EVALUATION OF FUNCTIONAL, PROXIMATE AND SENSORY QUALITIES OF BREADS BASED ON BLENDS OF DIOCLEA REFLEXA AND WHEAT FLOUR

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Abstract

Quality evaluation of breads produced from wheat flour supplemented with *Dioclea reflexa*flour was investigated composite flours were prepared by blending wheat with *Dioclea reflexa*flour is ratios of 100.0, 97.5:2.5, 95:5, 92.5:7.5, 90:10, 87.5:12.5 and 85:15%respectively. Flour blends were evaluated for functional properties of composite while bread samples were analyzed for proximate and sensory qualities. Data obtained were subjected to inferential and descriptive statistics. Means were separated with Duncan Multiple Range Test (DMRT). The functional properties of composite flour such as swelling capacity water absorption capacity, emulsion activity, emulsion stability foam capacity,gelatinization temperature andbulkdensity increased as the incorporation of *Dioclea reflexa*flour increased. Proximate analysis result revealed significant ($p \leq 0.05$) increase in protein (13.71 – 19.11%), ash (1.32 – 2.04%) fibre (0.43 – 1.04%) content, while carbohydrate (61.42 – 54.12%) content decreased with addition of *Dioclea reflexa*. The functional properties reflected that foam activity, foam stability, emulsion capacity, emulsion stability, swelling capacity, dispersibility and gelation temperature increased with increase in *Dioclea reflexa*flour no significant ($P \geq 0.05$) differences occurred in the sensory attributes of products from 100% wheat and 90:10 flour blend. Hence acceptable bread from 90:10 (wheat: *Dioclea reflexa*blend have been formulated, this compared favorably with whole wheat product.

Keywords:Bread, *Dioclea reflexa*, Functional Properties, Wheat Flour, Proximate Composition.

Introduction

Consumption of baked products is greatly increasing due to the ever increasing urbanization. Bread is an important food product that is cherished across the entire continents because of its sensorial and textural properties. It has been used as human food since ancient times and has been contributing over 50% of dietary energy due to its high carbohydrate content (Onoja 2007, Mastromalteo *et al*., 2013). It is rich in both macro and micro nutrients, especially, protein, carbohydrate, fibre as well as iron, magnesium, sodium: phosphorus and some vitamins (B-vitamins). It has been shown that the rate of bread carbohydrate digestion greatly affects the absorption of glucose and consequently regulates the metabolic reactions that alter the glycemic and lipidemic postprandial responses in humans (Usha *etal., 2011;*Boby and Leelamma, 2003). Many researchers have reported that the amylose/amylopection ratios, the starch granule structureas well as protein matrix characteristics, all play an important role in determining the pattern of their hydrolysis and digestibility and consequently affect the glycemic index of bread. (Englyst *et al*., 2003:Mastromalteo*et al*., 2013). In addition protein as well as starch/carbohydrate contents have been shown to influence both the loaf volume and the appearance of the bread (Honda and Jood, 2005). Nevertheless, these baked foods do not have sufficient essential nutrients required for good health (FAO/WHO, 2004) supplementation of cereal-base food with legume for production of bakery products to improve their nutrient quality has been reported (Akubor, 2008; Onoja *et al*., 2014). These works showed that composite flour produced bakery products that were higher in nutrient quality compared with the 100% wheat products. This is because legume protein is high in lysine, an essential limiting amino acid in most cereals. Cereals on the other hand are high in methionine andcystine which are deficient in legumes (FAO, 2004). Therefore, blending legumes with cereal will provide desirable protein pattern that would help to enhance nutritionalstatus of the population moreover the high mineral and vitamin contents of these food crops are responsible for the increased nutritive quality of the supplemented products (Hotz and Gibson 2007: Uwaegbule and Ayinka 2008). In particular the functional properties of the composite flour have been found to be suitable for the production of bakery products (Honda and Jood, 2005; Akubor, 2008). Due to their high fibre content legumes have also been included within the group of functional foods due to their hypocholesterolemic and hypoglycemic effects (Boby and Leelamma 2003). Functional properties are the fundamental physico-chemical properties that reflect the complex interaction between the composition, structure, molecular conformation and physico-chemical properties of food components together with the nature of environment in which are associated and measured environment in which these are associated and measured (Kinsella 1976). Functional characteristics are required to evaluate and possibly help to predict how new proteins, fat, fibre and carbohydrates may behave in specific systems as well as demonstrate whether or not such protein can be used to stimulate or replace conventional protein (Mattil, 1971)

Diocleareflexa (DR) called marble vine or sea purse is a legume belonging to the sub-family *papilinoideae*which originates from the Caribbean in Carolina but successfully sea dispersed to West Africa (Akinyede *et al*., 2016).

