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Physical, chemical and sensory properties of bread from blends of wheat and lima bean flours

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ABSTRACT: The study was conducted to determine the physical, chemical, and sensory properties of bread produced from wheat and lima beans flour blends. The study adopted a 1 by 5 plus 1 factorial design; lima beans were processed into flour and used to substitute wheat flour in different proportions (0, 10, 20, 30, 40, and 50%). Bread produced from 100% wheat flour was used as control. The proximate result of the bread samples showed that substitution of wheat flour with lima bean flour significantly increased the protein, ash and the crude fiber content of the products with values ranging from 13.76-24.26%, 2.92-3.84%, and 5.42-6.00% respectively while a significant decrease was observed in the moisture, fat and carbohydrate content of the products with values ranging from 18.78-15.41%, 4.75-3.30%, and 54.37-47.19%, respectively. Increasing substitution level of wheat flour with lima beans flour increased all the functional parameters; water absorption capacity from 0.77-2.46 g/ml, oil absorption capacity 1.38-1.87 g/ml, swelling properties 1.07-1.98 g/cm3, bulk density 0.95-1.68 g/g and foam ability 2.07-2.67 mg. From the physical properties, it was observed that loaf weight increases with an increase in substitution levels but on the other hand, loaf volume and specific volume decreases significantly ($P< 0.05$) at increasing substitution levels from 150.24-173.98 g, 701.05-482.09 ml, and 4.67-2.77 cm3 respectively. The mean sensory score of the bread samples showed that all the composite bread samples were generally acceptable. However, sample substituted with 20% lima bean flour was best preferred having the highest score ratings by the panellist in all the sensory quality attributes evaluated.

Keywords: Lima beans flour, Composite bread, proximate composition, functional properties, physical properties, sensory attributes.

Introduction

Malnutrition is prevalent in Nigeria (ICF, 2013; Kuku-Shittu et al., 2016) most especially Protein-energy malnutrition (PEM) which refers to a form of malnutrition where there is inadequate intake of protein. Ubesie and Ibeziakor (2016) reported that the burden of PEM in Nigeria is still high and that the severe forms of the disease are usually associated with a high level of morbidity even in the tertiary health facilities. In most developing countries including Nigeria, they predominantly consume cereals and roots crops in most cases which do not provide good quality protein in their diet (Okoye et al., 2018; Nwafor et al., 2019). Thus, PEM can be alleviated through food enrichment of plant origin. Research efforts to address this challenge have involved the use of composite flours from wheat and other protein-rich legumes such as lima bean. Legumes have been the major sources of low-cost proteins and, when combined with cereals and grains, form a complete protein (Ishaya and Aletor, 2019).

Lima bean is a legume grown for its edible seeds and is rich in high-quality protein (including lysine), starch, dietary fiber (especially soluble fiber in the form of pectin, iron, potassium, and magnesium), B-complex vitamins (niacin, folate and vit.B6). The proximate composition varies among varieties; protein content ranged from 20.69–23.08 %, crude fat, 0.59–1.14 %, crude fiber, 4.06–6.86 %, ash, 4.39–5.61%, moisture 9.19-11.83 %, carbohydrate 54.31-59.64 %, and energy, 313.28-328.10 kcal/100 g while on mineral content, it contains 2.45 and 172.77 mg/100g, for Iron and Phosphorus respectively (Yellavila et al., 2015)

Despite its nutritional value, lima bean is an underutilized legume in Nigeria that is rich in high-quality protein especially lysine (Ishaya and Aletor, 2019) which is limiting in cereal crop, it is cheaper and readily available, therefore if it is used in the substitution of cereal grain like wheat, it will improve the protein content and nutritional quality of baked products thereby making it a valuable tool for hunger and protein-energy malnutrition and hence, prevents the crop from going into extinction.

Cereal products, particularly bread forms a basic part of the human diet in many countries from centuries owing to its characteristic sensory properties and nutritional quality (Shaikh et al., 2017). It is a fermented bakery product that is mainly prepared from wheat flour, yeast, water, and salt by a series of unit operations including mixing, kneading, shaping, fermentation, and baking. Bread prepared from whole wheat is considered to be poor nutritionally especially in protein quality (Shaikh et al., 2017). Hence, the need to produce bread from composite flour of wheat and lima beans. Several researchers have reported on bread from composite flours using protein sources such as breadfruit and breadnut (Malomo et al., 2011), soya beans (Abrehet et al., 2018), kidney beans (Ukeyima et al., 2019) or the use of other starch sources includes cocoyam (Mongi et al., 2011), fermented banana (Adebayo-Oyetoro et al., 2016), sorghum and rice (Shaikh et al., 2017). Malomo et al., (2011) reported that the addition of breadfruit and breadnut at a 15% level improved the protein and mineral contents of the bread as well as the acceptability by the panelist. Abrehet et al. (2018) and Ukeyima et al. (2019) both reported that the proximate composition, physical, mineral content, and sensory qualities of the composite bread was improved. Mongi et al. (2011) reported that carbohydrate, crude fiber, and ash contents of the cocoyam-composite loaves of bread increased while the moisture and protein contents decreased with progressive increase in the cocoyam flour substitution. Adebayo-Oyetoro et al. (2016) reported that the protein, carbohydrate, and fat contents reduced while the fiber, moisture, and ash contents increased with increasing inclusion of the fermented plantain flour. Shaikh et al. (2017) reported that the protein, ash, and crude fiber contents were increased while moisture and fat content were decreased with increasing substitution of whole wheat flour with sorghum and rice flours.

