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Quality Characteristics of Bread from Wheat and Garden Peas Flours

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The functional, physicochemical and sensory evaluation of bread from wheat and garden peas flours were investigated. Five (5) bread samples were produced from the proportion of wheat and garden pea flours as 90%:10% (B), 80%:20% (C), 70%:30% (D), 60%:40% (E) and 100% wheat was the control sample (A) using standard methods. All the functional parameters differed ($p \leq 0.05$) significantly. The moisture, crude protein, crude fat, Ash and crude fiber increased ($p \leq 0.05$) significantly while the carbohydrate content decrease ($p \leq 0.05$) significantly with corresponding increase in the percentage of the composite flour from 10-40%. The result of the physical properties showed that there was a significant difference in all the physical parameters. Also, sensory results showed that there were significant differences in all the sensory scores. However, consumers preferred the bread from 100% wheat flour and 90% and 10% (Sample B) of wheat and garden peas flours substitution.

Keywords: *Wheat and garden peas flours; functional analysis; proximate analysis; physical analysis; sensory attributes.*

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1. INTRODUCTION

Bread is one of the most important staple foods and the second most widely consumed non-indigenous food products after rice in Nigeria [1]. It is one of the many convenient breakfast foods widely consumed by both old and young people in Nigeria [2]. Bread is a fermented confectionary product produced mainly from wheat flour, water, yeast and salt by series of processes involving mixing, kneading, proofing, moulding and baking [3]. The word bread is used to describe the whole range of different bread varieties which may vary in weight, shape, crust hardness, crumb cell structure, softness, colour and eating quality [4]. Wheat is the conventional flour used in the production of bread in Nigeria. It is however expensive because it is not grown in Nigeria due to unfavourable climatic conditions. It is imported from other countries using huge foreign exchange. Cases of increased number of people with celiac disease have been recorded Segura and Rosella [5] and Sampath et al. [6]. In the last few years, there is an increased trend towards healthy eating which has resulted in the development of many novel functional foods including use of other locally available crops for bread production. Partial or total substitution of wheat flour with the other cereals, legumes and fruits in non-wheat producing countries like Nigeria is on record [7,8,9]. The use of local agricultural fruit such garden peas fruit in bread production would diversify their use; enhance value addition and nutrients of the bread.

Peas are cool-season crop grown for their edible seed or seed pods [10]. Garden or green peas are recognized as nutritious sources of high quality plant-based protein rich in fiber, protein, Vitamin A, Vitamin B6, vitamin C, vitamin K, phosphorus, magnesium, copper, iron, zinc and lutein [11]. The high nutrient density of peas make them a valuable food commodity capable of meeting the dietary needs of the estimated 800-900 million undernourished individuals worldwide [12].

Previous studies have shown the incorporation of non-wheat flours in bread production.

Greene and Bovel-Benjamin [13] investigated the microscopic and sensory properties of bread supplemented with sweet potato and found that substitution level of 65% can be used in bread making.

Furthermore [14] evaluated the production of sour maize bread using soybean flour blends. These workers suggested the addition of not more than 10% protein supplement in the form of soybean flour or other legumes (with amino acid profile comparable to that of soybean) is expected to give nutritionally balanced and acceptable maize-bread.

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 [15]. The incorporation of garden peas flour in wheat flour for the production of bread would increase the protein and nutrient contents of the bread, diversify the use of the crops, encourage farmers to produce local crops which would boost their economic power, add value to the local crops, reduce total dependence on imported wheat flour and save foreign exchange for Nigeria. The aim of the research was to produce bread from composite flour of wheat and garden peas flours, to determine the functional properties of the composite flour as well as the physicochemical and sensory properties of the bread.

2. SUBJECTS/MATERIALS AND METHODS

Wheat and garden peas flours, margarine, sugar, water, yeast and salt were obtained from North Bank Market, Makurdi, Nigeria.

2.1 Flow Chart for the Preparation of Garden Peas Flour

Garden Pea flour was prepared according to the modified method of Uchechukwu et al. [16]. The flow chart for the production of Garden pea flour is shown in Fig. 1.