In South Nigeria the Yorubas call it 'agbarin', Ibo 'capenter' while the efiks call it 'ilaba'. The seeds are abundant and are used by children all over the West Africa in a game played like marbles, the player jerking the seed with a spinning motion into a ring to knock out those of his opponents. DR is grossly underutilized in Nigeria regions where food shortages and famine are endemic their agricultural and food potential needs to be evaluated. The desired spice element is the seed and the powered cotyledon is used in preparing a special soup which is valued because of its delicious aroma and sharp taste that increase appetite (Akinyede *et al*., 2005, Oladosu*et al.,* 2010 and Akinyede *et al*., 2016) there have been folk uses of the seeds as a remedy for treating rheumatism, itching and other infection caused by pathogens (Faleye, 2012).

The study provides the information about a commercially viable application of increasing protein and fibrecontentin bread and also these can solve the problem of malnutrition and other essential macro and micro nutrient deficiency among the population. The objective of the present study was also to expand the utility of *Dioclea reflexa* flour by value addition through incorporating with wheat flour to prepare the composite flour and used to develop the bread and their characterization. Little work has been reported on the study of functional properties of flours and bread made from composite flour incorporating wheat flour and *Dioclea reflexa* flour.

Present study was conducted to determine the functional properties of wheat and composite flour and also evaluate the proximate and consumer acceptability of the bread samples produced.

MATERIAL AND METHODS

Wheat flour, yeast, margarine, *Dioclea reflexa* seed were brought from market deport at Ilaro, Ogun State. The Dioclea reflexa seed were cleaned and milled into flourand defatted. The flour for bread production was blend of *Dioclea reflexa* flour and wheat flour. The flours were obtained by blending in the ratio of (0:100, 2.5:97.5, 5.0:95.0, 7.5:92.5, 10.0:9.0, 12.5:87.5, 15.0:85.0) Dioclea reflexa wheat flour. Method of Igbadu*et al.* (2014) was used to produce the bread. Sensory evaluation was carried out using twenty (20) semi trained panelists. Samples were scored for appearance, colour, texture, taste, aroma and general acceptability on a 9-point hedonic scale rating.

Determination of Functional Properties of Wheat–*Dioclea reflexa* Flour Blends

Bulk Density

The bulk density of wheat–*Dioclea reflexa* flour blends was determined using a standard laboratory method (AOAC, 2006). Sample blends were weighed (7 g) into a 50 ml graduated measuring cylinder. The cylinder was tapped gently against the palm of the hand until a constant volume was obtained. Bulk density was calculated as:

$$\text{Bulk density (g/ml)} = \frac{\text{Weight of sample}}{\text{Volume of sample after tapping}}$$

Water Absorption Capacity and Oil Absorption Capacity

Water Absorption Capacity (WAC) and Oil Absorption Capacity (OAC) were determined using the method reported by Awoyale *et al*. (2011). Exactly10 ml of distilled water for WAC and 10 ml of edible oil for OAC were mixed with 1g of flour each and blended for 30 seconds. The samples were allowed to stand for 30 minutes and centrifuged at 1300rpm for another 30 min at room temperature (27 ± 2°C). The supernatant was decanted. The weight of water or oil absorbed by the flour was calculated and expressed as percentage WAC or OAC.

Swelling Capacity

This was determined by using the method reported by Adebowale, Adeyemi and Oshodi (2005). Flour samples (10g) were placed in a washed, dried and weighed graduated measuring cylinder. Distilled water (100 ml) was added, stirred and allowed to stand for 1 hour. The supernatant was discarded and the cylinder with its content was weighed to obtain the weight of the net sample.

