sphenostylisstenocarpa*) has been reported by Nzelu (2008) to beanimportant indigenous legume in Nigeria with high level of protein among other great potentialsanditisconsumed inmanyAfrican countries.Itis nutritionallysuperiorto mostotherlegumesinterms of digestible proteins and minerals contents.It is also one of the less-known and under-utilized legumes readily available in the country. A substitution of wheat flour with African yambeanflourinbreadproductionenhancesqualityofproducedbread,increasesthenutritionalvalue, and also reduces the huge amount of money spent in wheat importation as well as reducing theunit price of bread. African yam beanhas different range of colours from pale white to spottedblack, cream and brown in between (Okoye *et al*., 2015). It is grown abundantly in the Northernpart of Nigeria for its seed. It has a lot of medicinal and health benefits as it is associated withtreatment of chronic and severe wounds. It contains toxic elements which may negatively affectorimpairproteindigestibilityandmineralavailability.However,thesetoxicsubstancesinAfrican yam bean are heat labile and inactivated during heat processing into bread. Bread productioninvolves a series of steps such as mixing of ingredients, fermentation of the dough, dividing andmoulding (rounding off)of the dough,proofing,bakinginpre-heatedovenofa stipulatedtemperature,cooling, slicingand packaging.

A lot of research is focused on use of wheat for bread production but there is paucity ofinformationonproductionofbreadfromgerminatedAfricanyambeanseedwhichisalocalcropwith high levels of protein. Therefore, this work becomes apt and aimed at partial percentagereplacementofwheatwithAfricanYambeanflourinproductionofbreadtoenhanceitsnutritionalqualitywhileincreasingutilizationas wellasprevent extinctionofAfricanyambean seeds

2. MATERIALSANDMETHODS

2.1. ProcurementofRawMaterials.

TherawmaterialsusedinthisstudywereAfricanYamBeanseeds(Sphenostylisstenocarpa)wheat flour, sugar, skim milk powder, salt, margarine and yeast (Saccharomyces cerevisiae) which werepurchasedfromOgbeteMainMarketinEnuguState,NigeriaandtransportedtotheFoodProcessLaboratoryoftheDepartmentofFoodScienceandTechnology,EnuguStateUniversityofScienceandTechnology, Agbani.

2.1.1.PreparationofAfrican Yambean Seedsforflourproduction.

Onekilogram ofAfrican Yam Bean seeds were sorted to remove dirts as well as otherextraneousmaterials,thoroughlycleanedwithtapwaterandsteepedin2.5litresofportablewaterin a plastic bowl and left at room temperature for 12 hours. The steeping water was changed atintervals of 3 hours to prevent fermentation, cross contamination and for activation of the seeds’enzymes. The water was drained while wet bean seeds were spread on a moistened jute bag on amaltingtablefor3daystogerminate.Thesproutedseedswereharvestedanddriedinapreheatedoven with hot air at 60 ^{o}C for 12 hours. The rootlets on the dried seeds were rubbed in betweenpalms,brokentoremove hullsandwinnowed.Themalted,driedanddehulledbeanswereground intofineflourwithanattritionmill (locallyfabricatedAsikoAlldoublegridingmill),sievedwith500 mm mesh size cheese cloth, packaged in Ziploc bag as African Yam Bean flour and stored infreezer forfurtheranalysis as shown in Fig.1.