2.2 Composite Flour Preparation

Composite flour was prepared according to the modified method Igbabul et al. [17] as shown in Fig. 2.

2.3 Blend Formulation of Wheat and Garden Pea Flours

Five flour blends, each containing wheat and garden peas flours were prepared by mixing flours in the proportions of 90:10 (B), 80:20 (C), 70:30 (D) and 60:40 (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.

2.4 Baking Process

The five blends of composite flour were baked into bread using the method of Badifu and Akaa [18]. The wheat flour and composite flour were mixed with 2.5 g salt, 5 g yeast, 40 g sugar and 20 g fat in 250 ml water followed by manual mixing for 5 min to obtain adough. The dough was kneaded for some minutes. The kneaded dough was transferred into the baking pans greased with 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 (25min) at relative humidity. The bread samples were cooled to room temperature and used for analysis.

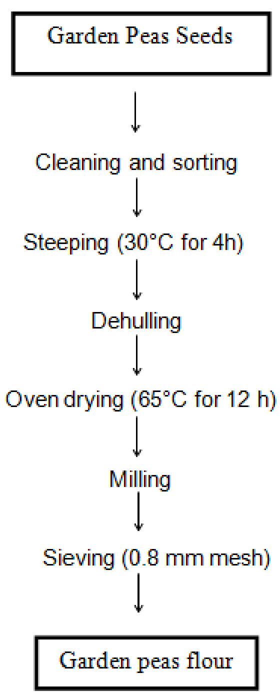

Fig. 1. Flow chart for production of garden peas flour
Source: [16]

2.5 Determination of the Functional Properties of Wheat and Garden Peas Composite Flour

The method of AOAC [19] was used to determine the bulk density of the composite flours. A 10 ml capacity graduated measuring cylinder was gently filled with the sample and the bottom of the cylinder was tapped on the laboratory bench several times until there was no further dimunition of the sample level after filling to the 10ml mark. Foaming capacity (FC) was determined according to Narayana and Narsinga [20]. One gram flour sample was added to 50 ml distilled water at ambient temperature in a graduated cylinder. The suspension were mixed and shaken for 5min to foam. The volume of foam at 30secs after whipping was expressed as foam capacity. Swelling index was determined according to the method of AOAC [19]. One gram of the sample was poured into a 10 ml measuring cylinder and the volume it occupied recorded. Distilled water was added up to the 10 ml mark and the measuring cylinder allowed to stand for 45min, after which the new volume of flour was recorded. The ratio of the initial volume to the final volume gave the swelling index and Gelation capacity was determined by the method of Onwuka [21]. Suspensions of samples in 5 ml of distilled water in test tubes were prepared using 2-20% (W/V) of the samples in 5 ml of distilled water in test tubes. The sample test tubes were heated for an hour in a boiling water bath followed by rapid cooling under running cold tap water. The test tubes were further cooled for 2 hours at 4ºC to get the gelation capacity for each sample.

2.6 Determination of the Proximate Composition of Bread from Wheat and Garden Peas Flours

Standard methods of analysis were used to determine the proximate composition of the wheat and the composite bread samples using AOAC [19]. The moisture content (MC) was determined by drying samples in an oven at 100ºC for 24 hours to obtain % MC. Crude protein percentage was determined using the Kjeldahl method with the 8400 analyzer unit (FOSS, Sweden) and the % nitrogen obtained was used to calculate the percentage crude protein. The soxhlet extraction method was used to determined the fat content, extraction was carried out using boiling point of 40-60ºC for 8 hours, the solvent was removed by evapouration on a water bath and remaining part in the flask was dried at 80ºC for 30 mins cooled in the desiccator. The percentage ash (%) was determined by incinerating the samples in a muffle furnace at 50ºC for 4 hours. The ash was cooled in the desiccator and weighed. Crude fiber (% CF) was determined by dilute acid and alkali hydrolysis. While Carbohydrate content was determined by difference according to Ihekoronye and Ngoddy [22] as thus: $\% \, Carbohydrate = 100 - (\%moisture + \%Protein + \%Fat + \%Ash + \%Fibre)$

