Original Research Article

Quality Assessment of Bread from Wheat, Water yam and Soybean flours

Abstract: The physicochemical and sensory evaluation of bread from the composite of wheat, water yam and soybean flours were determined. Five bread samples were produced from the proportion of wheat/water yam/soybean flours as 80%:10%:10% (B), 75%:15%:10% (C), 70%:20%:10% (D), 65%:25%10% (E) and 100% wheat was the control sample (A). The moisture, crude protein, fiber and ash increased ($p \leq 0.05$) significantly while the carbohydrate and fat content decreased ($p \leq 0.05$) significantly with corresponding increase in the percentage of the composite flour from 10-25% for water yam flour at constant 10 % soybean level. The result of the physical properties showed that there was a significant difference in all the physical parameters except loaf weight which didn't increased ($p \geq 0.05$) significantly with increase addition of water yam flour at constant soybean level. The result of the sensory analysis showed there were significant differences in all the sensory scores. However consumers preferred the bread from the composite flours of 20% substitution for both water yam and soybean flours.

1.0 INTRODUCTION

Bread is a fermented confectionary product produced mainly from wheat flour, water, yeast and salt by a series of processes involving mixing, kneading, proofing, shaping and baking (1). Due to high cost of wheat which increases the cost of bread, composite flours are recommended for bread production (2). Composite flour technology refers to the process of mixing various flours from tubers with cereals or legumes with or without the addition of wheat flour in proper proportions to make use of local cultivated crops to produce high quality food products (3). Water yam (*Discorea alata*) is a food crop with potential for partial replacement of wheat in bread making. Water yam flour can serve as a source of energy and nutrients (carbohydrates, beta-carotene and minerals) and can increase dietary fiber in processed food products. Addition of various proportions of water yam flour to wheat flour can enhance it's nutritive values in terms of fiber and bioactive compounds such as resistant starches, dioscorine, diosgenin and a water soluble polysaccharides (4). Lee *et al.* (5) reported that soybean is an important source of proteins (40%), lipids (20%), minerals (5%), and B vitamins for human nutrition. Apart from being an excellent source of cheap proteins, it also contains all essential fatty acids, magnesium, lecithin, riboflavin, thiamine, fiber and folic acid (6). The aim of this study was to

determine the physicochemical and sensory properties of bread from wheat, water yam and soybean composite flours.
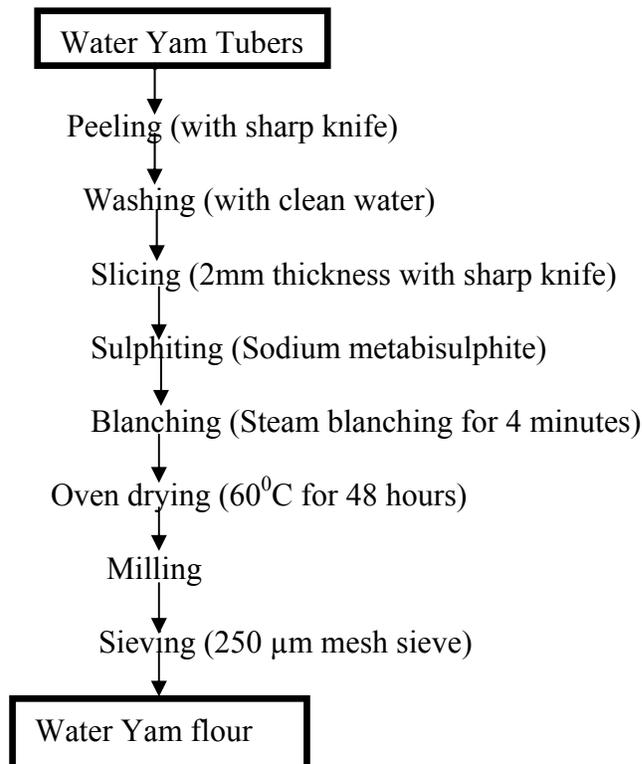
2.0 MATERIALS AND METHODS

2.1 Source of Materials and Equipments.

Water yam (*Dioscorea alata*) was obtained from a farmer in Oju Local Government Area of Benue State, Nigeria. Wheat flour, sugar, salt, margarine and dried yeast were procured from Wurukum market, Makurdi, Nigeria.