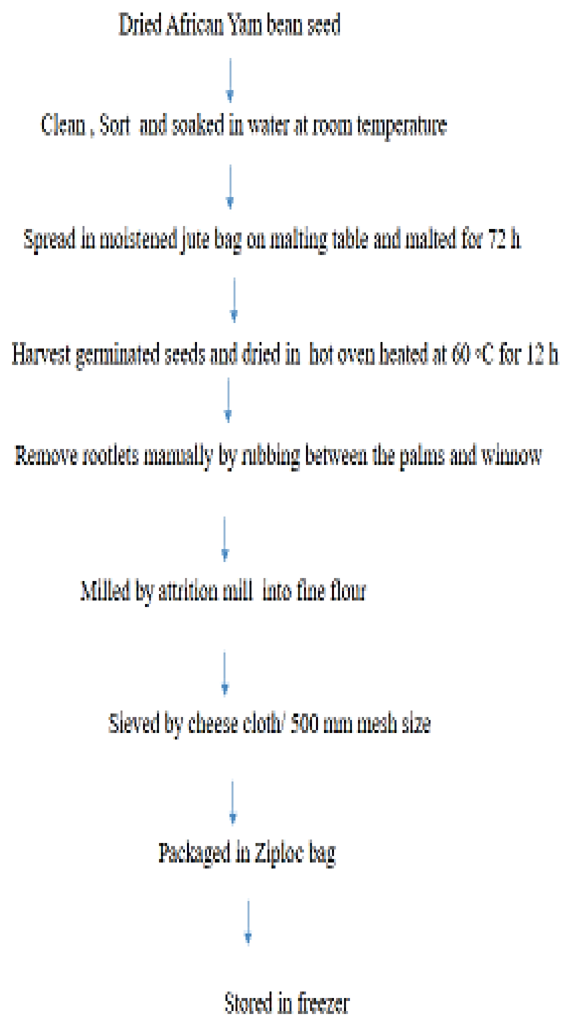

Fig. 1: Flow chart of Production of germinated African yam bean seeds flour

2.2 Composition of theflourblends

Thewheat and African yam bean flour were mixed in percentage ratios of 100: 0,90:10,80:20 and70:30 as samples A, B, C andD, respectively. The blends were thoroughly sieved toobtain homogenized finer particle-size of standard formulation as shown in Table1. A comprehensive bread recipe is shown in Table 2. Thereafter,these samples were packaged in a Ziploc bag and stored in freezer until required for analysis andbreadproduction.

Table1:Composition of Wheat–AfricanYamBean seed Flourblends

Flour	A	B	C	D
Wheat	100	90	80	70
AricaYamBean	0	10	20	30

Table2:BreadRecipeComposition

Sample	A	B	C	D
Wheat flour (g)	500	450	400	350
Sweet potato flour(g)	0	50	100	150
Sugar (g)	140	140	140	140
Salt(g)	7.5	7.5	7.5	7.5
Margarine(g)	20	20	20	20
Yeast(g)	3.0	3.0	3.0	3.0
Water(mL)	450	460	470	485

2.3 Wheat-AfricanYamBeanBreadProductionprodures

A modified straight dough method of bread production process as described by Okaka*et al*.(2005); Okoye and Okaka (2009)was adopted. The ingredients were measurd and weighed asshown in Table 2 and Plate 1. The yeast was dissolved in clean bowlwith 30 ml of water and 140g of sugar.The recipe used in the production was therefore, 500 g of flour, 7.5 g of salt, 140 g of sugar, 25 gofskimmilk(powder),20gofmargarine,3gof yeast,and450mlofwater.Boththedryandwetingredients flour (wheat & African yam bean) blends were thoroughly mixed using dough mixerstirring for 5 min. The mixed dough was allowed to prove in a bowel enclosed with clean dampclothforabout1hatambienttemperature(28^{o}C)beforekneadingandtighteningwithmargarinetoi mprovethe texture, smoothness and for proper elasticity.

Thereafter, the proofed dough samples were cut, moulded to shape and sized to 100 g, placedinpreviouslycleaned-greased-bakingpansandcoveredwithdampclothtopreventskindehydrationatthesurfaceatambienttemperature for1huntilithasincreasedto2–3timesitssize

Plate 1

A – 100 % v
B – 90 % wl
C – 80 % wl
D – 70 % wl

forfinalproofing.Thenmouldedsizeddoughwasbakedinapreheatedovenat200^{o}Cfor45min,andthe bread laterdepanned, cooled and packagedas shown in Fig.2.