The swelling capacity was calculated as:

$$Swelling\ Capacity\ (\%) = \frac{Final\ volume - Initial\ Volume}{Initial\ Volume} \times 100$$

Dispersibility

The method reported by Adegunwa *et al*. (2015) was used. Exactly 10 g of flour was suspended in a 100 ml measuring cylinder and distilled water was added to reach a volume of 100 ml. The set-up was stirred vigorously and allowed to settle for three hours. The volume of settled particles was recorded and subtracted from 100. The difference was reported as percentage dispersion.

Emulsification Capacity and Stability

Emulsification capacity (EC) was determined using the method described by Klompong, Benjakul, Kantachote, and Shahidi (2007). Flour sample (2 g) was blended with 25 ml distilled water at room temperature for 30 seconds in a warring blender at 1,600 rpm. After complete dispersion, 25 ml vegetable oil was added gradually. The blending continued for another 30 seconds and the emulsion was transferred to a centrifuge tube and centrifuged at 1,600 rpm for 5 minutes. The volume of oil separated from the sample after centrifuging was read directly from the tube. Emulsion capacity was expressed as the amount of oil emulsified and held per gram of sample. The emulsion stability was estimated after heating the emulsion contained in calibrated centrifuge tube at 80 % for 30 minute. The emulsion stability expressed as percentage and was calculated as the ratio to the height of emulsified layer to the total height of the mixture

Foaming capacity and foam stability

Foaming capacity (FC) was determined by the method of Sze-Tao and Sathe (2000). A weighed sample (250 mg) was mixed with 250 ml distilled water and the pH adjusted to 2, 4, 6, 8, and 10. This solution was whipped for 3 minutes in a stainless GS Blender (model 38 BL45, Dynamic Corporation, Auburn Hills, MI, USA). The whipped solution was then poured into a 100 ml graduated cylinder. The total sample volume was taken at 0 minutes for foam capacity and at 10 minutes intervals, up to 60 minutes for foam stability. Foam capacity and foam stability were then calculated thus:

$$Foam\ Capacity\ (FC)\% = \frac{(volume\ after\ whipping - volume\ before\ whipping)ml}{(volume\ before\ whipping)ml} \times 100$$

$$Foam\ Stability\ (FS)\% = \frac{(volume\ after\ standing - volume\ before\ whipping)ml}{(volume\ before\ whipping)ml} \times 100$$

Gelation Temperature

Gelation temperature was determined by the method decribed by Shinde (2001). One gram flour sample was weighed accurately in triplicate and transferred to 20ml screw capped tubes. Ten ml of water was added to each sample. The samples were heated slowly in water bath until they formed a gel. At complete gel formation, the respective temperature was measured and taken as gelatinization temperature.

Pasting Characteristic

The pasting characteristics were determined by using Rapid Visco-Analyzer (RVA) (model 3D RVA, Newport Scientific Pvt. Ltd, Narrabeen, Australia). A suspension of 4 g (14% wet basis) sample in 25 ml was made of distilled water the RVA can and inserted into the tower, which was lowered into the system. The suspension was heated from 50 to 95°C and then cooled back to 50°C within 12 minutes, rotating the can at a speed of 160 rpm with continuous stirring of the contents with a plastic paddle. Parameters determined were peak viscosity, trough, breakdown, setback, final viscosity, peak time and pasting temperature.

Determination of Proximate Composition of wheat-*Dioclea reflexa* Biscuits

Moisture, ash, fat, protein, and fiber contents were determined using the official methods (AOAC, 2006). Carbohydrate was determined by difference (100–[sum of moisture, ash, fat, protein, and fiber contents]). Atwater factor was used to estimate the energy values (4 x % carbohydrate + 4 x % protein + 9 x % fat) in kcal/100 g.

Sensory Evaluation of Biscuit

A 9-point hedonic preference scale and multiple comparison tests were used to test the acceptability of biscuit samples. This was achieved by evaluating the samples with 40 panelists, comprising of 22 males and 18 females between the ages 15–31 who are staff, students, and members of the community. After seeking the consent of the panelist (including that of the teenagers and their parents), they were all screened with respect to their interest and ability to differentiate foods sensory attributes in three sections. The panelists were later presented with randomly coded samples each and were asked to score each attribute based on color, taste, aroma, shape, crispiness, and overall acceptability using a 9-point hedonic scale, where 1
corresponded to like extremely and 9 corresponded to dislike extremely.