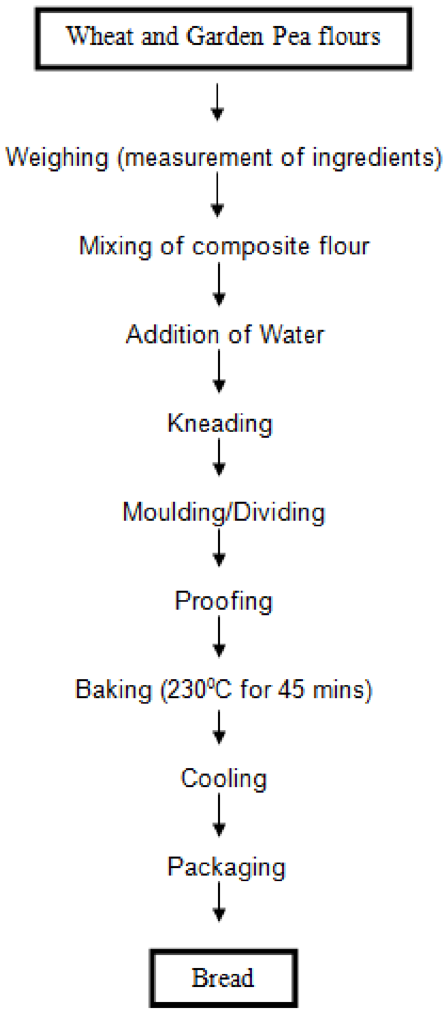

Fig. 2. Flow chart for the production of composite flours
Source: [17]

2.7 Determination of Physical Properties of Dough and Bread Loaves

Dough development in terms of increase in volume as affected by fermentation was determined according [22]; a portion of the dough was placed inside a 500 ml graduated beaker and placed on level surface (laboratory table). Initial and final volume at the beginning and end of fermentation was determined. Fermentation and proofing rates were calculated by dividing the average volume increase due to fermentation [23]. Bread characteristics were evaluated by measuring the loaf weight, loaf volume and specific volume. 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 Giami et al. [24] 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).

2.8 Sensory Evaluation of the Bread Samples

The sensory evaluation of the breads including the one made from 100% wheat flour and the composite flours were evaluated for texture, flavour, aroma, crust colour, crumb colour and general acceptability of the product by a 20 man panel on a 9 point hedonic scale to obtain a duplicate (1=extremely disliked and 9= extremely liked) as described by Iwe [25].

2.9 Statistical Analysis

Data obtained was subjected to Analysis of Variance (ANOVA) followed by Duncan's new multiple range test (DNMRT) to compare treatment means. Statistical significance was accepted at ($p \geq 0.05$) [26].

3. RESULTS AND DISCUSSION

3.1 Functional Properties of Wheat and Garden Peas Composite Flour

The functional properties of flour samples is presented in Table 1. The bulk density, foaming capacity, swelling index and gelation capacity differed ($p \leq 0.05$) significantly. They ranged from 0.651-0.718 g/ml, 24.75-26.48%, 2.36 to 6.67 and 7.333-14.33 respectively. The results of bulk density, foaming capacity and swelling index are in agreement with [4]. Also, gelation capacity is in agreement with Nwosu et al. [27]. Bulk density is the measure of the heaviness of a flour sample. Increase in foaming capacity was attributed to the presence of garden peas in the blends.

Decrease in swelling index was attributed to the weak bond forces in garden pea flour. Also, Variation in gelation capacity among the samples was attributed to compositional differences with respect to their starch content.

3.2 Results of Proximate Composition of Bread from Wheat and Garden Peas Flours

The proximate composition of bread samples is presented in Table 2. The moisture, crude protein, crude fat, Ash and crude fiber increased (p≤0.05) significantly with increase substitution of 10-40% garden peas flour. The moisture content varied from 18.88-28.88%, protein from 13.25-16.16%, fat 5.11-6.89%, Ash 5.67-6.87% and fiber 1.20-1.71% respectively. The increase in ash and fiber content of the bread samples may be attributed to high ash content of the garden peas flour which indicates the high mineral contents in it. While the carbohydrates content on the other hand decreased (p≤0.05) significantly with increase in garden peas substitution. The lower content of carbohydrate in the composite flour could be due to addition of garden peas flour. This result is similar with the one reported by Islam et al. [28].