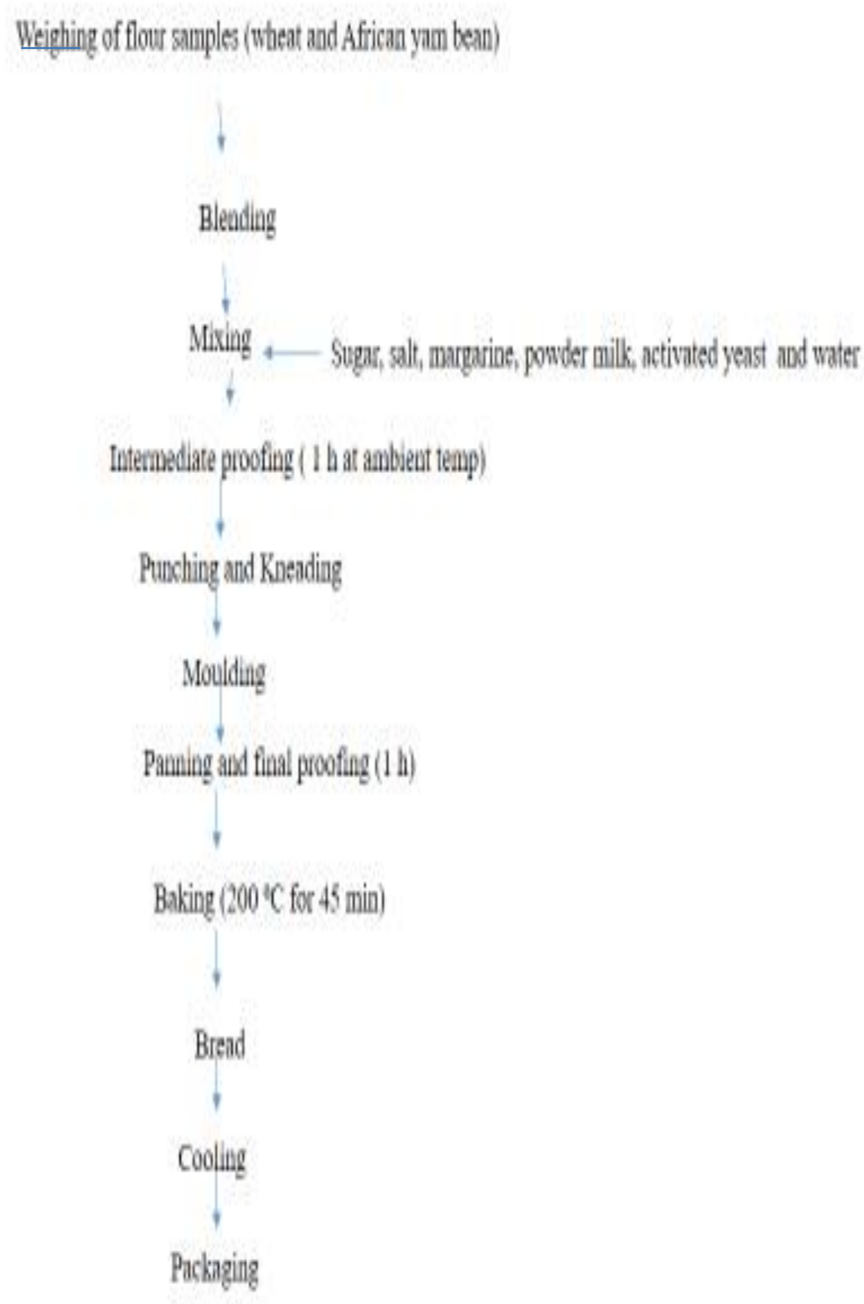

Fig. 2. Flow diagram for bread production

2.4.Analysisof thefloursamples

2.4.1.ProximateCompositionoffloursamples

2.4.1.1.Determination ofMoisturecontent

Moisture content of the samples was determined as described by standard methods ofAOAC (2010) using hot air oven method. The Moisture dish was cleaned and weighed (W_1). Athreegramofthesampleswasweighedintotarredmoisturedishes(W_2).Thesesamplesweredriedinahot-airovenat105 ^{o}Cfor2h.Themoisturedishwasremovedfromtheoven andcooledin adesiccatortoaconstantweight(W_3).Thedisheswerere-weighed,andpercentagemoisturecontentcalculated as shown in eqn.1.

$$\text{MoistureContent}(\%) = \frac{W2-W3}{W2-W1} X100 \qquad \text{Eqn.1}$$

Where:w_1=weightofemptymoisturedish
w_2 = weight of moisture dish with sample prior to hot-air oven dryingw$_3$= weightofmoisturedishwithsampleafterhot-airovendrying

2.4.1.1.2.DeterminationofProtein Content

The crude protein contentof each of the samples was determined by the Micro KjeldahltechniqueasdescribedbyAOAC(2010).A2gofeachsamplewasplacedinthreedifferent Kjeldahl flasks. Three gramsof anhydrous sodium sulphate and 2gof hydrated copper sulphate(catalyst)wereaddedtoeachflask.Then20mlofconcentratedtetraoxosulphate(IV)acid(H_2SO_4)was added to digest each of the samples. The flask with the samples was placed on an electricheater in a fume chamber and heated gently in an inclined position until blacking occurred.Increasedheatingcontimueduntilaclearsolutionwasobtainedandallowedtocool.Thecontentsof the digestion flask were diluted to 100 ml with distilled water and transferred into a 200 mLvolumetricflask.

TheflasksweereplacedinaKjeldahldistillationunit,neutralizedwith10mlof40%sodiumhydroxide (added through the funnel) and two pieces of zinc metal; then the liberated ammoniawas collected in 100 ml of 4 % boric acid with 2 – 4 drops of screened methyl red. The distillateswere titrated with 0.01N hydrochloric acid (HCI), until the titre value of the end point changedfromgreen to pink. Thequantityof nitrogenwascalculated usingeqn. 2.

$$\text{Nitrogen } (\%) = \frac{(\text{Titre}-\text{Blank})\text{x}14.008\text{xNormality}100}{\text{W}} \qquad \text{Eqn.2}$$

Where:Titrevalue

Blankvalue

W-Weight ofsampledried

%crudeproteincontent=% Nitrogenx6.25.

2.4.1.1.3.DeterminationofFatContent

The fat content of the sample wasdeterminedasdescribedbystandardsmethodsofAOAC(2010)usingsolventextractionmethod. Theextractionflaskwaswashedwithdistilledwater,driedand cooled in a desiccator. A 2 g of the sample was weighed (W_1) into the extraction thimblepreviously weighed. Thereafter, placed in the Soxhlet apparatus. The washed Soxhlet flask wasweighed (W_2) and filled to about three quarter of its volume with petroleum ether (that has theboilingpoint rangeof 40-60 ^{o}C).