Materials and Methods

Lima beans were purchased at Bodija market Ibadan, Oyo State; it was then identified at the Department of Plant Biology, University of Ilorin (UILH/007/1447), and was processed in the Department of Home Economics and Food Science general laboratory. Wheat flour, butter, sugar, yeast, milk, whole egg, and salt were purchased at Ipata local market, Ilorin Kwara State.

Production of Lima Beans Flour

The preparation of lima bean flour was done by using the method reported by (Julianti et al., 2015). The lima bean grains were selected, washed, and soaked into water for 6 hours and it was then boiled in a pressure cooker for 10 minutes. They were removed, dehulled, washed, drained in a sieve and it was dried at 50oC for 24 hours after which was ground into flour in hammer mill. The flour was sieved through a 0.5 mesh sieve. The flour sample was kept in an airtight container until use

Composite Formulation of Wheat and Lima Beans Flour Blends

Composite flour was prepared by substituting wheat flour with lima bean flour at various percentages as shown in (Table 1). Kenwood mixer (Model A 907 D, Kenwood Ltd, England.) was used for mixing flour samples at speed 5 for 7 minutes to ensure uniformity.

Table 1: Formulation of Wheat and Lima Beans Flour Blends

Sample	Wheat Flour (%)	Lima Bean (%)
A	100	0
B	90	10
C	80	20
D	70	30
E	60	40
F	50	50

Source: Julianti *et al.*, 2014

Preparation of Bread

The preparation of the bread involves the replacement of part of the Wheat Flour (WF) with 10, 20, 30, 40, and 50% lima bean flour. The 100% wheat bread served as control. Baking was carried out on the blends using standard bread baking procedures established for the straight dough as reported by Igbabul et al., (2014). The formula and baking conditions are given in (Table 2). After mixing, the dough was covered to proof for about 30 minutes and it was kneaded, moulded, placed into a greased pan left to proof for another 2 hours, and finally baked at 180oC for 25-30 minutes in an electric oven. The loaves were then taken out of the tins, cooled at ambient temperature for 30 minutes.

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Table 2: Baking Recipe of the Composite Bread

Ingredients	Quantity
Composite flour (g)	200
Dry yeast (g)	4.0
Salt (g)	3.0
Sugar (g)	10
Fat (g)	20
Milk (g)	10
Water (ml)	Varied
Proofing	2½ hours at 30-35ºC
Baking	25-30 minutes at 180ºC

Source: Igbabul *et al.* (2014).

Functional Properties

The functional properties such as water absorption capacity, oil absorption capacity, bulk density, swelling capacity, and foaming properties were determined by methods described by Onwuka (2005).

Chemical Analysis

The proximate composition (moisture content, ash content, protein content, fat content, crude fiber, and carbohydrate content) of the bread were determined by methods described by AOAC (2010).

Physical Analysis

The bread's physical characteristics: loaf volume, loaf weight, and specific volume was determined by methods described by AACC. (2000). Colour characteristics were determined using the method reported by Amal (2015).

Sensory Evaluation

Loaves were cooled for 1-2 hours at room temperature (25oC) in a sealed plastic bag. The bread was then cut into 2 x 3 x 5 cm slices using a bread knife. Sensory evaluation was performed using 50 panelists that are randomly selected from the student of Home Economics and Food Science Department, University of Ilorin. Samples were randomly assigned to each panelist. The panelists were asked to evaluate each loaf for crumb colour, crumb texture, crust colour, taste, aroma, chewability and overall acceptability. A 9-point hedonic scale was used where1 = dislike extremely to 9 = like extremely (Ihekoroye and Ngoddy, 1985).

Statistical Analysis

Analyses were done in duplicate and all data obtained were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Science (SPSS) version 20.0 software 2016.

Results and Discussion

Functional Properties of Wheat and Lima Beans Flour Blends

The result obtained from the functional properties of flour blends shows that all the properties evaluated increases with increasing level of substitution (Table 3). The water absorption capacity of the composite flour ranged from 0.77 g/ml-2.46 g/ml. These values agree with the trend of Igbabul et al. (2014) but with higher values 2.44 g/ml-2.87 g/ml reported for wheat, sweet potato, and hamburger bean flour but disagrees with the findings of Ukeyima et al., (2019) whose values decreased from 1.10 g/ml-0.60 g/ml for wheat-kidney beans composite flour. Flours with high water absorption have more hydrophilic constituents, such as polysaccharides (Yellavila et al., 2015). The high water absorption capacity observed in this study could be due to the high insoluble fiber present in lima bean flour. The protein quality of lima beans flour may also have effects in the higher water absorption capacity (Yellavila et al., 2015).