Statistical Analysis

Data generated were subjected to one-way analysis of variance (ANOVA). Means obtained from triplicate determinations were separated with the Duncan Multiple Range Test (DMRT) at 0.05 significant levels using the Statistic Package for Social Sciences (SPSS version 23) for Windows.

Results and Discussion

Different functional properties of composite flour were analysed using standard procedures. Table1. Functional properties are the intrinsic physic chemical properties that reflect the complex interaction between the composition, structure, confirmation and physico-chemical properties of protein and other food components and the nature of environment in which these are associated and measured (Suresh Chandra *et al*., 2014). The effect of incorporation proportions of different flours on the functional properties of composite flours are discussed as follows.

Bulk Density (BD)

The bulk density (g/cm^3) of flour is the density measured without the influence of any compression. The bulk density of flour changed from 0.677g/ml to 0.757g/ml. the highest bulk density was observed for Co (100:0) flour (0.757g/ml) followed by A (97.5:2.5%) and lowest for F(85:15) 0.677g/ml. Values obtained for all flour blends were lower than those reported for wheat-bambara-cassava flour 0.74glml – 0.83glml (Oluwole and Karim 2005) the present study revealed that bulk density depends on the particle size and initial moisture content of flour. The low bulk density would be an advantage in the formulation of complementary foods (Akapata and Akubor, 1999) and will occupy more space of packed in a packaging material Akoja *et al* 2016.

Water Absorption Capacity (WAC)

The water absorption capacity for composite flour is given in table 1. The WAC ranged between 138 to 187% for all flour the WAC was observed highest in sampl3e co (100:0) 18>% and lowest in F (85:15) 138% the result suggest that addition of *Dioclea reflexa* flour affected the amount of water absorption. This could be due to molecular structure of *Dioclea reflexa* starch which inhibited water absorption, as could be seen from the lower values of WAC with increase in proportions of *Dioclea reflexa* flour to Wheat flour. Similar observation was reported by Kaushal *et al* (2012). Kuntz (1971) reported that lower WAC in some flour maybe due to less availability of polar amino ands in flours.

The flour with high water absorption may have more hydrophilic constituents such as polysaccharide. Protein has both hydrophilic and hydrophobic nature and therefore they can interact with water in foods. The observed variation in different flours may be due to different protein concentration, their degree of interaction with water and conformational characteristics (Butt and Batool, 2010)

Oil Absorption Capacity (OAC)

The OAC ranged between 135±0.02 to 150±0.01 among all the flour. The OAC decreased with increase in the proportion of *Dioclea reflexa* flours. OAC is the ability of a food or food ingredient to absorb oil or fat. The ability of protein to bind fat is important, since fat act as flavor retainers and increase the mouth feel of food, improve palatability and extend the shelf life of bakery or meat products, meat extender, doughnuts pancakes, baked good and soup mixes. The possible reason for decrease in the OAC of the composite flour after incorporation of *Dioclea reflexa* is the variation in the presence of non-polar side chain, which might bind the hydrocarbon side chain of the oil among the flours. (Jitngarmkusol *et al*., 2008)

Farming Capacity (FC%) and Foam Stability (FS %)

Foam capacity of protein refers to the amount of interfacial area that can be created by the protein (Fennama, 1996).Foam is a colloidal of many gas bubbles trapped in a liquid or solid. Small air bubbles are surrounded by thin liquid films. Foam capacity and foam stability increased as the levels of inclusion of *Dioclea reflexa* are increasing. The values were in the range (13.49 to 17.52% and 2.30-6.55%) respectively, for FC and FS. These results were significantly ($p \leq 0.05$) different between all the samples, with sample F (85:15) having the highest and (A) 97.5:2.5 flour blende the lowest within the fortified wheat flour blends.

Emulsion Capacity and Stability

Protein being the surface active agent can form and stabilize the emulsion by creating electrostatic repulsion on oil droplet surface (Kaushal *et al*., 2012). The Emulsion Capacity (EA) and Emulsion Stability (ES) of composite flours were found to be significantly increased with decreasing in the proportion of wheat flours.

EA of different flour ranged between 45.10 and 48.51%. The highest EA for F (85:15) and lowest for Co (100% wheat) were observed. Emulsion stability (ES) for different flours varied from 38.53 to 42.43%. Highest ES was observed for sample F (85:15) (42.43%) and lowest for wheat flour (38.83%).