2.2.1 Water Yam Flour preparation

Water yam (*Dioscorea alata*) was prepared according to the modified method of (2). The *Dioscorea alata* flour was stored separately from the wheat flour in a tightly covered plastic jars to prevent moisture re-absorption. The flow chart for the production of water yam is shown in **figure 1.0.**

Water Yam Tubers

Peeling (with sharp knife)

Washing (with clean water)

Slicing (2mm thickness with sharp knife)

Sulphiting (Sodium metabisulphite)

Blanching (Steam blanching for 4 minutes)

Oven drying (60^0C for 48 hours)

Milling

Sieving (250 μm mesh sieve)

Water Yam flour

Figure 1.0: Flow chart for the production of water yam flour

Source: (2).

2.2.2 Soybean flour preparation

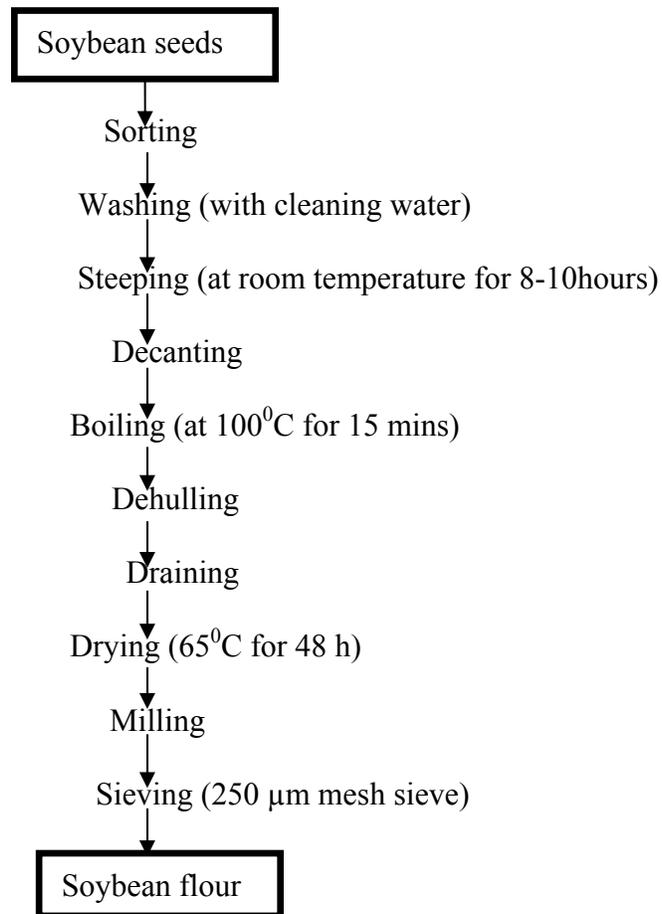Soybean flour was prepared according to the method described by (6) as shown in Fig 2.0

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┌─────────────────┐
│  Soybean seeds  │
└─────────────────┘
         │
      Sorting
         │
    Washing (with cleaning water)
         │
    Steeping (at room temperature for 8-10hours)
         │
      Decanting
         │
    Boiling (at 100⁰C for 15 mins)
         │
      Dehulling
         │
      Draining
         │
    Drying (65⁰C for 48 h)
         │
      Milling
         │
    Sieving (250 μm mesh sieve)
         │
┌─────────────────┐
│  Soybean flour  │
└─────────────────┘
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Fig 2: Flow chart for the production of soybean flour

2.2.3 Blend formulation of wheat, water yam and soybean flours

Five flour blends, each containing wheat, water yam and soybean flours were prepared by mixing flours in the proportion of 80:10:10 (B), 75:15;10 (C), 70:20:10 (D),65:25:10 (E). The control sample was 100% wheat flour (A). The five samples were packaged in black low density polyethylene bags and stored at room temperature until use for analyses and bread production.