The apparatus was then set-up and extraction was carried out for 4 refluxed or 1 h. Theprocesswasstoppedatendoftheprocesstime,thimbleremovedandpetroleum etherdistilledofftheflask,driedandcooledinadesiccatorandreweighed(W_3).Thefatcontentwasexpressedasaweightofrawsample. Thefat contentwas calculated as shown in eqn.3:

$$\%\text{Fat Content} = \frac{W3-W2}{W1} \times 100 \qquad \text{Eqn. 3}$$

Where;W_1=Weightofsample

W_2=Weight ofemptyflask

W_3=Weightofemptyflask+weightofoil

2.4.1.1.4.DeterminationofAshContent

The ash contents of each sample was measured as described by AOAC (2010) using Mufflefurnace. A two gram of the sample (W_2) was weighed into a previously cleaned, washed, dried,cooled crucible, weighed (W_1) and transferred to the pre-heated furnace. The temperature of thefurnace was then allowed to reach about 550 °C after placing the dish in it. The temperature wasmaintained until whitish-grey colour was obtained which was an indication that all the organicmatterof thesamplehadbeen destroyed.

The crucible was then brought out from the furnace, cooled in a desiccator and re-weighed(W_3).Thepercentageashcontent was calculated asshown in eqn.4:

$$\%\text{AshContent}=\frac{W_3-W_1}{W_2-W_1}\text{x}100 \qquad \text{Eqn.4}$$

Where:W1=Weightofemptycrucible

W2 = Weight of empty crucible + sample before

ashingW3 =Weightcrucible+ash

2.4.1.1.5.DeterminationofCrudeFiberContent

The crude fibre content of each of the sample was determined by the method of AOAC(2010). The Erlenmeyer flask was cleaned, washed, dried in oven and cooled in a desiccator.

Afivegram(W_1)ofeachsamplewasweighedintoaspecificdifferent500mLErlenmeyerflaskand40 mL of 0.3N sulphuric acid and 0.2 N sodium hydroxide solution were added to the flask. Themixture was heated and refluxed for exactly 1 h counting from the start of boiling (using aircondenser).

The flask was removed from heater, cooled a little and filtered through a 150 cm number 4Whatman paper. The residue was continuously washed with distilled water and transferred to acrucible.Thecruciblecontainingtheresiduewasplacedinanovenanddriedovernightat105 ^{o}C.Thereafter drying, transferred to a desiccator to cool and weighed (W_2). Finally, the residue wastransferredtoapreviouslyweighedcrucibleandplacedinamufflefurnaceheatedat500^{o}Cfor6hours until light gray ash was obtained, removed from the muffle furnace, cooled in a desiccatorandreweighed (W_3). Thecrudefibrewascalculated as shownin eqn.5.

$$\%CrudeFibreContent = \frac{W2-W3}{W_1} x \frac{100}{1} \qquad \text{Eqn.5}$$

Where W_3 = Weight of Crucible + sample before ignitionW_2=Weightofcrucible+ ashalterignition
W_1= Weightofsample

2.4.1.1.6.DeterminationofCarbohydrateContent

Thecarbohydratecontentwasdetermindasdescribedbythestandardmethodsof AOAC(2010) bydifferenceas show in eqn.6.

$$\%Carbohydrate\ content = 100\% - \%(Moisture + Protein + Fat + Ash + Crudefibre) \qquad \text{Eqn.6}$$

2. 5.DeterminationofFunctionalProperties

2.5.1. Determinationof BulkDensity

Thebulkdensitywasdeterminedasdescribedby Ayo *etal*.(2016).Afivegramofflourblendswaspoure dinto5mldrymeasuringcylinderandthevolumerecordedforloosebulkdensity.Thebottom of the measuring cylinder was gently tapped on a Laboratory bench until no samples wasdissolved by the weight of equal volume of distilled water at the same temperature. The bulkdensitywas estimated asmass per unit volume ofthesampleas shown in eqn.7.

$$Bulkdensity = \frac{Massofsample(g)}{Volumeofsampleaftertapped\ (mL)} \qquad \text{Eqn.7}$$

2.5.2. DeterminationofSwellingCapacity

ThiswasdeterminedasdescribedbyOnwuka(2005).Atwentyfivegramofthefloursamplewasmea suredinto100mLmeasuringcylinder.Themeasuringcylinderwas thereafterfilledwithwaterto100 mLbenchmark.

The mixture was shaken several times and allowed to settle. The volume of the flour wasrecorded after 15 min as (B) before swelling and (C) after swelling. The swelling in the volume wasdetermined bythe differencein volume divided bythe initial volume as shown in eqn.8.

$$\text{Swellingindex} = \frac{C-B}{A} \qquad \text{Eqn.8}$$

WhereA=
initialvolumeof25goffloursamplesB=volume
beforeswelling
C=volumeafterswelling

2.4.3.DeterminationofWaterAbsorptionCapacity(WAC)

This was determined as described by byOnwuka (2005). One gram of the sample wasweighed into a dry centrifuge tube and mixed with distilled water to make up 10mL dispersion.Itwas centrifugeat 3500rpm for 15min.