The oil absorption capacity of composite flour ranged between 1.38 g/ml and 1.87 g/ml which shows that there are significant differences (P<0.05) as the substitution level of lima beans flour increases. The values were in line with the findings of 1.59 g/ml-2.14 g/ml reported by Igbabul et al. (2014) but disagree with the values 0.76g/m-1.03 g/ml reported by Ukeyima et al. (2019). The composition of protein (soluble and insoluble) and other components (possibly carbohydrate) present in the lima beans flour may have contributed to the higher oil absorption capacity in this study. Oils and fat are key ingredients in bread production, they are used to enhance gas retention and thereby increase both volume and softness. In addition to their leavening action, fats also serve to tenderize bread and preserve freshness (Oliver, 2014).

The bulk density of the wheat-lima bean flour blend ranges between 0.95 g/cm3-1.68 g/cm3 with (100%WF) having the lowest value of 0.95 cm3. These values correlate with Adegunwa et al. (2014) who reported 0.76 g/cm3-1.83 g/cm3 for instant plantain-bread fruit composite flour blends but higher than the values 0.72 g/cm3-0.79 g/cm3 reported by Adebayo-Oyetoro et al. (2016). The higher the bulk density, the greater the compactness of the flour as the particle size is inversely proportional to bulk density ((Eke-Ejiofor and Kiin-Kabari 2012). The high bulk density of flour suggested suitability for use in food applications (Adegunwa et al., 2014).

The swelling capacity of the flour blends ranged from 1.07 g/g-1.98 g/g with the lowest value observed in 100% wheat flour. The values obtained were lower than the values 2.89 g/g-5.92 g/g of Ukeyima et al. (2019) and 2.69 g/ml-10.75 g/g of Peluola-Adeyemi et al. (2020). The swelling capacity of flour shows the degree of the water absorption of the starch granules in flour (Julianti et al, 2015) or an indicator of the extent of starch damage (Adebowale et al., 2012). The low swelling capacity may be due to the formation of the starch-lipid and starch-lipid-protein complex (Feng et al., 2018; Wang et al, 2020) which results when lipids form a helical inclusion complex with amylose in starch restricting starch granule hydration and swelling (Oyeyinka et al., 2016).

Foaming capacity of the composite flour blends increased with increasing level of substitution and the values ranged from 2.07 mg-2.67 mg. The values were lower than 3.95%-4.11% (Igbabul et al., 2014) and

26.94 cm3-32.69 cm3 (Ukeyima et al., 2019) Research showed that flexible protein molecules reduce surface tension to give good foamability. Foam ability is related to the rate of decrease of surface tension of the air-water interface caused by the absorption of protein molecules which slows down the rate of coalescence (Yellavila et al., 2015). Foaming properties are dependent on the proteins and some other components, such as carbohydrates, that are present in the flours (Dossou et al., 2014). The increased foaming capacity observed in this study suggest that the protein in lima beans have a higher amount of surface-active since it has been reported that high amount of surface-active (saponins) are generally present in legumes, which are also water-soluble and may, therefore, influence the foaming capacity (Ekpo and Ugbenyen, 2011; Dossou et al., 2014)

Table 3: Functional Properties of Wheat and Lima Beans Flour Blends

Samples Wheat Flour (%)	Lima beans Flour (%)	Water absorption capacity(g/ml)	Oil absorption capacity(g/ml)	Bulk density (g/cm^3)	Swelling properties (g/g)	Foaming capacity (mg)
100	0	0.77^f±0.03	1.38^e±0.01	0.95^f±0.01	1.07^f±0.03	2.07^e±0.01
90	10	1.92^e±0.03	1.55^d±0.01	1.47^e±0.03	1.43^e±0.04	2.26^d±0.03
80	20	2.09^d±0.03	1.68^c±0.01	1.52^d±0.03	1.62^d±0.01	2.29^d±0.03
70	30	2.24^c±0.03	1.76^b±0.03	1.58^c±0.01	1.77^c±0.03	2.41^c±0.03
60	40	2.32^b±0.01	1.81^b±0.03	1.63^b±0.01	1.88^b±0.01	2.52^b±0.03
50	50	2.46^a±0.01	1.87^a±0.03	1.68^a±0.01	1.98^a±0.01	2.67^a±0.03

*Values in the same column with the same superscript are not significantly different at P<0.05 using Duncan multiple test across column. *Values are means ± standard deviation of duplicate determinations

Proximate Composition of Bread Produced from Wheat and Lima Beans flour blends

The result obtained from the proximate composition of composite bread (Table 4) shows that the protein, ash, and crude fiber contents increased while the moisture, crude fat, and carbohydrate decreased with increasing levels of lima beans flour substitution. The moisture content of the composite bread ranged between 15.41 and 18.78% with 100% wheat bread having the highest moisture content 50:50% wheat-lima beans having the lowest. The decrease in moisture content with an increase in the level of substitution shows the certainty of prolonging shelf life. The range of moisture content implied that the lima bean flour had good storage potential since it was known that moisture and water activity of the product determine the shelf life of food products. The values were similar to the values 17.31%-20.99% in the findings of Mongi et al. (2011) and 18.96-20.07% Abrehet et al. (2018) but lower than the values 28.94%-36.95% in the findings of Adebayo-Oyetoro et al. (2016), who reported that moisture content of the composite bread increased with increasing non-wheat flour substitution.