2.2.4 Baking process

The five blends of composite flour were baked into bread using the modified method of (2). The wheat flour and composite flour were mixed with 5g salt, 10 g yeast, 7g sugar in 250 ml water followed by manual mixing for 5 min to obtain a dough. The dough was kneaded for some minutes. The kneaded dough was transferred into the baking pans greased with

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plasticized fat and covered with basins. The dough was allowed to ferment for 35 mins at room temperature in the baking pans. The fermented dough was then allowed to undergo proofing for 25mins at relative humidity. The bread were cooled to room temperature and used for analysis.

2.3 Determination of the proximate composition of the composite bread from wheat, water yam and soybean composite flours.

2.3.1 Moisture Determination

Moisture content was determined using the air oven dry method (7). A clean dish with a lid was dried in an oven (GENLAB, England B6S, serial no: 85K054) at 100°C for 30min. It was cooled in desiccators and weighed. Two (2) grams of sample was then weighed into the dish. The dish with its content was then put in the oven at 105°C and dried to a fairly constant weight. The loss in weight from the original sample (before heating) was reported as percentage moisture.

$$\% \, Moisture = \frac{weight \, loss \, (W2-W3)}{Weight \, of \, Sample \, (W2-W1)} \, x \, 100 \, \dots\dots\dots\dots\dots\dots\dots \, (1)$$

Where: W_1 = weight of dish, W_2 = weight of dish + sample before drying, W_3 = weight of dish + sample after drying.

2.3.2 Crude Protein Determination

The Kjeldahl method as described by AOAC (7) was used to determine the percentage crude protein. Two (2) grams of sample was weighed into a Kjeldahl digestion flask using a digital weighing balance (3000g x 0.01g 6.6LB). A catalyst mixture weighing 0.88g (96% anhydrous sodium sulphate, 3.5% copper sulphate and 0.5% selenium dioxide) was added. Concentrated sulphuric acid (7ml) was added and swirled to mix content. The Kjeldahl flask was heated gently in an inclined position in the fume chamber until no particles of the sample was adhered to the side of flask. The solution was heated more strongly to make the liquid boil with intermittent shaking of the flask until clear solution was obtained. The solution was allowed to cool and diluted to 25ml with distilled water in a volumetric flask. Ten (10) ml of diluted digest was transferred into a steam distillation apparatus. The digest was made alkaline with 8ml of 40% NaOH. To the receiving flask, 5ml of 2% boric acid solution was added and 3 drops of mixed indicator was dropped. The distillation apparatus was connected to the receiving flask with the delivery tube dipped into the 100ml conical flask and titrated with 0.01 HCl. A blank titration was done. The percentagenitrogen was calculated from the formula:

$$\% \, Nitrogen = \frac{(S-B) \times 0.0014 \times 100 \times D}{sample \, weight} \, \dots\dots\dots\dots\dots\dots\dots \, (2)$$

Where, S = sample titre, B = Blank titre, S - B = Corrected titre, D = Diluted factor

% Crude Protein = % Nitrogenx 6.25 (correction factor).

2.3.3 Crude Fat Determination

Fat was determined using Soxhlet method as described by AOAC (7).Samples were weighed into a thimble and loose plug fat free cotton wool was fitted into the top of the thimble with its content inserted into the bottom extractor of the Soxhlet apparatus. Flat bottom flask (250ml) of known weight containing 150 – 200ml of 40 – 60°C hexane was fitted to the extractor. The apparatus was heated and fat extracted for 8h. The solvent was recovered and the flask (containing oil and solvent mixture) was transferred into a hot air oven (GENLAB, England B6S,

serial no: 85K054) at 105°C for 1 h to remove the residual moisture and to evaporate the solvent. It was later transferred into desiccator to cool for 15 min before weighing. Percentage fat content was calculated as

$$\% \ Crude \ Fat = \frac{weight \ of \ extracted \ fat}{Weight \ of \ Sample} \ x \ 100 \dots\dots\dots\dots\dots\dots\dots \ (3)$$

