QUALITY PARAMETERS OF BREAD PRODUCED FROM SUBSTITUTION OF WHEAT FLOUR WITH CASSAVA FLOUR USING SOYBEAN AS AN IMPROVER

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ABSTRACT

Bread samples were produced from the substitution of wheat flour with cassava flour using malted soybean flour as an improver. Analysis of their proximate composition revealed that the ash contents, the crude fibre contents and the carbohydrate contents increased significantly ($P \leq 0.05$) from 100% wheat bread (1.54 ± 0.01)%, (1.20 ± 0.02)% and (35.18 ± 0.01)% to FWC (50:50) which had (1.69 ± 0.01)%, (1.44 ± 0.02)% and $(46:05 \pm 0.01)$%, respectively. On the other hand, the fat contents and the crude protein contents varied significantly ($P \leq 0.05$) from 100% wheat bread (16.48 ± 0.03)% and (14.36 ± 0.02)% to FWC (50:50) which had (8.75 ± 0.01)% and (11.06 ± 0.02)% respectively. The moisture contents and the dry matter contents differed significantly ($P \leq 0.05$) with NPZ (90:10) having the least moisture (29.53 ± 0.07)% while STY (70:30) had the highest moisture (31.46 ± 0.04)% and the least dry matter (68.54 ± 0.04)%. The results of the sensory evaluation showed that, 100% wheat bread had a mean value of 6.07 in terms of taste and there was no significant difference ($P \geq 0.05$) in the tastes of the breads up to 20% substitution with cassava flour. Also, there was no significant difference ($P \geq 0.05$) in the aroma of the breads up to 50% substitution. There was no significant difference ($P \geq 0.05$) in the other sensory parameters up to 30% substitution with cassava flour. Results of the functional properties indicated that wheat flour had the highest bulk density (0.70 ± 0.02)g/ml while malted soybean flour had the highest Gelation (1.50 ± 0.05)% wt/^{vo}/v. The wettability of wheat flour (52 ± 3.0)sec was the highest while malted soybean flour had the highest water absorption capacity (3.0 ± 0.02). Cassava flour had the highest oil absorption capacity (1.75 ± 0.01) whereas wheat flour had the highest swelling index (3.80 ± 0.03). Though the loaf weights varied the loaf volume, the specific loaf volume and the oven spring reduced appreciably as the substitution with cassava flour increased. Based on the above findings, it is recommended that cassava flour be substituted for wheat flour up to 30% using malted soybean flour as an improver in making breads whose sensory and proximate attributes could be comparable with those of 100% wheat bread.

Keywords: Substitution, proximate composition, functional properties, sensory attributes, improver

INTRODUCTION

Cassava (*Manihot esculenta crantz)* also known as yucca, manioc and mandioc in various parts of South America is a herbaceous perennial crop of the *Euphorbiaceae* family (Ngoka, 1997). Cassava belongs to the order *Malpighiales,* sub-family *crotonoideae*, genus *manihot* and species *Manihot esculenta* (FAO, 2008). In Nigeria where it is consumed extensively as the major staple food, cassava is known among the Igbo, Yoruba and Hausa tribes as 'akpu', 'ege' and 'rogo' respectively. The two major varieties grown in Nigeria are the sweet and bitter varieties which are classified on the basis of the cyanogenic glucoside contents of their roots (Erhabor and Emokaro, 2007).

Nutritionally, cassava is a major source of dietary energy for low income consumers in many parts of tropical Africa including the major urban areas (Berry, 1993). One hundred grams of cassava roots contain 62.5g of water, 34.7g of starch, 1.2g of protein, 0.3g of fat, 33g of calcium and 36mg of vitamin C while 100g of the leaves on the other hand contain 80.5g of water, 9.6g of starch, 6.8g of protein, 1.3g of fat, 20.6g of calcium and 265mg of vitamin C (Nweke *et al*., 2002).

The edible parts of cassava are the roots and the leaves. The roots of sweet varieties may be eaten raw, roasted in an open fire or boiled in water. According to Nweke *et al.,* (2002), the cyanogenic glucosides in the roots are destroyed by slowly cooking the roots in water. Boiled cassava roots may be pounded alone or in combination with other starch staple foods such as; yam, cocoyam, sweet potato, etc and then eaten with soup. Nweke and Kormawa (2004) reported that cassava roots are processed into local cassava snack foods in the eastern part of Nigeria known as Abacha, Eberebe, Jigbo, Mpataka and Nsisa by peeling, washing, boiling, cooling, shredding, soaking in water and may be sundried prior to eaten. Cassava roots can also be processed locally into granulated csassava products such as garri which has a long shelf-life and in a ready-to-eat form (Cardoso *et al.,* 2005, Onabolu, 2001). Presently, cassava roots can be processed into modern cassava food products such as cassava meat cakes, cassava chaps, cassava relish, cassava flakes, cassava cookies and cassava strips (IITA, 2006). On the other hand, the leaves are also good source of vitamin A, Vitamin C, iron, calcium and protein. In Tanzania and Congo, rural cassava farmers plant "tree cassava" called 'Mpuru' and 'Pondu' respectively which they prepare by leaching the glucosides in hot water, pounding the leaves into pulp with a mortar and pestle and then boiling in water with groundnut, fish and oil (Nweke*et al*., 2002).

There are a lot of problems associated with cassava storage, processing and maximum utilization as food in the tropics where is it grown. Cassava roots are highly perishable and therefore cannot be stored in fresh form after harvest for more than a few days (Oluwole *et al*., 2004). Cassava roots most especially the bitter varieties contain a lot of cyanogenic glucosides (Linamarin and Lotaustralin) which hydrolyses in the presence of the enzyme linamarase contained in the roots to give toxic hydrocyanide acid when the cells are disrupted (Iwuoha *et al.,* 2003). Despite being a cheap source of food calories, cassava is nutritionally deficient in protein (Adindu and Aprioku, 2006). Enwere (1998) also reported that cassava is deficient in the essential aminos acids; methionine, lysine, tryptophan, phenylalanine and tyrosine but rich in arginine.

Therefore, the objectives of this research are;
♦   To employ different processing methods that will help in the detoxification of the cyanogenic glucosides from cassava roots.
♦   The use of the flour obtained from these cassava roots as composite flour fortified with malted soybean flour in making breads.
♦   Subjecting the breads to sensory analysis so as to ascertain their level of acceptability.

The above results if favourable will help to; reduce the high demand for wheat in making breads, provide an alternative and cheap source of increasing the protein intake of bread consumers and encourage mass production of high quality cassava flour in Nigeria.

MATERIALS AND METHODS

Raw Material, Equipment and Chemical Procurement

The wheat flour (Golden Penny Brand) sample and other materials such as; soybean seeds, sugar (sucrose), yeast (royal instant dry yeast) salt, fat or shortening (simas margarine) used in this

research were purchased from Eke-ukwu market in Owerri Municipal L.G.A. of Imo State. The cassava tubers (variety; TMS 30572) were obtained from National Root Crops Research Institute (NRCRI) Umudike, Umuahia, Abia State. Both the soybean seeds and the cassava tubers were processed into flours in the Food Science and Technology Laboratory, Federal University of Technology, Owerri (FUTO) which was also the place where the entire laboratory work on this research were carried out. All the chemicals used during this research were of analytical grade.

