

Evaluation of Quality Characteristics of Soy Fortified Wheat-Cassava Composite Bread

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Abstract: Preliminary studies of proximate composition, physical characteristics and sensory properties of bread formulated from blends of Soy protein isolate (SPI), High Quality Cassava Flour (HQCF) and wheat flour (WF) were carried out. Soy protein isolate and HQCF were used to replace wheat flour at 10, 15 and 20%. Proximate, physical characteristics were carried out using standard analytical procedures. The developed bread samples were subjected to sensory analyses using a 9- point Hedonic scale. Data obtained were subjected to Analysis of Variance ANOVA and means separated by Duncan Multiple Range test. Results showed that the 20% soy protein isolate fortified samples improved protein content of the bread sample (16.54%) than that of 15% fortified samples. It ranged from 4.69-16.54%. There was a significant increase in all the soy protein isolate fortified samples compared to the control sample that was not fortified with soy protein isolate. The soy protein fortified bread samples had higher loaf weights than the cassava bread. It ranged from 262.5g -287g, while a significant reduction ($p < 0.05$) existed in the loaf volume and specific loaf volume of the soy fortified bread with increased level of soy protein isolate and cassava flour inclusion. It ranged from 600 -1000 cm³ and 2.23 -3.73cm³/g respectively. The mean sensory scores obtained revealed that all the fortified bread samples had acceptable loaf appearance, crust colour, crumb colour, texture and taste significantly comparable to those of non fortified bread. However, there was a slight significant difference in the overall acceptability of the fortified bread (6.80 and 6.40) to those of non fortified samples with the highest score of 7.13. Thus, composite blends of soy protein isolate and wheat flour up to 15% could be adopted as a means of supplementation without significant impairment of overall acceptability.

Keywords: Bread, Soy Protein Isolate (SPI), High Quality Cassava Flour (HQCF), Wheat Flour

1. Introduction

In recent times, consumers are becoming increasingly aware and interested in healthful foods and lifestyles. Soybean is one of the most important oil and protein crops of the world. Soybeans as food are very versatile and inexpensive plant protein that is highly rich in essential nutrients. They are also an excellent source of good-quality protein of high biological value comparable to other protein foods, and suitable for all ages. It is also suitable for low income economy countries such as Nigeria where malnutrition is on the increase. Soybeans also contain biologically active or metabolic proteins, such as enzymes, trypsin inhibitors, hemagglutinins, and cysteine proteases very

similar to papain.

Soybean proteins have been of public interest and have called for intense investigation. This is as a result of their increasing roles in human nutrition over the last few decades [1] Soybean protein is a complete vegetable protein containing about 30 to 45% protein with a good source of all of essential amino acids for human nutrition.

Soy protein products are an ideal source of some of the essential amino acids used to complement cereal proteins. At present, the application of soy proteins is more versatile than many other food proteins in various worldwide nutritional programs. Soy protein is categorized into three forms: soy flour, soy protein isolates, and soy protein concentrates. Soy protein isolate is a major proteinaceous fraction usually as dry powder food ingredient that has been separated or

isolated from the other components of the soybean, making it 90 to 95 percent protein on a moisture-free basis and nearly carbohydrate and fat-free. The major food applications where soy proteins are used are infant formulas, medical nutrition products, animal product substitutes, as a protein supplement and bakery products. Isolated soy protein is the sole protein source for some infant formulas. It can be found in protein bars, meal replacement shakes, bottled fruit drinks, soups and sauces, meat analogs, baked goods, breakfast cereals, and some dietary supplements. Evidence had shown that soy isoflavones had beneficial effects in the prevention of cardiovascular disease osteoporosis via phytoestrogen effects of isoflavones, and prevention of neovascularization in ocular conditions [2] and [3]. Consequently, the development of high protein soy breads can form a popular carrier of nutrition to vulnerable groups like the elderly, pregnant and nursing mothers, young and school children.

Baked products particularly bread is considered to be used as a convenient vehicle for incorporation of some functional healthful food products to meet the consumers health's demand. Various researches have been conducted to improve the nutritional quality and functionality of baked products particularly breads in order to meet the consumers health needs through the addition of dietary fibre, antioxidants and micronutrients [4] - [7]

Bread is one of the most important staples in Nigeria widely consumed by all age groups across all socio economic groups after rice [8]. It is a leavened baked product majorly made from wheat flour with the addition of other ingredients such as salt, fat, sugar, and yeast. However, wheat is a grain of choice in bread making and a good source of calories and other nutrients but its protein is deficient in essential amino acids such as lysine and threonine [9] and [10].