2.3.4 Crude Fibre Determination

The method described by AOAC (7) was used for fibre determination. Two (2) grams of the sample was extracted using Diethyl ether. This was digested and filtered through the california Buchner system. The resulting residue was dried at 130 ± 2°C for 2 h, cooled in a dessicator and weighed. The residue was then transferred in to a muffle furnace (Shanghai box type resistance furnace, No.:SX2-4-10N) and ignited at 550°C for 30 min, cooled and weighed. The percentagecrude fibre content was calculated as:

$$\% \ Crude \ fibre \ = \frac{Loss \ in \ weight \ after \ incineration}{Weight \ of \ original \ food} \times 100 \dots\dots\dots\dots\dots\dots \ (4)$$

2.3.5 Ash Determination

The AOAC (7) method for determining ash content was used. Two (2) gram of sample was weighed into an ashing dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content was then heated in a muffle furnace at 550°C for 6-7 h. The dish was cooled in a desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentageof the original sample weight.

$$\% \ Ash = \frac{(W3 - W1)}{(W2 - W1)} \ x \ 100 \dots\dots\dots\dots\dots\dots\dots \ (5)$$

Where:
W1 = Weight of empty crucible,
W_2 = Weight of crucible + sample before ashing,
W_3 = Weight of crucible + content after ashing.

2.3.6 Carbohydrate Determination

Carbohydrate content was determined by difference according to Ihekoronye and Ngoddy (8) as follows:

$$\% \ Carbohydrate = 100 - (\%moisture + \%Protein + \%Fat + \%Ash \ + \ \%Fibre) \dots\dots 6$$

2.4 Determination of physical properties of dough and Bread loaves

Dough development in terms of increase in volume as affected by fermentation and proofing was determined according (9); a portion of the dough was placed inside a 500ml graduated beaker and placed on level surface (laboratory table). Initial and final volume at the beginning and end of fermentation and proofing were determined. Fermentation and proofing rates were calculated by dividing the average volume increase due to fermentation and proofing respectively (9). Bread characteristics were evaluated by measuring the loaf weight, loaf volume, specific volume and oven spring. Loaf weight was measured 30 minutes after the loaves were removed from the oven using a weighing balance whereas loaf volume was measured using the rapeseed displacement method as modified by (10) as follows: A weighed loaf was placed in the container and the weighed seeds was used to fill the container and leveled off as before. The overspill was weighed and from the weight obtained, volume of seed

displaced by the loaf was then calculated. The specific volume was determined by dividing the loaf volume by its corresponding loaf weight (cm^3/g) as described (10). And the oven spring was the difference between heights of breads after baking to height of dough before baking

2.5 Sensory Evaluation of the Bread Samples

<mark>The sensory evaluation of the breads including the one made from 100% wheat flour and the composite flour were evaluated for texture, taste, aroma, crust colour, crumb colour and general acceptability of the product by a 20 man panel of both staff and students of the Department of Food Science and Technology, Federal University of Agriculture, Makurdi, Nigeria on a 9 point hedonic scale (1=extremely disliked and 9= extremely liked) as described by (11).</mark>

2.6 Statistical analysis

Data obtained was subjected to Analysis of Variance (ANOVA) followed by Tukey's Least Significant Difference(LSD) test to compare treatment means; differences was considered significant at 95% ($P \leq 0.05$) (SPSS Version 21 software).

3.0 RESULTS AND DISCUSSION

3.1 Proximate Composition

The proximate composition of bread samples is presented in **Table 1**. The moisture, protein, fiber and ash content of the bread samples increased ($p \leq 0.05$) significantly with increase substitution of 10-25 % of water yam flour with 10% constant soybean flour. The moisture content varied from 18.56-30.11, protein from 8.25-10.99 fiber from 1.38-1.78 and ash content 0.89-1.00 respectively. The fat and carbohydrates contents on the other hand decreased ($p \leq 0.05$) significantly with increase water yam substitution at constant soybean level. The increase in moisture content could be due to the high moisture content of water yam (12), increase in protein is due to the substitution effect of soybean and water yam with wheat. (13).The increase in ash and fiber content may be attributed to high ash content of the water yam flour or the combined effects of water yam and soybean flours which indicates the high mineral contents in it. The decrease in fat content could be attributed to the addition of water yam which is reported to be low in fat (14) while the lower content of carbohydrate in the composite flours could be attributed to the low fat content of the wheat-water yam flour and low percent substitution of soya flours similar result was reported by (15).