Raw-Material Preparation
Production of Malted Soybean Flour

The soybean seeds were sorted manually using a stainless steel tray, weighed and then steeped in a ratio of 1:3 (seed to water) of distilled water at room temperature for 12hours. The water was constantly changed every 3hours to avoid the fermentation of the seeds. When this time elapsed, the hydrated seeds were then spread on jute bags at room temperature to germinate. Water was usually sprinkled on the seeds every 4hours before germination started after 24 hours. This germination was terminated on the fourth day by drying the sprouted seeds in a Genlab oven set at 60^0c for 3 hours. The fourth day of sprouting or germination was chosen because, a preliminary malting carried out earlier showed that the maximum length of the sprouted or germinated seeds' radicles occurred on the fourth day of germination and this indicated the peak of enzyme activities in the seeds. The temperature range and time frame were used to ensure that enough activated enzymes remained in the malted flour without being destroyed completely. After drying, the seeds were then dehulled manually and the hulls and dried radicles removed via manual winnowing using a plastic tray. The seeds in this form were finally milled into flour using an electric milling machine, sifted with sieves of aperture size (53ɥm) and then allowed to cool before being put into a plastic container where it was tightly covered and stored for analysis. The flow chart for the production of malted soybean flour is given in figure I.
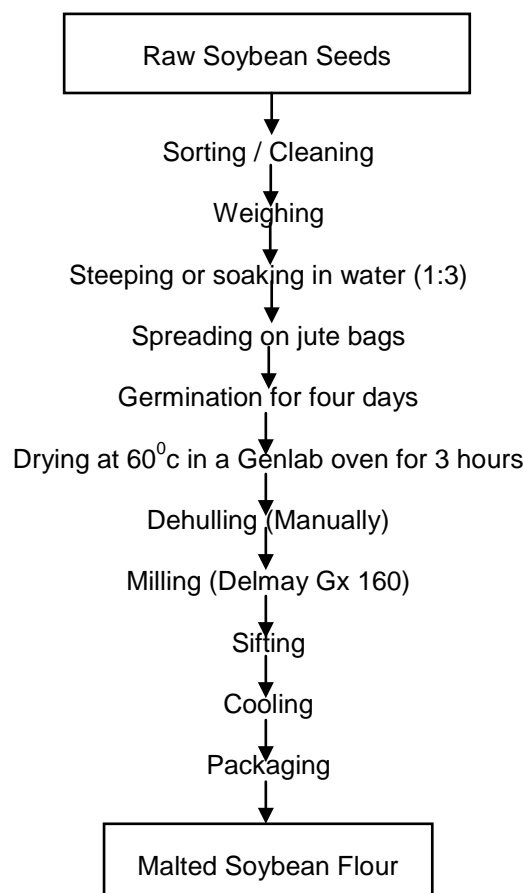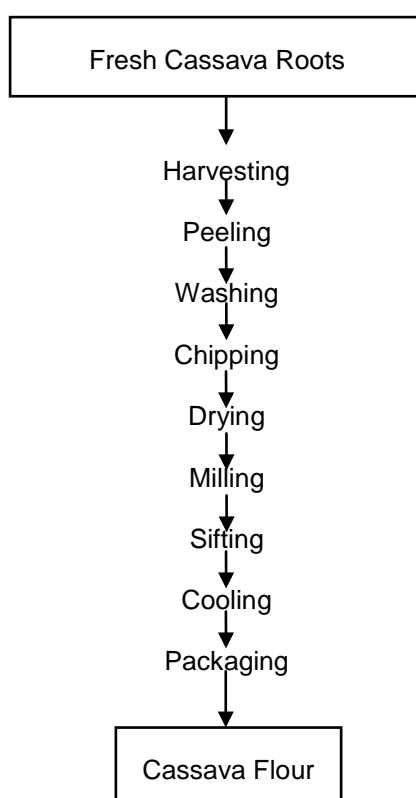
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        ┌─────────────────────────┐
        │   Raw Soybean Seeds     │
        └─────────────────────────┘
                    │
            Sorting / Cleaning
                    │
                Weighing
                    │
        Steeping or soaking in water (1:3)
                    │
          Spreading on jute bags
                    │
         Germination for four days
                    │
     Drying at 60⁰c in a Genlab oven for 3 hours
                    │
           Dehulling (Manually)
                    │
          Milling (Delmay Gx 160)
                    │
                 Sifting
                    │
                 Cooling
                    │
                Packaging
                    │
        ┌─────────────────────────┐
        │  Malted Soybean Flour   │
        └─────────────────────────┘
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Fig. 1: The flow chart for the production of malted soybean flour.

Production of High Quality Unfermented Cassava Flour

The cassava tubers (variety: TMS 30572) were weighed with a balance and then peeled manually with the aid of stainless steel knives. The peeled cassava tubers were then washed and weighed again on a balance to check the percentage yield after peeling. They were then chipped manually with stainless steel knives, followed by drying in a Genlab oven set at 105^0c, until they dried completely within 24 hours. The dried cassava chips were then allowed to cool before being milled into flour using an electric milling machine (Delmay GX 160).

Finally, the milled cassava flour was sifted using sieves of aperture size (53 micrometre) to remove extraneous materials from the flour. The fine cassava flour thus obtained was then put in tightly covered plastic container for further use. The flow chart of the entire processes is given in figure II below.

Fresh Cassava Roots

Harvesting

Peeling

Washing

Chipping

Drying

Milling

Sifting

Cooling

Packaging

Cassava Flour

Fig 2: Flowchart for the production of High Quality Unfermented Cassava Flour.

Production of bread samples
Preparation of Composite Flours

Wheat flour and cassava flour were blended in the ratios of 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80 and 10:90 with each sample weighed out into three places using a weighing balance and a plastic spoon. One hundred percent wheat flour was also weighed out into three places. The flour blends including the (control) one hundred percent wheat flour were each blended with 20g

of malted soybean flour. The composite flour thus obtained were then stored separately in tightly covered plastic containers under dry condition for later use. This is shown in Table I.

Production of bread samples from wheat – cassava composite flours

The bread samples were produced in batches by mixing and kneading manually each of the above flour blends with the ingredients in table II using a stainless steel bowel. After thorough kneading in each case, the dough was allowed to ferment and develop for 15minutes before being knocked back and then moulded into cylindrical shape. After moulding in each case, the dough was then placed in a well oiled baking pan where it proofed for 40 minutes at room temperature before it was baked in a cabinet oven pre-heated and set at 230^0c for 25 minutes. After baking, the dough was brought out in each case from the oven and immediately depanned by knocking out. The knocked out bread was then placed on a wooden table to cool and to avoid condensation. The flowchart is given in figure III.

Proximate analysis

The Association of Official Analytical Chemist (A.O.A.C, 1990) procedure was used to determine the proximate compositions of the wheat flour, cassava flour, malted soybean flour and the bread samples made from the various blends of the above flours.

Determination of Moisture Content

Two (2) grams of each of the samples was weighed out with the aid of an analytical balance into dried, cooled and weighed dish in each case. The samples in the dishes were then put into a Genlab moisture extraction oven set at 105^0c and allowed to dry for 3 hours. When this time elapsed, the samples were then transferred into a dessicator with the aid of a laboratory tong and then allowed to cool for 30 minutes. After cooling in the dessicator, they were weighed again and their respective weights recorded accordingly. The above processes were repeated for each sample until a constant weight was obtained in each case. The difference in weight was calculated as a percentage of the original sample.