Table 4: Proximate Composition of Bread Produced from Wheat and Lima Beans flour blends (%)

Samples Wheat Flour	Lima bean Flour	Moisture content	Ash	Crude protein	Crude fat	Crude fibre	Carbohydrate
100	0	18.78^a±0.03	2.92^d±0.04	13.76^f±0.01	4.75^a±0.04	5.42^e±0.03	54.37^a±0.07
90	10	17.84^b±0.04	3.43^c±0.01	15.96^e±0.04	4.66^a±0.03	5.66^d±0.03	52.45^b±0.07
80	20	17.53^c±0.04	3.45^c±0.06	18.44^d±0.06	4.47^b±0.03	5.81^c±0.04	50.30^c±0.06
70	30	16.89^d±0.03	3.69^b±0.04	20.86^c±0.03	3.80^c±0.06	5.89^b±0.03	48.87^d±0.01
60	40	16.64^e±0.04	3.73^b±0.03	22.70^b±0.03	3.56^d±0.04	5.96^{ab}±0.03	47.41^e±0.08
50	50	15.41^f±0.06	3.84^a±0.04	24.26^a±0.03	3.30^e±0.03	6.00^a±0.03	47.19^f±0.07

*Values in the same column with the same superscript are not significantly different at P<0.05 using Duncan multiple test across column.*Values are means ± standard deviation of duplicate determinations

The protein content of the bread increased significantly ($p<0.05$) with increasing levels of lima beans from 13.76% to 24.26% The increase in protein content is since lima bean is reportedly rich in protein and to contain all the essential amino acids especially lysine (Ishaya and Aletor, 2019). The values were higher than the findings of previous researchers (Shaikh et al., 2017; Abrehet et al., 2018; Ukeyima et al., 2019) whose values were 8.45%-11.69%, 10.37%-11.87% and 8.36%-10.47% respectively

The ash contents give an insight into the amount of inorganic content of the samples where the mineral contents could be obtained. The values obtained for ash content was in the range of 2.92 - 3.84%. The values were higher than 1.52%-1.80%, 0.66%-1.53% and 2.05%-2.77% reported by Shaikh et al., (2017), Abrehet et al., (2018) and Ukeyima et al., (2019) respectively. The values obtained for ash contents were evidence that the composite bread could provide essential minerals needed for body metabolism.

The fat content decreases significantly ($P< 0.05$) from 4.75% – 3.30% with increasing inclusion of the lima beans flour in the blend. This implies that lima bean seed is not a good source of oil. Lima beans varieties were reported to contain 0.59%-1.14% fat (Yellavila et al., 2015). The result followed the same trend with findings of Adebayo-Oyetoro et al., (2016) and Shaikh et al., (2017) whose values equally decreased from 1.81%-1.66% and 6.75%-3.83% respectively but disagrees with Ukeyima et al. (2019) whose values increased from 11.31%-12.94%.

There was a significant ($p<0.05$) increase in the fiber content with increasing substitution and the values ranged from 5.42 – 6.00%. The values were higher than values 2.73%-4.96% and 0.29%-0.59% reported by Abrehet et al. (2019) and Ukeyima et al. (2019) respectively. Crude fiber contributes to the health of the gastrointestinal system and the metabolic system in man (Abrehet et al., 2018).

There was a significant decrease in carbohydrate content from 54.37 to 47.19% as the substitution level of lima beans flour increases. Substitution effect might be the major reason for this observation due to the fact that lima beans is attributed to high protein content and other constituents present in it. This value is in close agreement with values 52.98%-49.70% reported by Adebayo-Oyetoro et al., (2016) but lower than the values 50.45%-46.93% reported by Malomo et al. (2011).

Physical Properties of Bread Produced from Wheat and Lima Beans flour blends

The loaf weight increases as shown in Table 5 with increasing substitution of the composite flour and the values ranged from 150.24 g-173.98 g. The observed significant ($p<0.05$) increase in loaf weight with an increasing amount of lima bean flour substitution was due to less retention of carbon dioxide gas in the blended dough, hence providing dense bread texture which goes in line with the values reported by (Amal, 2015). The values were lower than the findings 550.00 g-558 g of Malomo et al. (2011) for wheat-breadfruit and breadnut composite bread and 243.21g-246.09g for wheat-kidney beans composite bread (Ukeyima et al., 2019).