Emulsion stability can be greatly increased when highly cohesive films are formed by the absorption of rigid globular protein molecules that are more resistant to mechanical deformation. (Suresh *et al*., 2014). All composite flours showed relatively good capacity of emulsion activity.

Swelling Capacity (SC)

The swelling capacity of different flours ranged between 7.60 to 11.73%. The lowest value of SC was observed in Co (100:0) (7.60%) whereas the maximum in F (85:15) 11.73. The swelling capacity of flours depends on size particles, types of variety and types of processing methods or unit operations. Swelling capacity of composite flours increased with increase in the level of incorporation ratio of Dioclea reflexa flour and decreased with level of wheat flour. Values obtained for allthe flour blend were lower than those reported for wheat-rice-green gram and potato flour blends (Suresh *et al*., 2014).

Dispersibility (DP)

Dispersibility (DP) is an index of the ease of reconstitution of the flour samples in water. The percentage (DP) ranged from 48.50 to 55.21% with sample (F) 85:15 flour blends having the highest while sample A (97.5:2.5) flour blends had the lowest. This showed that the sample F (85:15) flour blends has the ability to disperse more easily and faster in aqueous solution on during food processing than other samples.

Gelatinization Temperature (GT)

The temperature at which gelatinization of starch take place is known as the gelatinization temperature (Sahay and Singh 1996). The results obtained for GT revealed an increase in GT with an increase in Dioclea reflexa flour inclusion. The GT ranged from 60.75 to 71.31^{o}c with the control sample (100:0) having the least temperature while sample with 85.15% flour blends had the highest GT.

The study revealed that the flour which was higher in starch content had the lowest temperature for gelatinization. Therefore, GT of the composite flour increased with decreased in the incorporation ratio of wheat flour.

Results Tables

Table 1, Functional Properties of Flour Blends made from Composite of Wheat and Dioclea reflexa Flours

Parameters	Co	A	B	C	D	E	F
BD(g/ml)	0.757^{a}±0.01	0.738^{b}±0.05	0.726^{c}±0.03	0.718^{d}±0.03	0.712^{e}±0.01	0.691^{f}±0.01	0.675^{g}±0.03
WAC(g/g)	187^{a}±0.01	175^{b}±0.03	165^{c}±0.04	154^{d}±0.07	149^{e}±0.04	145^{f}±0.03	138^{g}±0.01
OAC(g/g)	150^{a}±0.01	148^{b}±0.02	145^{bc}±0.04	140^{c}±0.01	138^{d}±0.03	137^{e}±0.02	135^{f}±0.02
FC (%)	13.49^{g}±0.03	13.93^{f}±0.03	14.25^{e}±0.02	15.10^{d}±0.03	15.8^{c}±0.01	16.50^{b}±0.01	17.52^{a}±0.02
FS (%)	2.30^{g}±0.04	2.93^{f}±0.05	4.05^{e}±0.06	4.17^{d}±0.04	4.86^{c}±0.03	5.43^{b}±0.04	6.55^{a}±0.01

EC (%)	5.10^{g}±0.01	5.20^{f}±0.02	6.41^{e}±0.02	6.87^{d}±0.03	7.21^{c}±0.01	8.31^{b}±0.03	8.51^{a}±0.04
ES (%)	38.83^{g}±0.02	38.85^{f}±0.02	39.35^{e}±0.03	39.93^{d}±0.02	40.41±0.02	40.95^{b}±0.01	42.43^{a}±0.01
SC (%)	7.60^{g}±0.03	8.50^{f}±0.02	9.31^{e}±0.03	9.86^{d}±0.03	10.51^{c}±0.03	11.02^{b}±0.03	11.73^{a}±0.14
DP (%)	48.50^{f}±0.14	48.10^{g}±0.14	50.05^{e}±0.07	50.50^{d}±0.14	52.40^{c}±0.12	54.40^{b}±0.14	55.21^{a}±0.14
GT (^{o}C)	60.75^{g}±0.12	59.96^{f}±0.11	60.53^{e}±0.010	60.96^{d}±0.14	70.35^{c}±0.08	70.85^{b}±0.11	71.31^{a}±0.09

Values are means of three replicates and are represented in mean ± standard deviation. Means in the same column with different superscripts are significantly different ($p \leq 0.05$). BD= Bulk density, WAC= Water absorption capacity, OAC= Oil absorption capacity, FC= Foaming capacity, FS= Foaming Stability, EC= Emulsion capacity, ES= Emulsion stability, SC= Swelling capacity, DP= Dispersibility, GT= Gelation temperature. Wheat: *Dioclea reflexa* ratio, Co (Control) = 100:0%, A= 97.5:2.5%, B=95:5%, C=92.5:7.5%, D=90:10%, E87.5:12.5%, F=85:15%.