Table 1: Percentage Proximate composition of Bread from wheat, water yam and soybean composite flour.

Samples	Moisture	Protein	Fat	Ash	Fiber	Carbohydrate
A	$18.56^a\pm0.01$	$8.25^a\pm0.09$	$6.67^d\pm0.01$	$0.89^a\pm0.01$	$1.38^a\pm0.01$	$64.21^e\pm0.06$
B	$20.50^b\pm0.07$	$10.15^b\pm0.23$	$6.56^c\pm0.01$	$0.95^b\pm0.04$	$1.40^a\pm0.01$	$60.05^d\pm0.31$
C	$23.35^c\pm0.01$	$10.21^c\pm0.29$	$6.40^b\pm0.01$	$0.98^b\pm0.01$	$1.62^b\pm0.04$	$57.50^c\pm0.29$
D	$27.12^d\pm0.02$	$10.53^d\pm0.19$	$6.34^b\pm0.15$	$0.99^b\pm0.01$	$1.72^c\pm0.01$	$53.31^b\pm0.55$
E	$30.11^e\pm0.08$	$10.99^e\pm0.01$	$6.23^a\pm0.02$	$1.00^b\pm0.01$	$1.78^d\pm0.01$	$49.89^a\pm0.01$
LSD	0.06	0.05	0.05	0.05	0.04	0.40

Values are means ± standard deviation of duplicate determinations

Means with same superscript down the column are not significantly (P≥0.05) different

Keys: A = (100 % wheat flour control)B = (80% wheat flour, 10% water yam flour and 10% soybean flour) C = (75 % wheat flour, 15% water yam flour and 10% soybean flour) D = (70 % Wheat flour, 20% water yam flour and 10% soybean)E = (65 % wheat flour, 25% water yam flour and 10% soybean flour).

LSD: Least Significant Difference

Physical properties of Dough and bread loaves

Results of the physical properties of dough and bread samples are presented in **table 2**. The average dough volume decrease as the concentration of water yam flour increase at constant soybean level with respect to proofing and fermentation period. The values decrease from 87-71cm^3 as the proportion of water yam increased at constant soybean level after 35min of fermentation and the rate of fermentation decreased from 2.49-2.00cm^3/min. The average dough volume increase after proofing for 25 mins varied from 104-79cm^3/min. The proofing rate however decreased from 4.16-3.17cm^3/min. The result is in line with (16,17). The loaf volume, specific volume and oven spring was observed to decreased (p≤0.05) significantly while loaf weight didn't increased (p≥0.05) significantly as the proportion of water yam increased from 10-25% at constant soybean level of 10%. This could be due to reduction of the quantity of gluten in the dough with addition of composite flour resulting to less retention of carbon dioxide gas (18).

Table 2: Physical Properties of Bread from wheat, water yam and soybean composite flours

Samples	Av-Dough Volume increase After Fermentation (35min)	Fermentation Rate (ml/min)	AV-dough Volume increase After proofing (25min)	Proofing rate (ml/min)	Loaf weight (g)	Loaf Volume (cm^3)	Specific Volume (cm^3/)	Oven Spring (cm)
A	87.00^e±0.0	2.49^e±0.02	104.84^e±1.17	4.16^e±0.01	249.52^a±0.70	560.00^e±0.01	2.13^d±0.00	1.00^d±0.01
B	84.12^d±0.16	2.42^d±0.01	95.52^d±0.70	3.82^d±0.00	252.62^a±0.86	520.02^d±0.01	2.00^c±0.00	0.88^c±0.04
C	77.21^c±0.28	2.23^c±0.02	89.55^c±0.65	3.60^c±0.01	257.00^a±0.01	499.56^c±0.64	1.95^{bc}±0.00	0.73^b±0.07
D	75.02^b±0.01	2.14^b±0.00	85.00^b±0.01	3.40^b±0.01	260.25$^{a±}$0.19	480.00^b±0.01	1.90^b±0.01	0.67^a±0.01
E	71.02^a±0.01	2.00^a±0.01	79.11^a±1.29	3.17^a±0.01	263.55^a±0.65	459.59^a±0.64	1.84^a±0.00	0.66^a±0.02
LSD	6.93	0.20	9.35	0.35	0.05	19.50	0.05	0.03