Therefore, The objectives of this study therefore, was to formulate and develop functional breads from whole wheat flours composited with soy protein isolate and to evaluate the products baking properties, nutritional, sensory quality and consumer overall acceptability.

2. Materials and Methods

2.1. Source of Raw Materials

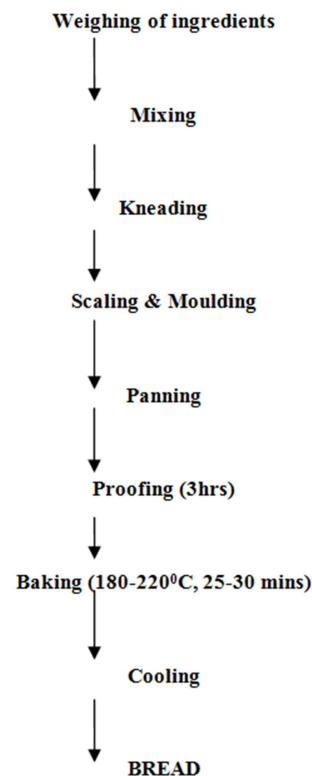
The Wheat Flour (WF) used was commercial baker's grade wheat flour milled by Nigeria Flour Mills (Golden Penny, Nigeria), Margarine, Baker's brand of yeast; iodized salt and colorless granulated sugar were purchased from a local market in Lagos, Nigeria. High quality Cassava flour (HQCF) was procured from Federal Institute of Industrial Research Oshodi and Soy Protein Isolate from Solae Europe, S. A Switzerland.

2.2. Method

The bread was produced using straight dough bulk fermentation method to establish the effects of soy protein isolate inclusion on the developed bread samples.

The wheat flour and high quality cassava flour were then

mixed, with varying inclusions of 0, 15 and 20% of the soy protein isolate. The composite flours used for bread baking is as follows; AB---15%SF, 10%CF, 75%WF; DE---15% SF, 20%CF, 65%WF; GH---18%SF, 20%CF, 62%WF; JK---20%SF, 10%CF, 70%WF; MN---20%SF, 15%CF, 65%WF; PQ---20%SF, 20%CF, 60%WF; XY---10% CF, 90% WF.



Source: FIIRO (2004).

Figure 1. Flow chart for the production of bread (straight dough process).

2.3. Evaluation of the Baking Qualities

Baking performance was carried out using straight dough method for bread baking and the resultant bread samples were evaluated in terms of physical characteristics such as loaf volume, weight, proximate composition and organoleptic properties.

Loaf weight:

The loaf weight was determined by weighing the bread loaves after baking, using the laboratory scale (CE- 410I, Camry Emperors, China) and the readings recorded in grammes.

Loaf volume:

The loaf volume was determined by using Rape seed displacement method [11]. This was done by loading millet grains into an empty box with calibrated mark until it reached the marked level and unloaded back. The bread sample was put into the box and the measured millet was loaded back again. The remaining sorghum grains left outside the box was measured using measuring cylinder and recorded as loaf volume in cm^3 .

Specific volume: The specific volume (volume to mass ratio) (cm^3/g) was thereafter calculated.

$$\text{Specific volume g/cm}^3 = \frac{\text{Loaf volume}}{\text{Loaf weight}}$$

Chemical Composition: The proximate parameter of the test bread samples was determined according to analytical procedures described by [12]. Total caloric content was determined by calculation using Atwater equation: Total caloric (Kcal/100g) = (protein content x 4) + (fat content x 9) + (Carbohydrate content x 4)

2.4. Consumer Acceptability Studies of the Developed Bread Samples Through Sensory Evaluation

The test bread samples were subjected to organoleptic analysis. A total of twenty semi-trained panelist drawn from the Staff and students on industrial training of Federal Institute of Industrial Research, Oshodi-Lagos, Nigeria, who are familiar with bread, participated in the evaluation. The

panelists were to eat the bread and score each sample using a 9-point Hedonic scale [13] where 1 = extremely unacceptable and 9 = extremely acceptable. Attributes evaluated include; bread appearance, crust color, crumb color, texture, taste, chew ability, flavor and overall acceptability. The resulting data were analyzed using Analysis of Variance (ANOVA), while the means were separated using Duncan multiple range test [14], significance was accepted at 5% level of probability ($p < 0.05$).

2.5. Statistical Analysis

The organoleptic properties of the test bread samples was statistically analyzed using the analysis of variance (ANOVA) and the Duncan Multiple range test with significance level at $p < 0.05$.

Table 1. Bread making performance.