Proximate Composition of Bread Samples

The proximate composition of the breads produced from the flour blends and the control is presented in Table 2.

The moisture content of the samples varied. The control sample (100:0) had the least value (18.03%) that differed from the test groups ($p \leq 0.05$) from sample 85:15 had the highest value 20.76% this was in agreement with the findings of Olaoye and Onilude (2011). It was observed that as the substitution increase the moisture content also increased.

The protein content of breads produced from the flour blends and the control ranged from 13.71 to 19.11%. Sample 85:15 had the highest protein values of the test breads could be ascribed to the synergistic effect of mutual food supplementation. It is known that when legumes supplement cereals, they provide a protein quality comparable to or higher than that of animal (Hotz and Gibson, 2007). The higher protein for the 85:15% blends over the other blends is probably due to its lower level of carbohydrates.

The protein drop in other test samples could be attributed to a dilution of protein by the increased level of carbohydrate in them. In particular, the control 100:0 blend having the lowest protein value (13.71%) show the highest carbohydrate value (61.42%). This observation agrees with the findings of other researchers (Kibite and Evans 1984; Onoja *et al*., 2014).

The values obtained for the Ash contents indicated that sample F(85:15) had the highest value of 2.04% as the Ash content was observed to with the percentage increase in the Dioclea reflexa level. The observation agrees with the findings of (Mongi *et al*., 2011).

The crude fibre (%) ranged from 0.43 to 1.04 and this showed a corresponding increase with increase in the proportion of Dioclea reflexa. Dioclea reflexa has relatively higher crude fibre than wheat and this could justify the result obtained for the different bread samples. This observation is in support of the findings of Onoja *et al*., 2014. Crude fibre is known to aid the digestive system of human (Ihekoronye and Ngoddy, 1985) indicating that the blends could attract good acceptability by many people as well as health organizations.

The fat content (%) of the breads followed the same trend with crude protein, though the incremental values were minimal. The low lipid level was expected since legumes and cereals store energy in form of starch rather than lipids.

The highest value of 2.92% was recorded for Sample F(85:15) while the lowest value of 2.41% was obtained for Co (100:0%)Fat plays a significant role in the shelf life of food products and as such relatively high fat content could be undesirable in baked food products. This is because fat can promote rancidity in foods, leading to development of unpleasant and odorous compounds (Ihekoronye and Ngoddy, 1985).

Table 2, Proximate Composition Of Wheat/Sea Purse *(Dioclea Reflexa)* Bread Sample

(WF: SPF) Samples	M.C (%)	PROTEIN	FAT	ASH	FIBRE	CHO
Co	18.03^{d}±0.31	13.71^{d}±0.32	2.41^{d}±0.01	1.32^{d}±0.03	0.43^{d}±0.03	61.42^{ab}±2.29
A	18.12^{d}±0.25	14.03^{c}±0.02	2.31^{e}±0.01	1.37^{d}±0.02	0.42^{d}±0.02	63.78^{a}±0.00
B	18.85^{c}±0.00	15.90^{bc}±0.00	2.54^{c}±0.00	1.50^{c}±0.00	0.50^{c}±0.00	60.71^{b}±0.00
C	19.83^{bc}±0.83	17.23^{b}±0.02	2.65^{bc}±0.01	1.72^{bc}±0.03	0.65^{bc}±0.03	57.91^{bc}±0.02
D	20.14^{b}±0.12	18.52^{ab}±0.02	2.73^{b}±0.01	1.82^{b}±0.02	0.73^{b}±0.03	56.06^{c}±0.05
E	20.43^{ab}±0.25	18.93^{ab}±0.25	2.82^{ab}±0.01	1.90^{ab}±0.02	0.86^{ab}±0.03	55.06^{d}±0.06
F	20.75^{a}±0.12	19.11a±0.12	2.92^{a}±0.01	2.04^{a}±0.03	1.04^{a}±0.02	54.12^{e}±0.05