Percentage moisture content $= \dfrac{W_2 - W_3}{W_2 - W_1} \times \dfrac{100}{1}$

Where W_1 = Initial weight of the empty dish, W_2 = Weight of the dish + undried sample and W_3 = Weight of the dish + dried sample.

Determination of Ash Content

Two (2) grams of each of the samples was weighed out with the aid of an analytical balance into a dried cooled and weighed crucible in each case. The samples were then charred by placing them on a Bunsen flame inside a fume cupboard to drive off most of the smoke for 30 minutes. The samples were thereafter transferred into a pre-heated muffle furnace already at 550^0C with the aid of a laboratory long. They were allowed to stay in the furnace for 3 hours until a white or light grey ash resulted. Samples that remained black or dark in colour after this time had elapsed were moistened with small amount of water to dissolve salts, dried in an oven and then the ashing processes repeated again. After ashing, the crucibles were then transferred into a dessicator with a laboratory long. When they cooled, they were each weighed again and recorded accordingly.

Percentage Ash Content $= \dfrac{W_3 - W_1}{W_2 - W_1} \times \dfrac{100}{1}$

Where W1 = weight of empty crucibles, W2 = weight of crucible + food sample before ashing and W3 = weight of crucible + ash

Determination of Crude Fibre Content

Five grams (5g) of each of the samples that were defatted (during fat analysis) were used in this determination. The defatted samples were each boiled in a 500ml flask containing 200ml of 1.2.5% H_2SO_4 solution under reflux for 30 minutes. When this time elapsed, the samples were washed with several portions of hot boiling water using a twofold muslin cloth to trap the residual particles.

The residual particles in each case were carefully transferred qualitatively back to the flasks and 200ml of 1.25% NaOH solution was then added into each flask.

Again, the samples were boiled for 30 minutes and washed as before with hot water. Then, they were each carefully transferred into a weighed crucible and then dried in a Genlab oven set at 105^0c for 3 hours. The dried samples were then transferred into a dessicator where they cooled for about 20 minutes before being weighed again. After weighing, they were transferred into a muffle furnace set at 550^0c for 2 hours (until they ashed)

Finally, they ware cooled in a dessicator and weighed again. The crude fibre content for each sample was calculated thus;

$$\text{Percentage crude fibre} = \frac{W_2 - W_3}{W_1} \times \frac{100}{1}$$

Where W_2 = weight of crucible + sample after washing and drying in the oven, W_3 = weight of crucible + sample as ash and W_1 = weight of the original sample.

Determination of Crude Protein Content

Half a gram (0.5g) of each of the samples was mixed with 10ml of concentrated H_2SO_4 in a kjeldahl digestion flask. A tablet of selenium catalyst was added to each of samples which were then digested (heated) inside a fume cupboard until a clear solution was obtained in a separate flask in each case. Also, a blank was made by digesting the above reagents without any sample in it. Then, all the digests were carefully transferred into a 100ml volumetric flask in each case and were made up with distilled water. A 100ml portion of each digest was mixed with equal volume of 45% NaOH solution in a kjeldahl distilling unit. The resulted mixtures were each distilled and the distillates collected in each case into 10ml of 4% boric acid solution containing three drops of mixed indicators (bromocresol green and methyl red). A total of 50ml of each distillate was obtained and titrated with 0.02 molar H_2SO_4 solution. Titration was done from the initial green colour to a deep red end-point. The nitrogen contents of each sample were calculated thus;

$$\text{Percentage Nitrogen} = \frac{(100 \times N \times 14 \times Vf) \, T}{W \times 1000 \times Va}$$

Where W = weight of sample analysed, N = concentration of H_2SO_4 titrant, Vf = total volume of digest, Va= volume of digest distilled and T = Titre value of the sample minus titre value of the blank. The above results for each sample was multiplied with the factor 6.25 to obtain the crude protein content of each sample.

Determination of Fat Content

Two hundred and fifty milliliters of boiling flasks were washed with water, dried in a Genlab oven set at 105^0c for 30 minutes, cooled in a dessicator and then used for each sample. The flasks were firstly labeled, weighed with an analytical balance and then filled with 300ml of petroleum ether in each. Then, five grams of each of the samples was weighed out with an analytic balance into a correspondingly labeled thimble. The extraction thimbles were in each case tightly plugged with cotton wool. The soxhlet apparatus was then assembled and allowed to reflux for 6 hours.

When this time elapsed, the thimble was removed and the petroleum ether was collected in each case in the top of the container in the set up and drained into another container for re-use. The flasks were removed in each case and then dried in a Genlab oven at 105^0c for 1 hour. After drying, they were transferred into a dessicator and allowed to cool and weighed. The percentage fat was calculated for each sample thus

$$\text{Percentage Fat} = \frac{C - A}{B} \times \frac{100\%}{1}$$

Where A = weight of empty flask, B = weight of the sample and C = weight of oil after drying.

Determination of Carbohydrate Content

The carbohydrate contents of each of the samples analysed were determined by difference using the formular below;

Percentage carbohydrate = 100 – (% moisture + % Ash + % crude fibre + % crude protein + % fat).

Determination of Dry Matter Content

The dry matter contents of the samples analysed were determined by difference using the formular below:

Percentage Dry Matter = 100 – (% moisture).

Functional properties of the flours
Determination of Bulk Density

The bulk density of each of the flour samples was determined according to the method of Giami *et al* (1992). A calibrated centrifuge tube was weighed using an analytical balance in each case and the samples were filled up to the 10ml mark. They were then tapped until there were no further changes in volume. The contents were each weighed with the aid of an analytical balance and from the difference in weights, the bulk density of each sample was calculated thus;

Bulk Density = $\underline{\text{Weight of sample (g) (g/ml)}}$
                        Volume of sample (ml)

Determination of Water and Oil Absorption Capacity

The method as described by Giami *et al*(1992) was used. One gram of each of the flour samples was weighed out with the aid of an analytical balance and mixed with 10ml of distilled water or refined palm oil with known density in a weighed 20ml centrifuge tube for each sample. The resulted slurries were agitated on a vortex mixer for 2 minutes, allowed to stand at a temperature of 28^0c for 30 minutes and then centrifuged supernatants were decanted and discarded. The adhering drops of the water or oil were removed and the tubes weighed in each case.

The weight of water or oil absorbed by 1g of each of the flour samples was calculated and expressed as water or oil absorption capacity of the samples.

Determination of Wettability

The method described by Onwuka (2005) was used. One gram of each of the flour samples was weighed out using an analytical balance and were each added into a 25ml graduated measuring cylinder with a diameter of 1cm. the finger was then placed over the open end of the cylinder in each case, inverted and was clamped at a height of 10cm from the surface of a 600ml beaker containing 500ml of distilled water. The finger was then removed and the test sample was allowed to be dumped. The wettability was recorded as the time required for the sample to become completely wet.

Determination of Gelation Capacity

The method described by Onwuka (2005) was used. Suspensions of the samples in 5ml of distilled water in test tubes were prepared using 2 – 20% (W/V) of the samples in 5ml of distilled water in test tubes. The sample test tubes were heated for 1hour in a boiling water-bath followed by rapid cooling under running cold tap water. The test tubes were further cooled for 2 hours at 4^0c. Then, the gelation capacity was determined for each sample as the least gelation concentration. That is, the concentration when the sample from the inverted test tube will not slip.