PARAMETER	AB	DE	GH	JK	MN	PQ	XY
Optimum water (ml)	708	730	750	750	750	727	530
Optimum mixing time (min)	20	20	20	20	25	25	15
Total dough weight (kg)	1.85	1.86	1.88	1.88	1.88	1.85	1.68
Scaled dough (g)	300	300	300	300	300	300	300
Loaf weight (g)	269.5	269	272	281.5	287	287	262.5
Loaf volume (cm ³)	812.5	700	687.5	657.5	625	600	1000
Specific loaf volume (cm ³ /g)	3.01	2.60	2.53	2.33	2.18	2.09	3.81

KEY: AB----15%SFI, 10%CF, 75%WF; DE---15% SFI, 20%CF, 65%WF; GH----18%SFI, 20%CF, 62%WF; JK---20%SFI, 10%CF, 70%WF; MN---20%SFI, 15%CF, 65%WF; PQ----20%SFI, 20%CF, 60%WF; XY---10% CF, 90% WF.

Table 2. Proximate parameters of developed bread samples.

Sample code	AB	DE	GH	JK	MN	PQ	XY
Parameters (%)							
Moisture content	37.20±1.20	38.60±0.85	42.60±0.42	38.00±0.42	40.40±0.42	42.10±0.77	33.4±2.0
Crude protein	14.77±0.08	16.02±1.04	14.56±0.01	16.54±0.01	16.54±0.01	16.45±0.05	4.69±3.5
Crude fat	1.57±0.5	0.14±0.01	0.85±0.11	0.23±0.35	1.45±0.11	1.59±0.10	0.44±0.42
Crude fibre	0.37±0.12	0.53±0.11	0.35±0.07	0.23±0.04	0.40±0.04	0.41±0.03	0.05±0.03
Total Ash	1.80±0.3	1.59±0.32	2.74±0.52	1.93±0.3	2.53±0.31	2.09±0.60	1.00±0.11
NFE	44.29±0.01	43.12±0.01	38.90±0.02	43.07±0.01	38.68±0.02	37.36±0.03	60.34±0.43
Energy (kCal/100g)	250.37	237.82	221.49	240.51	233.93	229.55	264.08

KEY: AB----15%SFI, 10%CF, 75%WF; DE---15% SFI, 20%CF, 65%WF; GH----18%SFI, 20%CF, 62%WF; JK---20%SFI, 10%CF, 70%WF; MN---20%SFI, 15%CF, 65%WF; PQ----20%SFI, 20%CF, 60%WF; XY---10% CF, 90% WF.

Table 3. Organoleptic properties of test bread samples.

ATTRIBUTES	AB	DE	GH	JK	MN	PQ	XY
Appearance / loaf shape	6.73 ^c	5.80 ^{abc}	4.80 ^a	6.40 ^{bc}	5.44 ^{ab}	4.73 ^a	6.90 ^c
Crust colour	6.90 ^d	6.33 ^{cd}	5.10 ^a	6.13 ^{bcd}	5.37 ^{abc}	5.30 ^{ab}	6.93 ^d
Crumb colour	6.30 ^b	5.73 ^{ab}	4.90 ^a	5.53 ^{ab}	4.81 ^a	4.46 ^a	6.70 ^b
Taste	6.10 ^b	5.93 ^b	5.40 ^{ab}	5.40 ^{ab}	4.18 ^a	4.13 ^a	5.93 ^b
Texture	6.30 ^c	6.10 ^{bc}	4.70 ^{ab}	5.10 ^{abc}	4.75 ^{ab}	4.70 ^a	6.53 ^c
Chewability	6.67 ^{bc}	6.27 ^{abc}	5.16 ^a	5.53 ^{abc}	5.20 ^{ab}	4.80 ^a	6.73 ^c
Flavour	5.93 ^{ab}	6.20 ^{ab}	5.80 ^{ab}	6.00 ^{ab}	5.88 ^{ab}	5.20 ^a	6.73 ^b
Overall acceptability	6.80 ^{bc}	6.40 ^{bc}	5.80 ^{ab}	6.00 ^{abc}	4.88 ^a	5.00 ^a	7.13 ^c

Means with the same superscript within a row are not significantly ($p > 0.05$) different

KEY: AB----15%SFI, 10%CF, 75%WF; DE---15% SFI, 20%CF, 65%WF; GH----18%SFI, 20%CF, 62%WF; JK---20%SFI, 10%CF, 70%WF; MN---20%SFI, 15%CF, 65%WF; PQ----20%SFI, 20%CF, 60%WF; XY---10% CF, 90% WF.