Values are means of three replicates and are represented in mean ± standard deviation. Means in the same column with different superscripts are significantly different ($p \leq 0.05$). BD= Bulk density, WAC= Water absorption capacity, OAC= Oil absorption capacity, FC= Foaming capacity, FS= Foaming Stability, EC= Emulsion capacity, ES= Emulsion stability, SC= Swelling capacity, DP= Dispersibility, GT= Gelation temperature. Wheat: *Dioclea reflexa* ratio*,* Co (Control) = 100:0%, A= 97.5:2.5%, B=95:5%, C=92.5:7.5%, D=90:10%, E87.5:12.5%, F=85:15%.

Sensorial Attributes of Bread from Wheat-*Dioclea reflexa* Blends

Table- presents the mean sensory evaluation scores of the breads. There were significant differences ($p \leq 0.05$) between the colour, aroma, taste, appearance, texture and overall acceptability of the control (100% wheat) and the wheat-*Dioclea reflexa* based bread. The control bread had the highest score 8.5 for colour, followed by 97.5:2.5 formulation (8.26) while the 85:15 formulation was the least preferred with a mean sensory score 6.70. The study revealed that colour scores were decreased with increasing incorporation of Dioclea reflexa with wheat flour. Although some of the sensory attributes of the breads from the other test blends were lower than those of the control 100:0 and 97.5:2.5 bread, they were however acceptable.

All the test samples recorded over 60% of overall acceptance. However, there was a slight difference in the degree of acceptance amongst the breads.

Table 3, Sensory Characteristics of Bread Supplemented With Sea Purse

Sample	Colour	Aroma	Taste	Appearance	Texture	Overall Acceptability
A	8.50^{a}±0.02	8.50^{a}±0.12	8.70^{a}±0.22	8.10^{a}±0.03	8.50^{a}±0.01	8.10^{a}±0.15
B	8.20^{a}±0.01	8.20^{a}±0.22	8.00 ^{a}±0.12	7.60^{ab}±0.05	8.20^{a}±0.15	8.00^{a}±0.16
C	8.00^{a}±0.03	8.10^{a}±0.21	7.50^{ab}±0.13	6.80^{b}±0.01	7.50^{ab}±0.04	7.70^{ab}±0.21
D	8.00^{a}±0.03	7.90^{ab}±0.12	7.80^{ab}±0.24	7.20^{ab}±0.04	8.10^{a}±0.04	7.80^{ab}±0.24
E	7.70^{ab}±0.05	7.70^{ab}±0.13	7.60^{ab}±0.13	7.90^{ab}±0.22	8.10^{a}±0.04	7.90^{ab}±0.17
F	7.20^{ab}±0.12	6.80^{b}±0.14	6.30^{c}±0.16	7.00^{ab}±0.15	7.00^{ab}±0.05	7.00^{ab}±0.15
G	6.70^{b}±0.14	6.30^{c}±0.12	6.30^{c}±0.04	6.60^{b}±0.11	6.30^{c}±0.03	6.90^{b}±0.12

Key values are means of triplicate determination. Means in the same row with different superscripts are significantly different ($p \leq 0.05$). Where A= (100% of whole wheat flour), B= 97.5% wheat flour:2.5% *Dioclea reflexa* flour, C=95% wheat flour:5% *Dioclea reflexa* flour, D=92.5% wheat flour :7.5%Diocleareflexa flour, E= 90% wheat flour:10%*Dioclea reflexa* flour, F=87.5% wheat flour:12.5% *Dioclea reflexa* flour, G= 85% wheat flour15%*Dioclea reflexa* flour.

Conclusion

The study showed that bread can be improved through supplementation with Dioclea reflexa flours. This is reflected in the improved protein (13.71-19.11%) which increased with increase in Dioclea reflexa flour. Bread from Wheat/ Dioclea reflexa blend can serve as a nutritious food and help redress the problem of protein energy malnutrition. The maximum levels of replacements which are from 2.5 to 10%. In addition to the aforementioned, there would be an increase in demand and utilization for Dioclea reflexa by the bakery of bread; hence this would eventually encourage the cultivation of more hectares by farmers for the crop and more income on returns

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