Determination of Swelling Index

The swelling index of each flour sample was determined as the ratio of swollen volume of a unit weight of each sample to its initial volume in a graduated measuring cylinder. One gram of each of the flour samples was weighed out with a weighing balance and dispensed or added into a 20ml measuring cylinder in each case. Then, this was followed by the addition of 10ml of distilled water in each measuring cylinder. The volumes of the samples were noted. They were then allowed to stand undisturbed for 1hour before their volumes were taken again and recorded accordingly. The swelling index or each flour sample was calculated thus; swelling index = V_2/V_1.

Where V_1 = Initial volume occupied by sample and V_2 = Final volume occupied by the sample after swelling.

Determination of Hydrogen Cyanide Content

This determination was strictly done on the cassava flour alone. The method of Onwuka (2005) was used for this determination. Five grams (5g) of the cassava flour was weighed out into a 250ml conical flask with aid of an analytical balance. This was followed by the addition of 50ml of distilled water into the flask. This was allowed to stay overnight. Then, the solution was filtered and 2ml of the filterate was poured inside a conical flask (200ml) and 4ml of alkaline picrate solution was added. This was then incubated in a water-bath for 5 minutes for colour development (reddish brown) and its absorbance was taken at 490nm wavelength using a spectrophotometer. Also, a blank was prepared using 2ml of distilled water and treated the same way as the sample. The cyanide standard curve. The calculation was done as follows:

$$\text{Hydrogen Cyanide Content} = \frac{Vf}{Va} \times \frac{1}{10^6} \times \frac{100}{1} \times \frac{10^3}{1}$$

(Mg/Kg)

Where Vf   =   Total volume of the extract
      Va   =   Total volume of the extract used and
      W   =   Weight of sample used.
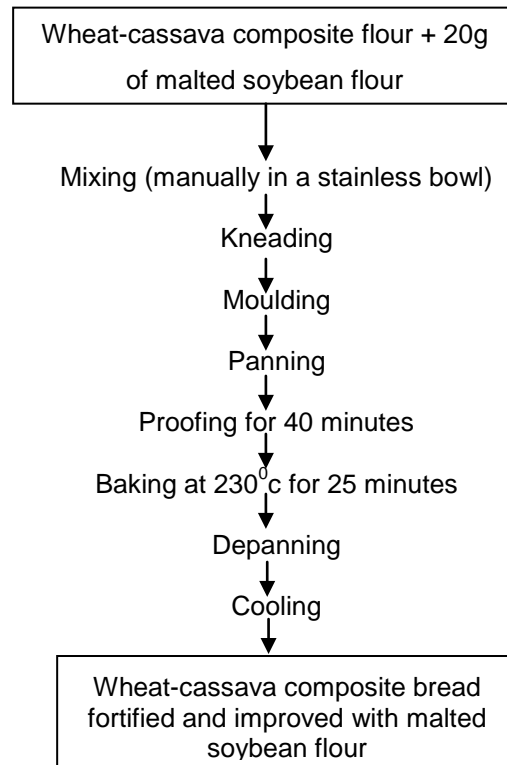
TABLE I : Formulation of samples

Wheat-cassava flour blends with malted soybean flour

Samples	Percentages and in grams	Flour in grams
DHW	100% W.F (200g)	20g M.S.F
NPZ	90% W.F.: 10% C.F. (180g:20g)	20g M.S.F
EZC	80% W.F: 20% C.F. (160g:40g)	20g M.S.F
STY	70% W.F: 30% C.F. (140g:60g)	20g M.S.F
XF4	60% W.F: 40% C.F. (120g:80g)	20g M.S.F
FWC	50% W.F: 50% C.F. (100g:100g)	20g M.S.F

Where: W.F = Wheat flour, C.F = Cassava flour and M.S.F. = Malted Soybean flour.

TABLE II: Recipe for the production of breads

Ingredients	Quantities in grams
Sugar	22
Yeast	2.5
Fat	10
Salt	1.5
Water	150ml
Malted soybean flour	20

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┌─────────────────────────────────────┐
│  Wheat-cassava composite flour + 20g │
│       of malted soybean flour        │
└─────────────────────────────────────┘
                   │
                   ▼
       Mixing (manually in a stainless bowl)
                   │
                   ▼
                Kneading
                   │
                   ▼
                Moulding
                   │
                   ▼
                Panning
                   │
                   ▼
          Proofing for 40 minutes
                   │
                   ▼
       Baking at 230⁰c for 25 minutes
                   │
                   ▼
                Depanning
                   │
                   ▼
                 Cooling
                   │
                   ▼
┌─────────────────────────────────────┐
│    Wheat-cassava composite bread     │
│  fortified and improved with malted  │
│           soybean flour              │
└─────────────────────────────────────┘
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Baking at 230^{0}c for 25 minutes

Fig III: Flow chart for the production of bread samples from wheat-cassava composite flour fortified and improved with malted soybean flour.