3.3 Physical Properties of Dough and Bread Loaves

Results of the physical properties of dough and bread samples is presented in Table 3. The average dough volume decrease as the concentration of garden peas flour increase with respect to fermentation and proofing rates. The values decrease from 45.83-19.17 cm^3 as the proportion of garden peas flour increased after 35min of fermentation and the rate of fermentation and proofing decreased from 2.11-0.88 cm^3/min and 3.94-1.65 cm^3/min. The result is in line with Olaoye et al. [29]. The loaf volume and specific volume was observed to decreased (p≤0.05) significantly 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. The loaf weight was also found to decrease with increasing proportion of garden peas flour increased from 10-40%. This result is similar with the one reported by Bojnanska et al. [30].

Table 1. Functional properties of wheat and garden peas flours

Samples	Bulk density (g/ml)	Foaming capacity (%)	Swelling index	Gelation capacity
A	0.718^{a}±0.003	24.75^{c}±0.33	6.67^{ab}±0.23	7.33^{e}±1.16
B	0.728^{a}±0.171	25.29^{bc}±0.08	6.98a±0.05	8.66^{d}±1.16
C	0.616^{c}±0.004	25.74^{abc}±0.02	6.73^{ab}±0.15	10.00^{c}±0.00
D	0.654^{b}±0.017	25.96^{ab}±0.06	6.53^{b}±0.15	12.33^{b}±1.16
E	0.651^{b}±0.012	26.48^{a}±1.20	2.36^{c}±0.26	14.33^{a}±1.16

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 = (90% wheat and 10% garden peas flours), C = (80 % Wheat and 20% garden peas four), D = (70 % wheat and 30 % garden peas flours) and E = (60 % wheat and 40% garden peas flours)

Table 2. Percentage proximate composition of bread from wheat and garden peas composite flour

Samples	Moisture	Protein	Fat	Ash	Fiber	Carbohydrate
A	18.88^{d}±0.14	13.25^{e}±0.02	5.11^{e}±0.02	5.67^{e}±0.03	1.20^{e}±0.02	74.75^{a}±0.02
B	19.16^{d}±0.07	13.86^{d}±0.02	6.04^{d}±0.01	5.81^{d}±0.01	1.35^{d}±0.01	72.95^{b}±0.02
C	22.16^{c}±0.03	14.84^{c}±0.13	6.27^{c}±0.03	6.09^{c}±0.01	1.52^{c}±0.02	71.29^{c}±0.13
D	26.57^{d}±1.28	15.66^{d}±0.02	6.77^{b}±0.02	6.36^{b}±0.01	1.65^{b}±0.02	69.58^{d}±0.02
E	28.88^{e}±0.66	16.16^{e}±0.18	6.89^{a}±0.76	6.87^{a}±0.02	1.71^{a}±0.06	68.42^{e}±0.09

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 = (90% wheat and 10% garden Peas flours), C = (80 % Wheat and 20% garden peas four), D = (70 % wheat and 30 % garden Peas flours) and E = (60 % Wheat and 40% Garden Peas flours

Table 3. Physical characteristics of dough and bread from wheat and garden peas flour