The loaf volume and specific volume decreased significantly from 701.85-482.09 cm3 and 4.67-2.77 cm3 respectively. The less loaf volume and specific volume of the composite bread were probably due to the dilution effects on gluten with the addition of lima bean flour to the wheat flour. This value is similar to values reported by Makinde and Akinoso (2014) that produced bread from wheat and black sesame flour but lesser than 1278.93 cm3-1826.64 cm3 reported by Malomo et al. (2011) The Gluten fraction is responsible for the elasticity of the dough by causing it to extend and trap the carbon dioxide generated by yeast during fermentation (Ukeyima et al., 2019). When gluten coagulates under the influence of heat during baking, it serves as the framework of the loaf, which becomes relatively rigid and does not collapse. The decrease in loaf volume and specific volume could be as a result of the substitution effect which might have reduced the gluten content in the dough. According to Malomo et al. (2011), the maximum specific volume should be 6.5 cm3 while the minimum 3.5 cm3. Therefore, based on the findings of this study, a limit of up to 30% substitution level with wheat flour in bread making is necessary to produce acceptable bread with weight and volume characteristics comparable to 100% wheat bread

The protein content of the bread increased significantly ($p<0.05$) with increasing levels of lima beans from 13.76% to 24.26% The increase in protein content is since lima bean is reportedly rich in protein and to contain all the essential amino acids especially lysine (Ishaya and Aletor, 2019). The values were higher than the findings of previous researchers (Shaikh *et al.,* 2017; Abrehet *et al.,* 2018; Ukeyima *et al.,* 2019) whose values were 8.45%-11.69%, 10.37%-11.87% and 8.36%-10.47% respectively

The ash contents give an insight of the amount of inorganic content of the samples where the mineral contents could be obtained. The values obtained for ash content was in the range of 2.92 - 3.84%. The values were higher than 1.52%-1.80%, 0.66%-1.53% and 2.05%-2.77% reported by Shaikh *et al.,* (2017), Abrehet *et al.,* (2018) and Ukeyima *et al.,* (2019) respectively. The values obtained for ash contents were evidence that the composite bread could provide essential minerals needed for body metabolism.

The fat content decreases significantly (P< 0.05) from 4.75% – 3.30% with increasing inclusion of the lima beans flour in the blend. This implies that lima bean seed is not a good source of oil. Lima beans varieties was reported to contain 0.59%-1.14% fat (Yellavila *et al.,* 2015). The result followed the same trend with findings of Adebayo-Oyetoro *et al.,* (2016) and Shaikh *et al.,* (2017) whose values equally decreased from 1.81%-1.66% and 6.75%-3.83% respectively but disagrees with Ukeyima *et al.* (2019) whose values increased from 11.31%-12.94%.

There was significant (p<0.05) increase in the fibre content with increasing substitution and the values ranged from 5.42 – 6.00%. The values were higher than values 2.73%-4.96% and 0.29%-0.59% reported by Abrehet *et al.* (2019) and Ukeyima *et al.* (2019) respectively. Crude fibre contributes to the health of the gastrointestinal system and metabolic system in man (Abrehet *et al.,* 2018).

There was significant decrease in carbohydrate content from 54.37 to 47.19% as the substitution level of lima beans flour increases. Substitution effect might be the major reason of this observation due to the fact that lima beans is attributed to high protein content and other constituents present in it. This value is in close agreement with values 52.98%-49.70% reported by Adebayo-Oyetoro *et al.,* (2016) but lower than the values 50.45%-46.93% reported by Malomo *et al.* (2011).

Table 5: Physical Properties of Bread Produced from Wheat and Lima Beans flour blends

Samples		Loaf weight (g)	Loaf volume (ml)	Specific volume(cm$^{3)}$
Wheat Flour (%)	Lima beans Flour (%)			
100	0	150.24^{f}±0.04	701.05^{a}±0.03	4.67^{a}±0.03
90	10	155.15^{e}±0.03	694.80^{b}±0.03	4.38^{b}±0.01
80	20	161.35^{d}±0.07	679.46^{c}±0.03	4.31^{c}±0.01
70	30	164.08^{c}±0.03	595.37^{d}±0.03	3.62^{d}±0.03
60	40	169.66^{b}±0.03	539.26^{e}±0.03	3.18^{e}±0.01
50	50	173.98^{a}±0.03	482.09^{f}±0.03	2.77^{f}±0.03

Values in the same column with the same superscript are not significantly different at P<0.05 using Duncan multiple test across column. Values are means ± standard deviation of duplicate determinations.