Breads from the composite flours

Plate 1

Plate 2a

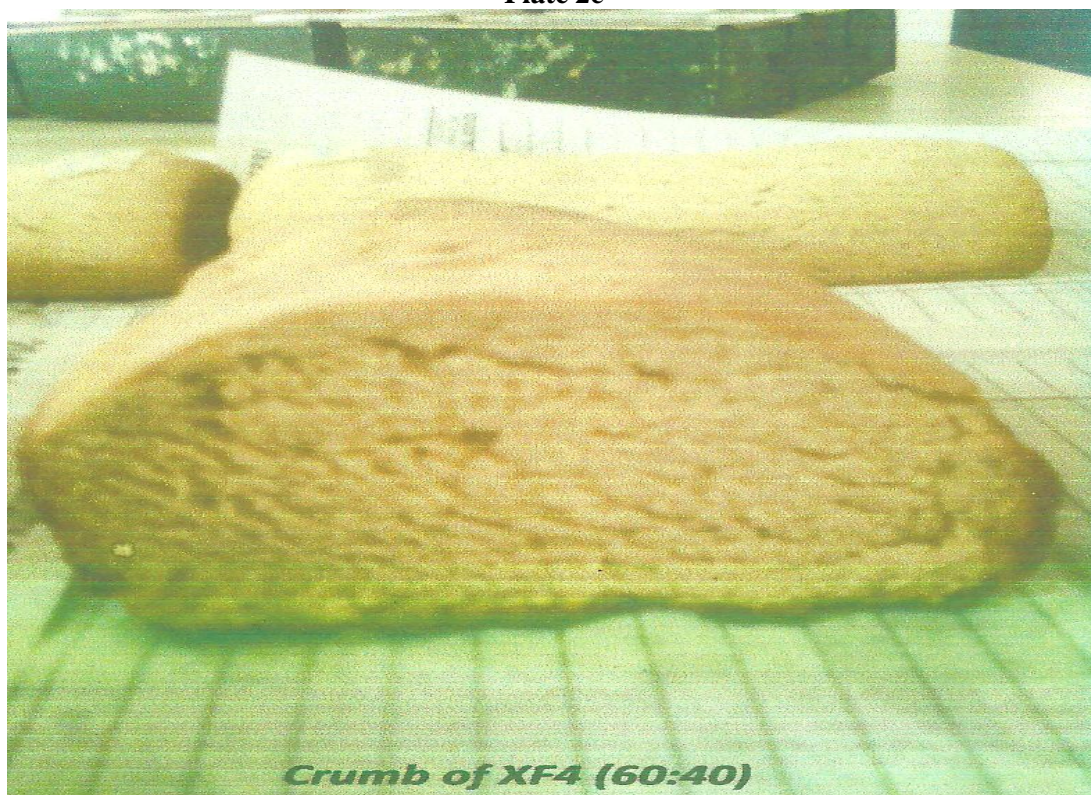**Plate 2b**

Plate 2c

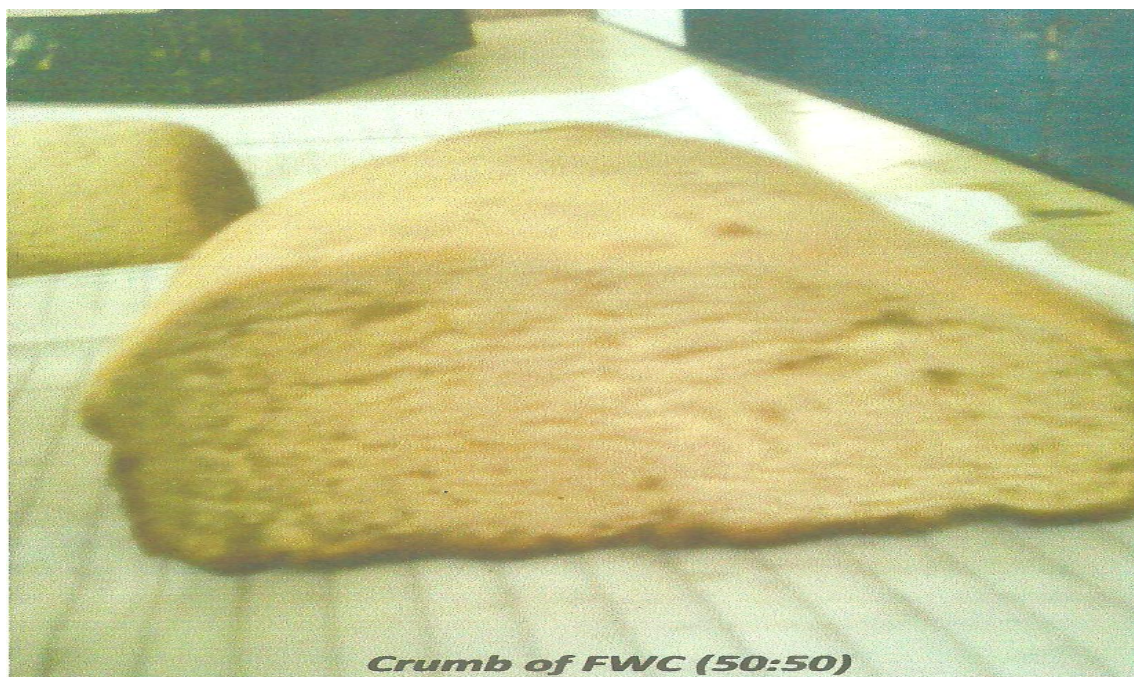**Plate 2d**

Crumb of FWC (50:50)

Plate 2e

Evaluation of the Characteristics of the Breads

The bread characteristics or baking qualities were evaluated by measuring the loaf volume, the loaf weight, the loaf specific volume, the oven spring and the organoleptic properties of the breads.

The Loaf Volume

The loaf volume of each bread sample was measured 50 minutes after the loaves were removed from the oven by using the rape-seed displacement method as described by Onwuka (2005). Soybean seeds were used in place of rape-seed. The weight of each of the bread samples was weighed with the aid of a weighing balance. This was then followed by taken the volume of the container from the graduation on its body which was recorded as $V_1(cm^3)$. The container was then filled with about 4–5volume of the loaf sample with the seeds until the seed dropping from a height of ½ foot above the container rim is cut-off such that the seeds formed a Plateau with the rim of the container. They were then poured out, weighed and recorded as $W_1(g)$. The weight of the seeds that filled the contained is equivalent to the total weight of seed that completely occupied the volume of the container. Then, 1/3 of the volume of the container was filled with the seeds, the loaf in each case laid flat at the centre of the container and then the remaining seeds used to fill up the container to overflow from ½ foot above the container. With a ruler, the seeds above the rim were cut off as they formed, plateau with the container. The seeds displaced by the loaf in each case were collected, weighed and recorded as $W_2(g)$ (this weight of seeds corresponded to the volume of space displaced by the loaf sample in each case placed in the container). The loaf volume for each bread sample was calculated thus;

Loaf Volume (cm^3) = $\dfrac{W_2 \ x \ V_1}{W_1}$

Where W_1 = weight of seeds that filled the container, W_2 = weight of seeds displaced by the loaf sample and V_1 – volume capacity of the container.

The Loaf Weight

The loaf weight for each of the bread samples was determined by weighing directly on a weighing balance.

The Specific Loaf Volume

The specific loaf volume for each sample was determined by dividing the loaf volume of each sample with the corresponding loaf weight thus;

Specific loaf volume = $\dfrac{\text{Loaf Volume (cm}^3/\text{g)}}{\text{Loaf weight}}$

The Oven Spring

The oven spring for each bread sample was determined from the difference in height of each dough before and after baking.

Sensory Evaluation of the Bread Samples

Sensory evaluation was carried out using a 15 main panelist to assess the organoleptic attributes of the bread samples. The organoleptic attributes assessed were; the taste, the aroma, the texture, the crust colour, the crumb colour and the overall acceptability. The panelists were selected randomly from the staff and students of the university. They were made to carry out the organoleptic assessment under controlled environment to avoid biased results. The bread samples wrapped with transparent polyethylene bags were presented in small sliced and coded identical white papers. The panelists were instructed to rate the breads based on 9-point hedonic scale ranging from 9=liked extremely to 1=disliked extremely. The raw scores were assembled and statistically analysed using the method described by Ihekoronye and Ngoddy (1985).

Statistical Analysis

Triplicate determinations were done. The significant differences obtained from the results were calculated using Fisher's least significant difference (LSD) test in a one way Analysis of Variance (ANOVA). The results were calculated using the statistical tools of Microsoft Excel.

RESULTS AND DISCUSSION

Proximate Compositions of the Flours and the Bread Samples

From table 3, the results of the proximate compositions of the wheat flour, cassava flour and malted soybean flour showed that the cassava flour had the highest moisture content of (10.17%) followed by that of the malted soybean flour (9.81%) while the wheat flour had the least moisture content of (9.72%). The above moisture content indicated that the cassava flour had more moisture in it than either of the other two flours.

However, the dry matter content results reversed the above trend with the wheat flour having the highest dry matter content of (90.28%). Malted soybean flour came second with a dry matter content of (90.19%) while cassava flour had the least dry matter content of (89.83%). It was also observed from table 3 that the ash content of malted soybean flour was the highest (4.29%) followed by that of the cassava flour (2.15%). Wheat flour had the least ash content of (1.93%). The low ash content of the wheat flour could be as a result of the fact that white wheat flours have very little amount of minerals compared to soybean and cassava. The ash content results showed that the malted soybean flour contained the highest minerals.