Thesupernatantsweredecantedwhilethetubewiththecontentwasreweighed.Thegaininmasswas calculated asthewater absorptioncapacityof thefloursampleasshownin eqn.9.

$$WAC = l\frac{umeofwaterabsorbed}{Weigh\ tofsample} x\ 100 \qquad \text{Eqn.9}$$

2.6. SensoryEvaluation

The sensory evaluation of the samples was carried out as described by Ihekoronye andNgoddy(1985)andIwe(2002)onthebakeddough.Thebreadloaveswereproducedandprepareda day ahead of sensory evaluation and stored at room temperature. The breads were presented incoded forms to 100 semi trained panelists comprising postgraduate and undergraduate studentsfromDepartmentsofAgriculturalEducation,UniversityofNigeriaandFoodScienceandTechnology,Enugu StateUniversityof Scienceand Technology,Agbani.

Thepanelistswereprovidedwithsachetsofwaterfororalrinsingofmouthinbetweentestingsamples and were asked to evaluate each loaf for crust and crumb organoleptic quality attributesofcolour,flavour,textureandoverallacceptability usinga9-pointhedonicscale,where1=dislikeextremelyand9=extremelylikeandthepanelistswereinstructedtorateaccordingtotheirdegreeoflikeness.

2.7. StatisticalAnalysis

Data obtained were analysed by one way analysis of variance (ANOVA) using StatisticalPackage for Social Sciences (SPPSS Version 25.0) software. The means of the samples wereseparated by Turkey Test at 5 % probability level. The results of the research were presented inmeansand standard deviations

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3. ResultsandDiscussion

3.1 ProximateCompositionoffloursamples.

The results on proximate composition of the samples are shown in Table 3. The Tableshowed that moisture content of the samples decreaed significantly ($p < 0.05$) withlevels ofsubstitution of African Yam bean flour. but increased among the percent substitution of Africanyambeanflour.SampleBhadtheleastmoisturecontentof9.64%,whilesampleA(control)hadth ehighest moisturecontent of 12.68 %.

"The moisture contentof the samples increased as the proportion of the African yam beanincreases. Themoisturecontentofflourblendshadinfluenceontheflourshelflifeandabove10 % are likely to cause spoilage of the products through increased microbial action" (Okpala*et al.*,2013; Barber and Obinna- Echem, 2016). The moisture content of food is a measure of stabilityandsusceptibilitytomicrobialcontamination.Thesevaluesexceptinsample'A'werelowertha n

10.32 % reported by Odedeji*et al*.(2014)who found out that low moisture content conferredlonger shelf life to bread composite flour. Moreover, moisture content is an important parameterincomposite flour because ithasaninfluenceonthe organoleptic, physicalandmicrobialproperties of bread. An ideal moisture content increase positively loaf volume of bread. "Flourswithmoisturecontentabove14%arenotstableatroomtemperatureandassuchorganismspresent inthem would start to grow, thusproducingoffodours" (Iwe*et al*., 2016).

The resultson changes in protein content in Table 3 indicated that flour bend values rangedfrom 12.62 – 14.89 %. . Based on the result, the protein contentof sample 'A' had least value(12.62%) while sample 'D' had the highest value (14.89%). Table 3 further showed that proteincontent increasedsignificantly ($p < 0.05$) with increased substitution of African yam bean flour.Theformulatedflourblendshadhigherproteincontentandquality.Theflourproteinquantityandqu alityofbreaddependonvarietyandextractionrateforflour.Theproteinvaluesobtainedinthestudyweresi milar to reported value of11.00%byOluwafemi and Seidu(2017).

Table 3 also showed that the fat content values of flour samples ranged from 1.68 to2.80%.Thefatcontentofthesamplesincreasedsignificantly($p<0.05$)withincreasedpercentagesubsti tutionofAfricanyambeanflourintheflourblends.Thelowfatcontentoftheflourblendsmay be attributed to ability of cereals and legumes to stores energy in form of starch rather thanlipids. The low fat levels also ensures longer shelf-life for the flour because fats containingproducts contain unsaturated fatty acids which are susceptible to oxidative rancidity. This findingis in line with reported findings by Onwuka *et al*. (2009) and Nwosu (2013) who found out thatAfricanyam bean has high oil content.

The results of ash content of flour blends as shown inTable 3 indicated that ash contentincrease significantly ($p < 0.05$) with increased supplementation of African yam bean flour.Sample'D'hadthehighestashcontentof3.27%,whilesample'A'hadtheleastashcontentof 2.46 %. TheTable showed that increasedsubstitution of African yam bean flour increased ashcontent in flour blends. This finding is in line with reported findings of Ojukwu *et al*. (2012) whostatedthatAfricanyambeanisarichsourceofashandMillicent(2022)whostatedthatashcontentincreasefrom0.78%to1.45%asthecocoyamandBambaragroundnutsfloursubstitutionlevels

increased inwheat partially substituted with cocoyam and Bambara groundnuts flour. The ashcontentofafoodsamplegives anideaofthemineralelementspresentinthefood. Itindicatesthecompositionofinorganicconstituentafterorganicmaterials(fats,proteinsandcarbohydrates)andmoisture have been removed by incineration.Minerals are essential and ought to be sufficientlyavailableinthecompositefloursamples."Mineralsareagroupofessentialnutrientswhichserveavarietyofimportantmetabolicfunctionsandarepartsofmoleculessuchashaemoglobin,adenosinetriphosphate(ATP) anddeoxyribonucleicacid (DNA)"(Iwe*et al*.,2016).