Values are ± means standard deviation of duplicate determinations

Means with same superscript down the column are not significantly (P≥0.05) different

Keys: A = (100 % wheat flour control) B = (80% wheat flour, 10% water yam flour and 10% soybean flour) C = (75 % wheat flour, 15% water yam flour and 10% soybean flour) D = (70 % wheat flour, 20% water yam flour and 10% soybean) E = (65 % Wheat flour, 25% water yam flour and 10 % soybean flour. LSD: Least Significant Difference

Sensory Scores of Bread Loaves

Result of the sensory attributes of bread made from wheat, water yam and soybean composite flour is presented in Table 3. The mean sensory scores for the taste ranged between 3.95 to 8.45. Sample B had the highest taste score (8.45). However, the taste scores decreased (p≤0.05) significantly with increase in the quantity of water yam flour. Taste is an important sensory attributes of any food. The consumption of bread is often enhanced by taste (19). The decrease in taste score maybe due to the change in taste sensation due to increased quantity of water yam. The aroma of bread samples ranged between 4.40-8.60. The scores for texture, crumb colour and crust colour varied between 2.75-8.40, 3.65-7.65 and 3.45-7.85 respectively. In terms of the overall acceptability, the mean scores ranged between 3.65-7.55. There was significant (p≤0.05) difference in all the sensory attributes and their scores decreased with addition of water yam flour. Bread is known to be of soft texture. Bread crumb that is soft is normally preferred by consumers. The decrease in the scores for texture with addition of water yam was found to correlate with the decrease in overall acceptability of the bread. Sample B with wheat, water yam and soybean composition of 80:10:10% respectively was found to have the highest sensory scores for all the attributes.

Table 3: Sensory Evaluation of Bread from wheat, Water yam and soybean composite flours

Samples	Taste	Aroma	Texture	Crumb Colour	Crust Colour	Overall Acceptability
A	$6.65^c\pm0.59$	$6.95^d\pm1.19$	$8.40^e\pm0.59$	$7.65^e\pm1.42$	$7.85^c\pm1.31$	$6.55^b\pm1.73$
B	$8.45^d\pm0.76$	$8.60^e\pm0.68$	$6.90^d\pm0.85$	$6.70^d\pm1.42$	$7.25^{bc}\pm1.29$	$7.55^c\pm0.69$
C	$5.65^b\pm0.81$	$6.35^c\pm1.04$	$4.80^c\pm0.83$	$5.65^c\pm1.42$	$4.45^{ab}\pm2.16$	$5.70^b\pm1.26$
D	$4.75^a\pm1.12$	$5.30^b\pm0.92$	$3.60^b\pm1.09$	$4.70^b\pm1.42$	$5.90^b\pm2.10$	$4.55^a\pm1.23$
E	$3.95^a\pm1.36$	$4.40^a\pm1.09$	$2.75^a\pm0.91$	$3.65^a\pm1.39$	$3.45^a\pm2.16$	$3.65^a\pm1.27$
LSD	1.82	1.67	2.12	1.06	3.42	2.92

Values are means± standard deviation of duplicate determinations

Means with same superscript down the column are not significantly (P≥0.05) different

Keys: A = (100 % wheat flour control), B = (80% wheat flour, 10% water yam flour and 10% soybean flour), C = (75 % wheat flour,   15% water yam flour and   10% soybean flour), D = (70 % wheat flour,   20% water yam flour and   10% soybean) and E = (65 % wheat flour,   25% water yam flour and   10% soybean flours).

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LSD: Least Significant Difference

4.0 CONCLUSION

The study has shown that bread of acceptable quality can be produced from composite of wheat, water yam and soybean flours. The bread samples have increased nutrients which are desirable for growth and good health. The supplementation of up to 10% water yam and 10% soybean flours were well accepted and therefore recommended. This study therefore recommends the inclusion of water yam and soybean in bread production inorder to enhance its protein content.

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