Also from table 3, the crude fibre content results indicated that the malted soybean flour had the highest crude fibre content of (5.18%) followed by the cassava flour (1.88%). Wheat flour had the

least crude fibre content of (0.66%). The high crude fibre content of the malted soybean flour could be as a result of the remains of the dried radicles and hulls. The fat content of the malted soybean flour (18.75%) from the table above indicated that it was far greater than those of the wheat flour (2.13%) and cassava flour (0.46%). Soybean, being an oil seed has more oil in it compared to wheat and cassava tubers. This led to the high fat content of the malted soybean flour compared to the other flours.

Moreover, the results of the crude protein contents of the flours from table 3 showed that the malted soybean flour had the highest crude protein content of (38.5%). Wheat flour had (10.69%) of crude protein while cassava flour had the least crude protein content of (2.63%). On the other hand, the carbohydrate content of cassava flour (82.93%) was the highest amongst the flours. The carbohydrate content of wheat flour was (74.75%) while that of malted soybean flour was obtained as (23.47%). The high crude protein content of the malted soybean flour was because, soybean has a lot of protein compared to the sources of the other flours (Riaz, 2006). Also, cassava tuber is a good source of carbohydrate compared to the sources of the other flours and hence the high carbohydrate content of the cassava flour.

Furthermore, the moisture contents of the bread samples from table 3 differed significantly at (P≤ 0.05) from sample DHW (100% wheat bread) with 31.24 ± 0.04)% moisture content down to sample STY (70:30) with (31.46 ± 0.04)% moisture content. But there was no significant difference in the moisture contents of sample XF4 (60:40) with (31.04 ± 0.02)% moisture content and sample FWC (50:50) with (31.02 ± 0.01)% moisture content at (P ≤ 0.05). Sample STY (70:30) had the highest moisture content (31.46 ± 0.04)% while sample NPZ (29.53 ± 0.1)%. The high moisture contents of the bread samples may be attributed to the water added during the baking process.

Similarly, the dry matter contents of the bread samples differed significantly at (P ≤ 0.05) from sample DHW (100% wheat bread) with (68.76 ± 0.04)% dry matter content down to sample STY (70:30) with (68.54 ± 0.04)% dry matter content. Again, there was no significant difference in the dry matter contents of sample XF4 (60:40) with dry matter content (68.96 ± 0.02)% and sample FWC (50:50) with dry matter content of (68.96 ± 0.01)%. Sample NPZ (90:10) had the highest dry matter content of (70.47 ± 0.1)% while sample STY with 68.54 ± 0.04)% dry matter was the least value obtained.

Nevertheless, table 3 showed that the Ash contents of the bread samples increased from sample DHW (100% wheat bread) with the least Ash content of (1.54 ± 0.01)% to sample FWC (50:50) with the highest Ash content of (1.69 ± 0.01)%. Although the Ash content of sample DHW (100% wheat bread) differed significantly at (P > 0.05) from the rest of the samples but there was no significant difference at (P ≥ 0.05) in the Ash contents of samples E2C (80:20), STY (70:30) and XF4 (60:40) with the following Ash contents. (1.63 ± 0.01)%, (1.64 ± 0.01)% and (1.66 ± 0.01)% respectively. Similarly, there was no significant difference in the Ash contents of samples; NPZ (90:10) and E2C (80:20) at P ≥ 0.05. It was equally observed from table 3 that no significant difference existed at (P ≥ 0.05) between the Ash contents of sample XF4 (60:40) and sample FWC (50:50) which had the respective Ash contents; (1.66 ± 0.01)% and (1.69 ± 0.01)%. A marked significant difference existed at (P ≤ 0.05) between the Ash content of sample NPZ (90:10) and those of samples STY (70:30), XF4 (60:40) and FWC (50:50). The Ash content of sample FWC (50:50) equally differed significantly at (P ≤ 0.05) with those of samples STY (70:30), E2C (80:20), NPZ (90:10) and DHW (100% wheat bread). The Ash content results indicated that as the substitution of cassava flour was increased, the Ash contents of the bread samples equally increased. This may be due to the high Ash content of the cassava flour which indicates the high mineral contents in it.

In the same vein, the crude fibre content of the bread samples also increased as the substitution of cassava flour was increased. Sample DHW (100% wheat bread) had the least crude fibre content (1.20 ± 0.02)% while sample FWC (50:50) had the highest crude fibre content (1.44 ± 0.02)%. There was no significant difference at P ≥ 0.05 in the crude fibre contents of samples NPZ (90:10), E2C (80:20), STY (70:30) and XF4 (60:40). No significant difference also existed at (P ≥ 0.05) in the crude fibre contents of samples DHW (100% wheat bread), NPZ (90:10) and E2C (80:20). Similarly, there was no significant difference at (P ≥ 0.05) in the crude fibre contents of sample SF4 (60:40) and sample FWC (50:50). The fat contents of the bread samples were high but decreased significantly at (P ≤ 0.05) as the substitution of cassava flour was increased. Sample DHW (100% wheat bread) had the highest fat content (16.48 ± 0.03)% may be because it was made from

100% wheat flour whose fat content was higher than that of cassava flour initially. Sample FWC (50:50) on the other hand, had the least fat content and this may be attributed to the high content of cassava flour (50%) used in making thus sample. But generally, the increase in the fat contents of the bread samples was as a result of the added fat during baking and the malted soybean flour used to improve on the characteristics of the breads. The crude protein contents of the bread samples from the results in table 3 were also very high but decreased significantly at ($P \leq 0.05$) just like the fat content as the substitution of cassava flour was increased. Again, sample DHW (100% wheat bread) had the highest crude protein content $(14.36 \pm 0.02)\%$ while sample FWC (50:50) also had the least crude protein content $(11.06 \pm 0.02)\%$. The reason for the reduction in protein content as the cassava flour substitution was increased may be attributed to the low protein content of cassava flour since it had a low protein content from the beginning. The general high crude protein content was because of the malted soybean flour used as an improver.

Finally, unlike the crude fibre contents of the bread samples that decreased as the cassava flour level of the products was increased, the carbohydrate contents of the breads increased significantly at ($P \leq 0.05$) in line with increase in cassava flour substitution sample FWC (50:50) had the highest carbohydrate content $(46.04 \pm 0.01)\%$ whereas, sample DHW (100% wheat bread) had the least carbohydrate content $(35.18 \pm 0.01)\%$. This results showed that cassava flour had more carbohydrate than either of the other two flours (Nweke *et al.,* 2002).