Theresults of the fibre content of the samples as shown in Table 3 indicated that sample'A' had the least value of 1.23 %, while sample 'D' had the highest value of 1.42 %. The Tableshowed that fibre content increased significantly ($p < 0.05$) with increased percent substitution ofAfrican yam bean flour in the flour blends. This may be attributed to high crude fibre content oflegumes. Crude fibre also slows down release of glucose into the blood stream and decreasesintercolonicpressurehencereducingriskofcoloncancerasreportedbyGibney(1989).Moreover,it has been reported by Ojukwu *et al*. (2012) that fibre content in food products aids in digestionoffood and functioning of gasro-intestinal tract.

The results of carbohydrate content of flour blends are shown in Table 3 indicated thatcarbohydrate contents ranged from 67.63 to 71.54 %. Sample 'D' had the least carbohydratecontent of 67.63 %, while sample 'B' had the highest content of 71.54 %. Sample 'B' had highercarbohydrate content than the control. The carbohydrate content of the samples decreased withincreased percentage substitution of African yam bean flour in the blends with an exceptionofsample B. Bread is one of the most important sources of carbohydrate and it occurred abundantlyintheformofstarch.Thisdecreasesincarbohydratecontentwithincreasingsubstitutionofbrownbeanflourwasreportedby Okaka(2009).CarbohydratecontentofsampleAdecreasedfrom69.33 %with additionofAfricanyam beanflourto67.63 %following30%substitution.

Thecarbohydratecontentsofthisstudyweresimilartoreportedcarbohydratecontentof

60.32 % by Odedeji*et al.* (2014). The carbohydrate contents of theflour blends are high and goodindicatorsthatthe productsmadefromthemwillbe goodsourcesofenergy.

Table3:Changes inProximatecomposition offlourblends

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash(%)	Fibre(%)	Carbohydrate (%)
A	8.21[a]±0.01	11.39[d]±0.01	1.68[d]±0.01	1.00[d]±0.01	1.23[d]± 0.02	78.49[a]±0.02
B	7.01[b]± 0.04	12.67[c]±0.04	2.12[c]±0.01	1.46[c]±0.01	1.32[c]±0.01	75.42[b]±0.02
C	5.81[c]± 0.06	13.93[b] ±0.05	2.67[b]± 0.04	1.71[b] ± 0.03	1.37[b] ± 0.03	74.51[c]±0.03
D	5.59[d]±0.03	14.89[a]±0.03	2.80[a]±0.05	2.02[a]± 0.04	1.42[a]±0.01	73.28[d]±0.05

Valuesaremean±standarddeviationfromtriplicatesamples.
Values with different superscripts in the same column are significantly different ($p < 0.05$)A- 100%wheatflour
B - 90 % wheat flour + 10 % African Yam Bean flourC - 80 % wheat flour + 20 % African Yam Bean flourD-70% wheatflour+30% AfricanYamBean flour

3.2 FunctionalPropertiesofflioursamples

3.2.1 Changesinwaterabsorptioncapacityofthefloursamples

"The water absorption capacity of the flour samples ranged from 60.00to 140.00 %.SampleAhadtheleastvalueof60.00%,whilesampleDhadthehighestvalueof140.00%.Waterabsorption capacity increased significantly ($p < 0.05$) with increasing levels of African yam beansubstitution in the composite flour blends. The difference in water absorption could be attributedto the quantity of damaged and undamaged starch present in the flour sample" (Asiedu 1989). It isanindicationoftheextenttowhichproteincanbeincorporatedintofoodformulation.Thevaluesobtainedinwheat–AfricanYambean flourblendswerehigherthatreportedvaluesof10.93 %bySuresh*et al.* (2015) in compositeflour.

"Theabilitytoabsorbwaterisveryimportantpropertyofthefloursusedinfoodformulations.The lower water absorption capacity of the wheat and other flours could be attributed to thepresence of lower amount of hydrophilic constituents in wheat" (Akubor and Badifu 2001). "Theincrease in water absorption capacity of the composite flours could be attributed to the presenceofhighhydrophobicaminoacidswithinterfereswiththeabilityoftheseflourstoabsorbwater.Alow water absorption capacityis attributed to tight association, while flour with high waterabsorption capacity is attributed to loose associationof amylose and amylopectin in the nativegranulesandtheweakbindingforcestomaintainthestarch granulesstructure"(Adebowale*etal*.,2008).Anincreaseinwaterabsorptioncapacityisassociatedwithincreaseintheamyloseleachingandsolubilityas well as loss of starch crystallineine structure.