Crumb and Crust Colour Characteristics of Bread Produced from Wheat and Lima Beans flour blends

The colour values L (light-dark), a (red-green), and b (yellow-blue) of the crust and crumb of bread samples substituted with lima beans flour are presented in Table (6.1 and 6.2). L values of the bread crumb decreased from 38.45-28.38. Bread made from 100% wheat flour had the highest value while least was recorded for 50:50 wheat-lima beans flour blends. The decrease in the lightness of the bread could be as a result of the contribution of protein content by the lima beans thereby increasing the reaction between an amino acid and sugar (caramelization and Maillard browning reaction) during baking (Ukeyima et al., 2019). The brownish bread appearance could be directly related to the increase in fiber content since lima beans contain high fiber content (Yellavila et al., 2015). The values ranged between 0.53 and 2.47 for bread made from 100% wheat flour and 50:50 wheat-lima beans flour blends respectively. The lowest result of the b-value was that of bread made from the 100% wheat flour (5.55), while the highest value (7.51) was recorded for bread made with 50:50 wheat-lima beans flour blends. The same trend was recorded for crust colour Table 6.2, where the L values equally decreased from 35.72-24.67; a- and b values increased from 8.18-12.24 and 19.89-23.83 respectively. The effect of lima bean flour substitution on the colour of the crumb and crust of bread samples was more obvious than that of wheat flour, where bread samples substituted with lima beans flour gave lower L-values and higher a-and b-values when compared with 100% wheat flour. Darker colours of the crumbs and crust of wheat bread and fortified bread have been reported by Serrem et al. (2011).

Table 6.1: **Crumb characteristics of Bread Produced from Wheat and Lima Beans flour blends**

Sample	L	A	b
100	38.45^{a}±0.03	0.53^{f}±0.01	5.55^{f}±0.03
90:10	30.43^{b}±0.04	1.03^{e}±0.03	6.01^{e}±0.01
80:20	33.72^{c}±0.01	1.63^{d}±0.03	6.49^{d}±0.03
70:30	32.60^{d}±0.01	1.85^{c}±0.03	6.83^{c}±0.03
60:40	30.01^{e}±0.01	2.24^{b}±0.03	7.17^{b}±0.03
50:50	28.38^{f}±0.01	2.47^{a}±0.01	7.51^{a}±0.03

Values in the same column with the same superscript are not significantly different at P<0.05 using Duncan multiple test across column. *Values are means ± standard deviation of duplicate determinations.

Table 6.2: Crust Characteristics of Bread Produced from Wheat and Lima Beans flour blends

Sample	L	A	b
100	35.72^{a}±0.03	8.18^{f}±0.04	19.89^{e}±0.03
90:10	31.89^{b}±0.01	9.46^{e}±0.04	19.98^{d}±0.01
80:20	30.43^{c}±0.03	10.53^{d}±0.04	20.01^{d}±0.01
70:30	28.10^{d}±0.01	10.89^{c}±0.03	21.65^{c}±0.03
60:40	26.10^{e}±0.03	11.61^{b}±0.03	22.05^{b}±0.01
50:50	24.67^{f}±0.03	12.24^{a}±0.03	23.83^{a}±0.03

Values in the same column with the same superscript are not significantly different at P<0.05 using Duncan multiple test across column. *Values are means ± standard deviation of duplicate determinations.

Sensory Evaluation

The results of the sensory evaluation of bread samples containing different levels of lima bean flour substitution as compared to the control are shown in Table 7. The results of bread crumb colour and crust colour did not show a consistent pattern for all the bread samples. The crumb colour and crust colour ranged from7.25-8.05 and 7.17-7.95 respectively. The inconsistency in the colours could be a result of the uneven mixing of the dough. The mean score for taste and aroma ranged from 7.30-8.50 and 6.95-7.90 respectively. Bread with 20% lima bean flour substitution had the highest score in both parameters and this may be due to aromatic compounds present in lima beans. Bread texture and chew-ability ranged from 7.00-7.85 and 7.45-8.05 respectively. The baking conditions (temperature and time variables); the state of the bread components, such as fiber, starch, protein (gluten) and the amounts of absorbed water during dough mixing, all contribute to the final texture of the bread (Serrem et al., 2011). On the overall acceptability, the mean score ranged from 7.05-8.25 with bread containing 20% lima beans substitution having the highest score. It was observed that bread substituted with 20% lima beans flour was best preferred in all the sensory attributes evaluated.

Table 7: Mean Sensory Scores of Bread Produced from Wheat and Lima Beans flour blends

Sample	Crumb colour	Taste	Crust Colour	Crumb Texture	Aroma	Chew ability	Overall acceptability
NTF	7.25^{e}±0.03	7.45^{c}±0.01	7.15^{f}±0.01	7.00^{e}±0.04	7.45^{c}±0.03	7.75^{b}±0.01	7.30^{d}±0.01
MAS	8.05^{a}±0.01	8.50^{a}±0.03	7.95^{a}±0.03	7.85^{a}±0.01	7.90^{a}±0.03	8.05^{a}±0.03	8.25^{a}±0.06
NAT	7.75^{b}±0.03	7.30^{d}±0.01	7.80^{b}±0.01	7.60^{c}±0.03	7.70^{b}±0.01	7.65^{c}±0.04	7.90^{b}±0.03
FAT	7.35^{d}±0.01	7.30^{d}±0.03	7.30^{e}±0.03	7.50^{d}±0.01	6.95^{d}±0.01	7.45^{d}±0.01	7.05^{e}±0.03
NRS	7.65^{c}±0.04	7.50^{c}±0.01	7.65^{c}±0.04	7.75^{b}±0.03	7.50^{c}±0.04	7.80^{b}±0.01	7.60^{c}±0.01
TOS	7.30^{de}±0.03	7.70^{b}±0.03	7.40^{d}±0.03	7.50^{d}±0.01	7.75^{b}±0.03	8.00^{a}±0.03	7.35^{d}±0.01