Table 3: Proximate Compositions Of Wheat Flour, Cassava Flour, Malted Soybean Flour And The Breads Made From The Various Blends Of The Flours

Flours	Moisture Contents (%)	Dry Matter Content (%)	Ash Content (%)	Crude Fibre Content (%)	Fat Content (%)	Crude Protein Content (%)	Carbohydrate Content (%)
				Components (g/100g flour)			
Wheat	9.72	90.28	1.93	0.68	2.23	10.69	74.75
Cassava	10.18	89.83	2.15	1.88	0.46	2.63	82.71
Malted Soybean	9.81	90.19	4.29	5.18	18.75	38.5	23.47
DHW	31.24 ± 0.04^b	68.76 ± 0.04^d	1.54 ± 0.01^d	1.20 ± 0.02^d	16.48 ± 0.03^a	14.36 ± 0.02^a	35.18 ± 0.01^f
NPZ	29.53 ± 0.1^e	70.47 ± 0.1^a	1.60 ± 0.02^c	1.26 ± 0.01^{bc}	15.30 ± 0.02^b	14.27 ± 0.02^b	$38,04 \pm 0.1^e$
E2C	30.53 ± 0.1^d	69.47 ± 0.1^b	1.63 ± 0.01^{bc}	1.29 ± 0.01^{bc}	13.48 ± 0.04^c	13.87 ± 0.01^c	39.20 ± 0.04^d
STY	31.46 ± 0.04^a	68.54 ± 0.04^e	1.64 ± 0.01^b	1.33 ± 0.02^b	10.75 ± 0.04^d	12.64 ± 0.01^d	42.18 ± 0.05^c
XF4	31.04 ± 0.02^c	68.96 ± 0.02^c	1.66 ± 0.01^{ab}	1.36 ± 0.01^{ab}	10.44 ± 0.02^e	11.48 ± 0.4^e	44.02 ± 0.1^b
FWC	31.02 ± 0.01^c	68.98 ± 0.01^c	$1,69 \pm 0.01^a$	1.44 ± 0.02^a	8.75 ± 0.01^f	11.06 ± 0.02^f	46.04 ± 0.01^a
LSD	0.17	0.17	0.03	0.10	0.13	0.05	0.20

Means in the same column with the same superscript are not significantly different at ($P \geq 0.05$)
Key:
DHW   =   100% wheat flour
NPZ   =   90% : 10% wheat flour / cassava flour
E2C   =   80% : 20% wheat flour / cassava flour
STY   =   70% : 30% wheat flour / cassava flour
XF4   =   60% : 40% wheat flour / cassava flour
FWC   =   50% : 50% wheat flour / cassava flour

Effect of Processing on the Functional Properties of the Flour Samples

From table 4, the bulk density of wheat flour was the highest (0.70 ± 0.02) g/ml followed by that of the malted soybean flour (0.66 ± 0.01) g/ml. Cassava flour had the least bulk density (0.52 ± 0.03) g/ml. The bulk density results indicated that cassava flour had more moisture than the other flours. Usually, the lower the bulk density of a food powder, the higher the moisture content

(Iheagwara, 2012). The gelation capacity results on the other hand indicated that malted soybean flour had the highest gelation capacity (1.52 ± 0.05). Wheat flour was next to it with a gelation capacity of (1.00 ± 0.02) whereas cassava flour had the least gelation capacity (0.60 ± 0.04). The high gelation capacity of malted soybean flour may have resulted because of its high protein content while the converse resulted low gelation capacity of cassava flour (Henkel, 2000).

However, the wettability results from table 4 clearly showed that wheat flour (52.0 ± 3.0) seconds had the highest wettability compared to those of the cassava flour (37.0 ± 1.0) seconds and malted soybean flour (31.0 ± 2.0) seconds. The wettability results implied that, wheat flour required much longer time than the other flour samples before it became completely wet. From table 4 also, the results of the water absorption capacity showed that, the malted soybean flour had the highest water absorption capacity (3.61 ± 0.02). The water absorption capacity of wheat flour was (2.07 ± 0.01) while that of cassava flour was (0.99 ± 0.04). The water absorption capacity decreased as the protein contents of the flours decreased malted soybean flour with the highest protein content had the highest water absorption capacity while cassava with the lowest protein content had the lowest water absorption capacity. Proteins, including gluten-forming proteins, absorb fully one to two times their weights in water, while starch absorbs only about one-quarter to one-half its weight in water (Iheagwara, 2012).

Finally, the oil absorption capacity results from table 4 also showed that, the oil absorption capacity of cassava flour (1.75 ± 0.01) was the highest followed closely by that of malted soybean flour (1.60 ± 0.03). Wheat flour had the least oil absorption capacity (1.52 ± 0.03). The results indicated that cassava flour had the ability to retain more oil compared to the other flours. On the other hand, wheat flour had the highest swelling index (3.80 ± 0.03) followed by that of cassava flour (3.74 ± 0.01). Malted soybean had the least swelling index (2.94 ± 0.02) while the mean value obtained for the hydrogen cyanide content of the cassava flour was (8.74 ± 0.05) mg/kg.

The hydrogen cyanide content is within the acceptable cyanide level in cassava flour. According to Aluko (2004), the maximum acceptable level of cyanide in cassava flour is 10mg/kg of cassava flour.

Table 4: Functional Properties of Wheat Flour, Cassava Flour, Malted Soybean Flour and the Hydrogen Cyanide Content of the Cassava Flour

Samples	Bulk Density (g/ml)	Gelation Capacity	Wettability (second)	Water Absorption	Oil Absorption	Swelling Index	Hydrogen Cyanide (mg/kg)
Wheat	0.70 ± 0.02	1.00 ± 0.02	52.00 ± 3.0	2.07 ± 0.01	1.52 ± 0.03	3.80 ± 0.03	-
Cassava	0.52 ± 0.03	0.60 ± 0.04	37.00 ± 1.0	0.99 ± 0.04	1.75 ± 0.01	3.74 ± 0.01	8.74 ± 0.5
Malted Soybean flour	0.66 ± 0.01	1.52 ± 0.05	31.00 ± 2.0	3.61 ± 0.02	1.60 ± 0.03	$2,94 \pm 0.02$	-

Sensory Evaluation of the Bread Samples

From table 5, the mean score for sample NPZ (90:10) in terms of sample DHW (100% wheat bread) with mean score of 6.07. Sample FWC had the least mean score of 4.80. Although, the mean scores for taste decreased as the level of cassava flour substitution increased, there was no significant difference in the tastes of the bread samples from DHW (100% wheat bread) up to 20% addition of cassava flour (E2C) at ($P \geq 0.05$). However, this trend changed at 30% substitution of wheat flour with cassava flour (sample STY). At this level of substitution, there was no significant difference at ($P \leq 0.05$) in the tastes of the samples; DHW (100% wheat bread), NPZ (90:10), E2C (80:20) and the rest of the bread samples; STY (70:30), XF4 (60:40) and FWC (50:50). Amongst samples STY (70:30), XF4 (60:40) and FWC (50:50), there was no significant difference in their tastes at ($P \geq 0.05$) though their mean scores varied slightly. The mean scores in this column showed that the tastes of the bread samples; STY (70:30), XF4 (60:40) and FWC (50:50) were neither liked nor disliked by the panelists who slightly liked those of the bread samples; DHW (100% wheat bread), NPZ (90:10) and E2C (80:20).

On the other hand, there was no significant difference (P ≥ 0.05) in the aroma of the entire bread samples from DHW (100% wheat bread) down to sample FWC (50:50 wheat/cassava bread) though the mean scores varied slightly with sample NPZ (90:10) having the highest mean score of (5:53) and samples STY (70:30) and FWC (50:50) had the least mean scores of (5.00) each. The reason why there was no significant difference at (P ≥ 0.05) in the aroma of the bread samples could be that the malted soybean flour used in each blend as an improver could have masked the odour of cassava flour in each of the various blends. This result therefore showed that even at 50% substitution of wheat flour with cassava flour using 20g of malted soybean flour in each blend as an improver, that there was no significant change in the aroma of the bread samples at (P ≥ 0.05).