"The blends with high water absorption may have more hydrophilic constituents. Protein hasboth hydrophilic and hydrophobicnature and therefore interact with water in foods. Waterabsorption capacity is a measure of starch digestibility as well as represents the ability of a product toassociate with water under a water limiting condition to improve its handling characteristics anddough making potentials" (Iwe and Onalope 2001). Flour blends with high water absorptioncapacity is good in formulation of foods like sausage, dough, processed cheese and other bakeryproducts.Waterabsorptioncapacityisimportantfunctionalpropertyrequiredinformulatingfoodinvolving dough handling, bulking, consistency of products and baking applications. Thus, theflourblends withthe highestwater absorptioncapacityisbestaccepted inbaking applications.

3.2.2.ChangesinBulkdensity of thefloursamples

The results of the changes in bulk density as shown in Table 4 ranged from 0.28 to 0.30g/mL. The results showed that bulk density of the flour decreased significantly ($p < 0.05$) withincreasing levels of African Yam bean flour substitution. Sample A had the highest value of 0.37g/mL, while Sample D had the least value of 0.30 g/mL.There were no significant difference ($p < 0.05$)insamplesBandC.Thebulkdensityvaluesofwheat–AfricanYambeanflourblendswerelowthan reported value of0.79 g/mLbyAwolu*etal*.(2017) onwheatcompositeflour.

However, the results were similar to reported values of 0.22 – 0.42 by Yusuf et al (2013) forcomplementaryfoods formulatedfrom sorghum, African yam bean and mango pulp mesocarpflour blends. Bulk density is function of particle size, particle size being inversely proportional tobulk density as reported byOnimawo and Akubor (2012) and composite flour with low bulkdensityis desirablefor easeofpackagingandtransportation.Bulk densitydependsontheparticlesize and initial moisture content of the composite flours. An increase in bulk density is anindicationofthesuitabilityofthecompositeflourinfoodformulations.However,compositeflourwith lowbulkdensitywouldbesuitableintheformulationofcomplementaryfoodsasreportedbyAkapata and Akubor (1999). This could lend to consumption of more food products resulting inhigh energy and nutritional density. Composite flour with high bulk density would be suitable foruse as thickener in food products as well as use in food preparation as it could reduce pastethicknessthat is essential in convalescentand childfeeding.

3.2.3Changesin SwellingIndexofthefloursamples

TheresultsofswellingindexofthesamplesareshowninTable4.Theswellingindexvaluesranged from 1.63 to 1.76 g/g. Sample D had significantly ($p <0.05$) the highest swelling indexvalue of

1.76 g/g. Whereas sample A had the least value of 1.63 g/g. Thetable showed thatswellingindexincreasedsignificantly(p<0.05)withincreasinglevelsofAfricanYambeanfloursub stitution. Swelling index has been reported byAjatta*et al*. (2016) to "depend on the variety offlour and processing method employed. The difference may be attributed to variety of the sampleand the processing method employed. It is also a good quality measure in formulation of bakeryproducts"."Itisanevidenceofnon–covalentbondingbetweenmoleculeswithinthestarchgranules.It is alsoa means of ascertainingthe ratio of amylose and amylopectin ratios" as reported by Iwe*etal*.(2016)influors."Theswellingcapacityoffloursdependsonsizeofparticles,typesofvarietyandt ypes of processingmethods or unit operations"(Igbabul*et al.*, 2014).

High starch content increasedthe swelling index of flours especially those starchy foodcompositions withhigh quantity ofamylopectin. Swelling indexhas beenknown to causechangesinthehydrodynamicpropertiesoffoodsandimpactdesirablecharacteristicsinthebodyma ss as well as increase in thickness and viscosity of such products as reported by Calzetta*et al*.(2000).

Table4:Functionalpropertiesofflourblends

Samples	Water absorption capacity(%)	Bulk density(g/mL)	Swelling-index (g/g)
A	60.00[d]±0.01	0.37[a]±0.01	1.63[d]±0.01
B	80.00[c]± 0.02	0.35[b]±0.00	1.64[c]±0.00
C	120.00[b]± 0.01	0.34[b]±0.00	1.71[b]±0.00
D	140.00[a] ± 0.03	0.30[c]±0.00	1.76[a]±0.01

Valuesaremean±standarddeviationfromtriplicatesamples.
Values with different superscripts in the same column are significantly different (p < 0.05)A- 100%wheatflour
B - 90 % wheat flour + 10 % African Yam Bean flourC - 80 % wheat flour + 20 % African Yam Bean flourD-70% wheatflour+30% AfricanYamBean flour

3.3 SensoryProperties oftheBreadLoaves

The results of the sensory properties of the bread loaves are shown in Table 5. Thetextureof the samples ranged from 3.90 to 6.55. Sample D had the highest texture scores of 6.55, whilesample A had the least texture scores compared to other samples. There were no significantdifferent(p>0.05)intexturescoresofsamplesBandCbuttheseamplesdifferedsignificantly (p < 0.05) from other samples. Sample D was moderately like by the panelists compared to othersamples. The texture scores of this study were in line with reported values of 5.20 and 8.10 byChikwendu*et al*. (2015)in wheat and soycompositebread.