Samples	Av-dough volume increase after fermentation	Fermentation rate (cm^3/min)	Proofing rate (cm^3/min)	Loaf weight (g)	Loaf volume (cm^3)	Specific volume (cm^3/g)
A	45.83^{a}±3.82	2.11^{a}±0.18	3.94^{a}±0.33	244.0^{c}±1.73	677.3^{a}±2.52	3.02^{a}±0.02
B	35.83^{b}±3.82	1.65^{b}±0.18	3.08^{b}±0.33	228.0^{b}±1.73	607.7^{b}±6.81	2.67^{b}±0.03
C	29.67^{bc}±6.25	1.36^{bc}±0.29	2.55^{bc}±0.53	224.3^{c}±0.58	577.7^{c}±9.02	2.57^{c}±0.03
D	22.83^{cd}±2.02	1.05^{cb}±0.09	1.96^{cd}±0.17	$229.6^{b\pm}$0.58	491.7^{d}±1.53	2.14^{d}±0.01
E	19.17^{d}±2.89	0.88^{d}±0.13	1.65^{d}±0.25	237.6^{a}±2.52	436.3^{e}±5.13	1.84^{e}±0.04

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 = (90% wheat and 10% garden peas flours), C = (80 % wheat and 20% garden peas four), D = (70 % wheat and 30 % garden peas flours) and E = (60 % wheat and 40% garden peas flours)

Table 4. Sensory evaluation of bread from wheat and garden peas composite flour

Samples	Taste	Flavour	Texture	Crumb colour	Crust colour	Overall acceptability
A	7.73^{ab}±1.4	8.07^{a}±1.03	7.33^{ab}±1.16	8.00^{a}±1.25	7.93^{a}±1.22	8.00^{a}±1.19
B	8.07^{a}±1.3	7.53^{a}±1.69	8.20^{a}±1.08	8.00^{a}±1.41	7.47^{ab}±2.20	7.87^{ab}±1.64
C	7.47^{ab}±0.8	7.33^{ab}±0.81	7.47^{abc}±1.00	7.53^{ab}±1.10	7.67^{ab}±0.81	7.40^{c}±0.91
D	7.20^{ab}±1.4	7.20^{ab}±1.11	6.93^{bc}±1.79	7.07^{ab}±1.62	7.07^{ab}±1.84	7.20^{d}±2.01
E	6.93^{b}±1.4	6.47^{b}±1.88	6.67^{c}±1.63	6.53^{b}±2.23	6.73^{b}±1.49	6.87^{d}±1.46

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 = (90% wheat and 10% garden peas flours), C = (80% wheat and 20% garden peas four), D = (70% Wheat and 30% garden peas flours) and E = (60% wheat and 40% garden peas flours)

3.4 Sensory Scores of Bread Loaves

Result of the sensory attributes of Bread made from wheat and soybean composite flour is presented in Table 4. The mean sensory scores for the taste ranged between 6.87 to 8.00. Sample B had the highest taste score (8.07). However, the taste scores decreased (p≤0.05) significantly with increase in the quantity of garden pea flours. Taste is an important sensory attributes of any food. The consumption of bread is often enhanced by taste Sim and Nya [31]. The decrease in taste score maybe due to the change in taste sensation due to increased quantity of garden peas flour and flavour ranged between 6.47-8.07. The scores for texture, crumb colour and crust colour varied between 6.67-7.33, 6.53-8.00 and 6.73-7.93 respectively. In terms of the overall acceptability, the mean scores ranged between 6.87-8.00. There was significant (p≤0.05) difference in all the sensory attributes and their scores decreased with addition of garden peas flour. The decrease in the scores for texture with addition of garden peas flour was found to correlate with the decrease in overall acceptability of the bread. Sample A with 100% followed by 90% wheat flour and 10% garden peas flour had the highest sensory scores for all the sensory attributes.

4. CONCLUSION

They were significant (p≤0.05) differences in functional, proximate composition of bread from the composite flour, physical properties of Dough and Bread from the composite flour and Sensory Scores of Bread samples. The study shown that bread of acceptable quality can be produced from composite of wheat and garden Peas flours. It is recommended that 90% wheat flour and 10% garden peas flour incorporation could be adopted in bread production without affecting quality adversely when compared with the 100% wheat flour bread. This will accrue in saving in the scarce resources in most developing countries, where wheat cultivation does not thrive well due to climatic reasons. The bread samples have increased nutrients which are desirable for growth and good health. This study therefore recommends the inclusion of garden peas flour in Bread production in order to enhance its nutritional content.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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