*Values in the same column with the same superscript are not significantly different at P<0.05 using Duncan multiple test across column *. Values are means ± standard deviation of 50 evaluations

KEYS: NTF =90% wheat flour: 10% lima bean composite bread
MAS =80% wheat flour: 20% lima bean composite bread
NAT = 70% wheat flour: 30% lima bean composite bread
FAT = 60% wheat flour: 40% lima bean composite bread
NRS = 50% wheat flour: 50% lima bean composite bread
TOS = 100% wheat bread (control)

Conclusion

The composite flour from wheat and lima beans showed good functionality as all the parameters increased with an increasing level of substitution. Substitution level of wheat with lima bean flour up to 50% improved the protein, crude fiber and ash content of bread and decreased the carbohydrate, fat, and moisture content. The loaf weight increases while the loaf volume and specific volume decreases with an increase in the level of substitution. The sensory evaluation of the bread showed that all samples were generally acceptable; however, bread produced with 20% level of lima bean flour substitution was rated best by the panelists. Production of bread from wheat and lima beans composite flour blends enriched the bread nutritionally and this could be used to solve malnutrition problems especially protein-energy malnutrition (PEM) and will equally increase the use of lima beans thereby preventing the crop from going into extinction.

References

AACC (2000). Approved Methods of AACC. Nineth ed. The American Association of Cereal Chemists, Saint Paul, Minnesota.

Abrehet, G.F., Kebede, A.A. and Meksud A. (2018). The Physico-Chemical Composition and Sensorial Quality of Kocho Bread Blended with Wheat *(Triticum Aestivum)* and Soybean *(Glycine Max)* Flour. *CPQ Nutrition*, 1(4), 01-14.

Adebayo-Oyetoro, A.O., Ogundipe, O.O. and Adeeko, K.N. (2016). Quality assessment and consumer acceptability of bread from wheat and fermented banana flour. *Food Science and Nutrition,* 4(3):364-369.

Adegunwa, M.O., Adebowale, A.A., Bakae, H.A. and Ovie, S.G. (2014). Compositional characteristics and functional properties of instant plantain-breadfruit four. *International Journal of Food Research,* 1(1):1-7.

Adebowale, A.A., Adegoke, M.T., Sanni, S.A., Adegunwa, M.A. and Fetuga, G.O. (2012). Functional properties and biscuit making potentials of sorghum-wheat flours composite. *American Journal of Food Technology,* 7(6):372-379.

Afzal, B., Pasha, I., Zahoor, T. and Nawaz, H. (2016). Nutritional potential of fenugreek supplemented bread with special reference to antioxidant profiling. *Pakistan Journal of Agricultural Science,* 53(1):217-223.

Amal, A.M. (2015). Quality evaluation of wheat-sweet potato composite flours and their utilization in bread making. *International Journal of Advanced Research in Biological Sciences*, 2:294-303.

A.O.A.C, (2010). Official Methods of Analysis, Association of Official Analytical Chemists, Washington, D.C.

Dossou, V.M., Agbenorhevi, J.K., Alemawor, F and Oduro, I. (2014). Physicochemical and Functional Properties of full fat and defatted Ackee (*Blighia sapida*) Aril Flours. *American Journal of Food Science and Technology*, 2(6): 187-191.

Eke-Ejiofor, J., and Kiin-Kabari, D.B. (2012). Effects of substitution on the functional properties of flour, proximate and sensory properties of wheat/plantain composite bread. *International Journal of Agricultural Science,* 2:1-5.

Ekpo, K.E and Ugbenyen, A.M. (2011). Comparative evaluation of certain functional properties of four different varieties of Lima Bean (*Phaseolus Lunatus*) flour. *Annals of Biological Research*, 2(2): 399-402.

Feng, T., Zhuang, H., Chen, F., Campanella, O., Bhopatkar, D., Carignano, M.A and Park, S.H. (2018): Chapter 7: Starch-Lipid and Starch-Protein Complexes and Their Application. Z. Jin (ed.), *Functional Starch and Applications in Food*, Springer Nature Singapore Pte Ltd. 176-226.

Igbabul, B.D., Bello, F.A. and Ekeh, C.N. (2014). Proximate composition and functional properties of wheat, sweet potato and hamburger bean flour blends. *Global Advanced Research Journal of Food Science and Technology,* 3(4):118-124.