TheresultsofscoresforflavourofthesamplesareshowninTable5.Thescoresrangedfrom 4.05to7.30.SampleAhadthehighestflavourscores,whilesampleDhadtheleastflavourscores.The results showed that flavour scores decreased with increasing levels of AfricanYam floursubstitution. There were no statistically significant differences (p > 0.05) in flavour scores ofsamples B, C and D. Samples B, C and D were rated neither liked nor dislike, slightly dislike andslightly dislike, respectively.The decreases in flavour with increased substitution of AfricanYambeanflourblendscould be attributedto beanyflavour of AfricanYam beans flour.

Theflavourscores ofthisstudywereinlinewith5.80to8.40reportedbyChikwendu*etal*.(2015) in wheat and soy composite bread and 8.60 to 8.90 reported by Kazakos et al. (2022) in

NovelSourdoughbreadmadefromwheatbranandtraditionalflour/sourmilkfood.Flavouristhesensorial pointer of the sweetness and taste of food. Moreover,the taste of flour blends wasinfluencedbythecaramelization reaction betweensugar and heat.

Thechangesincolourofthesamples areshowninTable5.Thecolourscoresofthesamplesranged from 5.70 to 7.60. Sample A had the highest colour scores of 7.60, while sample Dhadthe least colour scores of 5.70.There were no statistically significant difference ($p > 0.05$) incolour scores of samples A, B and C, which were rated like moderately and like moderately,respectively. There was no significant difference ($p > 0.05$) in colour scores of samples C and D.The colour scores obtained in the study were similar withthe values of 5.10 to 8.60 reportedvalues byOnoja *et al*.(2014) in breads produced from Orarudi (Vigasp) and wheat flour blends.colouris also aspecialsensoryattributethat determines the acceptanceofproducts.

Theresultsofoverallacceptabilityscores ofthesamples areshowninTable5.Theoverallacceptability scores ranged from 3.85 to 7.05. Samples Aand Ewere rated moderately desirableand moderately undesirable, respectively. There were no statistically significant differences ($p < 0.05$)inoverallacceptabilityscoresofsamplesB,CandD.BreadwithhigheramountsofAfricanyam bean flourwere darker in colour and less acceptable to the panelists, confirming the need touse African yam bean flourin lower amounts in foods to enhance acceptability. The overallacceptabilityscoresshowedthatsamplesacceptancedecreasedwithincreasedlevelsofsubstitutionwithAfricanYamBeanflour.Thisuglytrendcouldbecausedbythebeanyflavourarisingfromthe AfricanYamBeanflour.Hence,Isuggestuseofanalternativeprocessingmethodlikeroastingtodisguisethebeanyflavourandimprovedhighlytheacceptanceofthebreadloavesby every consumer. The overall result of this research was in line with similar research byOluwafemi and Seidu (2017) who had values of 5.80 to 7.87 in bread formulated from wheat andsoybeanflourblends.

Table5:Sensoryproperties ofbread loavesformulated fromwheat-AfricanYamflour blends

Samples	Texture	Flavour	Colour	Overallacceptability
A	3.90^{c} ±1.12	7.30 ^{a}±0.86	7.60^{a}±1.60	7.05^{a}±0.94
B	4.60 ^{b}±1.70	4.80 ^{bc}±1.64	6.90^{a}±1.37	4.85^{b}±1.85
C	5.50^{b}±1.54	4.25 ^{b}± 1.62	6.75^{ab}±1.62	4.40^{b}±1.60
D	6.55^{a} ±1.70	4.05^{bc}±1.90	5.70^{b}±2.05	3.85^{bc}±2.06

Valuesaremean±standarddeviationfromtriplicatesamples.
Values with different superscripts in the same column are significantly different ($p < 0.05$)A- 100%wheatflour
B - 90 % wheat flour + 10 % African Yam Bean flourC - 80 % wheat flour + 20 % African Yam Bean flourD-70% wheatflour+30% AfricanYamBean flour

4. CONCLUSION

TheflourblendsofsampleDhadhigherswellingindexandhigherwaterabsorptioncapacitythanothersamples.Italsohadhigherprotein,fat,ashandfibercontents,buthadleastcarbohydratecontentcomparedtoothersamples.Breadloavesmadefromthecontrol(sampleA)hadsignificantly(p< 0.05) higher flavour scores and colour scores as indicated by the panelists. There were nostatisticallysignificant differences (p>0.05)in colour scores betweensamples A, Band C.

Whereas bread loaves from sample D had the least colour scores; bread loaves of sample Dhad the highest sesory texture scores. There were statistically significant differences (p > 0.05) inthe texture scores of the samples.The texture, flavour and colour of African Yam bean seed floursubstitutedsampleswereappealingtothepanelists,buttheirbeanyflavoursdecreasedtheiroverallacceptance scores. Though application of African yam bean flour in baked products will reducefood loss and waste along food value chain, but bread with higher amounts of African yam beanseedflourweredarkerincolourandlessacceptabletothepanelists.Therefore,Africanyambeanseed floursubstitution inwheat bread should beinlower amounts to enhanceacceptability.

Hence, alternative methods of roasting or fermentationcan be adopted to mask the beanyflavourand improved itsoverall acceptabilityscore.

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