Also, there was no significant difference in the textures of the bread samples from sample DHW (100% wheat bread) down to sample STY (70:30) at (P ≤ 0.05). Though sample DHW (100% wheat bread) differed significantly in texture with sample XF4 (60:40) at (P ≤ 0.05), there was no significant difference at (P ≥ 0.05) in the textures of samples; NPZ (90:10), E2C (80:20), STY (70:30) and XF4 (60:40). A marked significant difference existed between sample FWC (50:50) texture and those of the rest of the samples except with sample XF4 (60:40) which had no significant difference in texture at (P ≥ 0.05) with sample FWC (50:50). These results showed that the malted soybean flour used as an improver may be responsible for the slight consistency in the texture of the bread samples. The mean scores of the bread samples decreased as cassava flour substitution was increased, with sample DHW (100% wheat bread) having the highest mean score of 6.20 and sample FWC (50:50), with the least mean score of 4.87. The mean scores showed that the textures of samples DHW (100% wheat bread), NPZ (90:10), E2C (80:20) and STY (70:30) were slightly liked by the panelists who neither liked nor disliked those of samples XF4 (60:40) and FWC (50:50).

Furthermore, the mean scores for the crust colour of the bread samples also decreased as the cassava flour substitution was increased with samples DHW (100% wheat bread) and NPZ (90:10) having the highest mean scores of (6.33) each and sample FWC (50:50) with the least mean score of (4.73). There was no significant difference in the crust colours of the bread samples; DHW (100% wheat bread), NPZ (90:10), E2C (80:20) and STY (70:30) at ((P ≥ 0.05)). This indicated that the crust colours of the breads were almost the same up to 30% substitution of cassava flour for wheat flour in the bread samples. Again, there was no significant difference in the crust colours of samples; STY (70:30) and XF4 (60:40) at (P ≥ 0.05). Bread sample FWC (50:50) differed significantly in crust colour at (P ≤ 0.05) when compared with those of DHW (100% wheat bread) NPZ (90:10), E2C (80:20) and STY (70:30) but there was no significant difference in its crust colour when compared with the crust colour of sample XF4 (60:40) at (P ≥ 0.05). These results showed clearly that the crust colours of the breads were comparable and almost the same as that of DHW (100% wheat bread) at (P ≤ 0.05). This may be attributed to the maillard reaction brought about by the amino acids from the proteins of the malted soybean flour and the wheat flour which reacted with the added sugar to brown the crusts of the breads. Increase in cassava flour substitution reduced this reaction because cassava flour has very minute quantity of protein compared to wheat flour. The crumb colour of the breads were the same p to 30% substitution (STY), a marked significant difference in the crumb colours existed at (P ≤ 0.05). Samples XF4 (60:40) and FWC (50:50) had the same mean scores of (4.93) each and this was the least mean score in terms of crumb colour. Samples XF4 (60:40) and FWC (50:50) had no significant difference in crumb colour when compared with sample STY (70:30).

Finally, the mean scores for overall acceptability showed that samples DHW (100% wheat bread) and E2C (80:20) had the highest mean scores of (6.40) each, followed by sample NPZ (90:10), with a mean score of (6.27). Sample FWC (50:50) had the least mean score of (4.93). The bread samples up to 30% substitution of cassava flour was acceptable and their characteristics similar to those of DHW (100% wheat bread). This trend changed remarkably from 40% cassava flour substitution downwards but nevertheless, there was no significant difference in the overall acceptability of sample XF4 (60:40) and sample STY (70:30) at (P ≥ 0.05). Sample FWC (50:50) differed significantly in the overall acceptability with the rest of the bread samples at (P ≤ 0.05) although sample XF4 (60:40) was an exception.

Table 5: Mean Scores of the Sensory Evaluation of the Bread Samples Made from Blends of Wheat Flour, Cassava Flour and Malted Soybean Flour

Samples	Taste	Aroma	Texture	Crust colour	Crumb colour	Overall Acceptability
			PARAMETERS			
DHW	6.07 ± 1.24^a	5.47 ± 1.36^a	6.20 ± 1.28^a	6.33 ± 1.45^a	6.13 ± 1.02^a	6.40 ± 1.36^a
NPZ	6.33 ± 1.07^a	5.73 ± 1.24^a	6.07 ± 0.99^{ab}	6.33 ± 1.19^a	5.87 ± 1.26^a	6.27 ± 0.93^a
E2C	5.87 ± 1.09^a	5.53 ± 0.88^a	5.87 ± 0.88^{ab}	6.07 ± 1.12^a	5.93 ± 1.18^a	6.40 ± 0.88^a
STY	4.87 ± 1.31^b	5.00 ± 0.73^a	5.80 ± 0.98^{ab}	5.93 ± 0.93^{ab}	5.80 ± 0.98^{ab}	6.00 ± 0.73^{ab}
XF4	4.93 ± 1.12^b	5.13 ± 1.02^a	5.27 ± 0.99^{bc}	5.13 ± 1.02^{bc}	4.93 ± 1.18^b	5.20 ± 0.98^{bc}
FWC	4.80 ± 1.43^b	5.00 ± 1.32^a	4.87 ± 1.86^c	4.73 ± 1.57^c	4.93 ± 1.53^b	4.93 ± 1.73^c
LSD	0.91	0.84	0.90	0.93	0.91	0.87

Means with the same superscripts within the same column are not significantly different at $(P \geq 0.05)$

Key:

DHW	=	100% wheat flour bread
NPZ	=	90% wheat flour + 10% cassava flour bread (90:10)
E2C	=	80% wheat flour + 20% cassava flour bread (80:20)
STY	=	70% wheat flour + 30% cassava flour bread (70:30)
XF4	=	60% wheat flour + 40% cassava flour bread (60:40)
FWC	=	50% wheat flour + 50% cassava flour bread (50:50)

Physical Properties of the Bread Samples

From table 6, sample DHW (100% wheat bread) had the highest oven spring (2.40)cm, loaf volume (1,400)cm^3 and specific loaf volume (3.93)cm^3/g while sample FWC (50:50) on the other hand had the least oven spring (0.30)cm, loaf volume (803)cm^3 and specific loaf volume (2.35)cm^3/g. The results in table 6 showed that the oven spring, loaf volume and specific loaf volume all decreased as the substitution of cassava flour was increased from 10% up to 50%. The loaf volume and the oven-spring are good indicators of the crumb, how light and airy the interior of the breads are. Little values indicate a dense and compact crumb. (www.thekitchn.com/word-of-month-ove...). The loaf weights did not follow any trend. Samples DHW (100% wheat bread) and STY (70:30) had (356) gram each as the highest loaf weight while sample XF4 had the least loaf weight (335) gram.

Table 6:   Oven Spring, Loaf Volume, Loaf Weight And Specific Loaf Volume Of The Various Breads

Samples	Oven Spring (cm)	Volume (cm^3)	Weight (g)	Specific Volume (cm^3/g)
DHW	2.40	1,400	356	3.93
NPZ	1,80	1,305	343	3.81
E2C	1.30	1,190	348	3.42
STY	1.10	1,032	356	2.90
XF4	0.80	946	335	2.82
FWC	0.30	803	341	2.35

CONCLUSIONS

From the results obtained, it is quite evident that up to 30% substitution of wheat flour with cassava flour in bread production could be achieved using malted soybean as an improver. This also resulted in breads whose sensory attributes and proximate compositions could be compared with breads produced from 100% wheat flour.

Based on these findings, it is recommended that malted soybean flour be used as an improver in cassava bread production which is now the in-thing in the country to reduce the pressure on wheat flour. Also that soybean should be cultivated more so that there will not be scarcity when it is needed.

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