Ihekoronye, A.I. and Ngoddy, P.O. (1985). Integrated Food Science and Technology for the Tropics, Macmillan Publishers Ltd., London.

International Classification of Functioning, Disability and Health (ICF) (2013). WHO Disability Assessment Schedule.

Ishaya F. and Aletor (2019). Nutritive potential and Functional attributes of lima beans (*Phaseolus lunatus*) and pigeon pea (*Cajan cajanus*) protein isolates. *Journal of Integrative Food Sciences and Nutrition,* 3(1):1-6.

Julianti, E., Rusmarilin, H. and Yusraini, E. (2015). Functional and rheological properties of composite flour from sweet potato, maize, soybean and xantan gum. *Journal of the Saudi Society of Agricultural Sciences,* 16:171-177.

Kuku-Shittu, O., Onabanjo, O., Fadare, O. and Oyeyemi, M. (2016). "Child malnutrition in Nigeria: Evidence from Kwara State." Volume 33, NSSP Working Papers. Washington, Dc: International Food Policy Research Institute.

Makinde, F.M. and Akinoso, R. (2014). Physical, nutritional and sensory qualities of bread samples made with wheat and black sesame (*Sesame indicum Linn*) flours. *International Food Research Journal,* 21(4):1635-1640.

Malomo, S.A., Eleyinmi, A.F. and Fashakin, J.B. (2011). Chemical composition, rheological properties and bread making potentials of composite flour from breadfruit, breadnut and wheat. *African Journal of Food Science*, 5(7):400-410.

Mongi, R.J., Ndabikunze, B.K., Chove, B.E., Mamiro, P., Ruhembe, C.C. and Ntwenya, J.G. (2011). Proximate composition, bread characteristics and sensory evaluation of cocoyam-wheat composite breads. *African Journal of Food, Agriculture, Nutrition and Development*, 11(7): 5586-5599.

Nwafor, J.O., Ezeocha, V.C. Kanu, A.C. and Onyebula, O.D. (2019). Food processing characteristics of water yam (Dioscorea alata) and cowpea (Vigna unguiculata) flour blends used locally for production of confectionaries. *Universal Journal of Agricultural Research*, 7(3):125-130.

Okoye, J.J. and Obi, C.D. (2017). Nutrient composition and sensory properties of wheat- African bread fruit composite flour cookies. *Sky Journal of Food Science,* 6(3):027-032.

Okoye, E.C., Njoku, E.U. and Ugwuanyi, G.R. (2018). Proximate composition, micronutrient contents and acceptability of ojojo from the blends of water yam and ricebeans flour. *International Journal of Food Science and Nutrition*, 3(5):5-10.

Oliver, B. (2014). Whole grains and traditional bread making processes to enhance health benefits of baked goods. A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy, School of Applied Sciences, College of Science, Engineering and Health, RMIT University. 1-160

Onwuka, G.I. (2005). Food analysis and instrumentation: Theory and Practice Naphthali prints, Lagos, Nigeria, 63-161.

Oyeyinka, S.A., Singh, S. and Amonsou, E.O. (2016). Physicochemical properties of starches extracted from Bambara groundnut landraces. *Starch-Starke*, 69 (3-4):1–8.

Peluola-Adeyemi, O.A., Oluwaranti, A., Bolaji, O.T., Adepoju, P.A., Adeyeye, S.A.O. and Bello, I.E. (2020). Quality significance and assessment of bread spiced with chilli pepper (*Capsicum annuum.*). *Journal of Food Stability,* 3(1): 81-91.

Shaikh, N., Marri, A., Khaskheli, S.G., Sheikh S.A. and Solangi, I.A. (2017). Proximate composition of whole wheat bread prepared with fortification of rice and sorghum flour. *Pure and Applied Biology,* 6(2): 412-417.

Ubesie, A.C. and Ibeziakor, N.S. (2016). High burden of protein energy malnutrition in Nigeria: Beyond the health care setting. *Annals of Medical and Health Sciences Research*, 2(1): 66-69.

Ukeyima, M. T., Dendegh, T. A. and Isusu, S. E. (2019) Quality Characteristics of Bread Produced from Wheat and White Kidney Bean Composite Flour. *European Journal of Nutrition and Food Safety,* 10(4): 263-272.

Serrem, C., Kock, H. and Taylor, J. (2011). Nutritional quality, sensory quality and consumer acceptability of sorghum and bread wheat biscuits fortified with defatted soy flour. *International Journal of Food Science and Technology,* 46: 74-83.

Wang S., Chao C., Cai J., Niu B., Copeland L. and Wang S. (2020): Starch–lipid and starch–lipid–protein complexes: A comprehensive review. *Comprehensive Review in Food Science and Food Safety,* 19: 1056–1079.

Yellavila, S.B., Agbenorhevi, J.K., Asibuo, J.Y. and Sampson, G.O. (2015). Proximate composition, minerals content and functional properties of five lima bean accessions. *Journal of Food Security*, 3(3): 69-74.