3. Results and Discussion

The result of the bread making performance was shown in Table 1. The physical characteristics of the bread include loaf weight, loaf volume and specific loaf volume. The loaf volume ranged from 600 to 1000cm³ with the highest value recorded by XY the control sample and lowest in PQ in 20% SPI fortified bread sample. Loaf weight ranged from 262.5 to 287 g. The loaf volume of developed bread samples decreased with increased level of Soy Protein Isolate (SPI) and High Quality Cassava Flour (HQCF) inclusion. This is in consonance with Agu et al and Okafor et al work that reported a decrease in loaf volume of bread with increased level of fluted pumpkin flour and mushroom powder [15] and [16]. The decrease in loaf volume of bread may be attributed to the disruption of gluten network which resulted from the interaction between gluten and soy protein isolate and HQCF. Loaf volume is regarded as the most important bread characteristic as it provides a quantitative measure of baking performance [17].

Specific volume for control bread sample was 3.81cm³/g. The results of the specific volume of bread found in this study indicated that there was a substantial decrease in the specific volume of bread at increased level of soy isolate inclusion. It ranged from 2.09 to 3.81cm³/g with highest value obtained from XY (control sample) and the lowest value from PQ. The results of present study are in agreement with the results reported by [18] who also reported a decreasing trend in specific volume of bread. This showed that increased level of soy protein isolate had a detrimental effect on the specific volume of bread. The specific volume, which is the ratio of the two properties, has been generally adopted in the literature as a more reliable measure of loaf size [8]. According to China Grain Products Research and Development Institute, CGPRDI (1983), the specific volume of standard bread should be 6 cm³/ g and should not be less than 3.5 cm³/ g [6]. From this study, it seems that only the control sample XY met the pass level of specific volume and AB (10% SPI) had 3.01cm³/g.

There was an increase in the level of optimum water used during dough mixing as the level of soy isolate protein and HQCF inclusion increases. This is attributed to the fact that soy flour had water absorption capacity and this also was in agreement with the result of [19] and [20] that reported a high water absorption capacity obtained with the soy flour supplementation. WAC is considered a critical function of protein in viscous foods, like soups, gravies, doughs and baked products.

Results for chemical composition were shown in Table 2. Significant reduction ($p < 0.05$) existed in the moisture content of the fortified bread with the level of inclusions studied. It ranged from 37.20 to 42.60% with the highest value in GH and lowest in AB.

There was a reduction in carbohydrate content as the level of soy protein isolate increases. It ranged from 37.36 to 60.34 with the in sample XY (60.34%) and lowest in sample PQ. A

decrease in energy values was observed as the level of soy protein substitution increases (241.0-264.08 Kcal). The low carbohydrate and energy values were as result of the low fat content of the composite breads. Similar trends were reported by [21] and [22] in the fortification of wheat flours with defatted and non-defatted soy flour, respectively. The composite breads contained energy values in the range of 221.49 to 250.37 Kcal, and hence conformed to the [23] recommended minimum energy content of 1674 kJ/ 100 g. The moisture contents of the composite breads increased with soy protein isolate substitution by a range of 33.4 to 42.60%. High moisture content has been associated with short shelf life of composite breads as they encourage microbial proliferation that lead to spoilage [24]. Significant increase ($p > 0.05$) was observed in crude protein contents of the developed bread samples at the levels of soy isolate inclusion studied. It ranged from 4.69 to 16.54% with the highest value in JK (20% SPI& 10% HQCF) and MN (20% SPI& 15% HQCF) and lowest in the unfortified sample XY. This increase is as a result of substitution of cassava -wheat flour (4.69% protein) with soya protein isolate of about 90% protein content.[25] also reported increase in protein content of the bread as a result of the addition of soy flour. Other studies have also reported a similar increase of protein content in sorghum-soy composite flours [26] and [27].

The mean sensory scores obtained revealed that all the fortified bread samples had acceptable loaf appearance, crust colour, crumb colour, texture and taste significantly comparable to those of non fortified bread. However, there was a slight significant difference in the overall acceptability of the fortified bread (6.80 and 6.40) to those of non fortified samples with the highest score of 7.13.

4. Conclusion

Composite breads with soy protein isolate substitutions were found to be nutritionally superior (have higher protein, fat and crude fibre content) to cassava wheat bread, because of its higher protein, fat and crude fibre content. Though, the cassava-wheat bread had better overall acceptability scores than the soy-composite breads, the composite breads would serve as functional food because of the high protein content. However, further research work should be focused on the quality evaluation such as biological value (BV), protein efficiency ratio (PER) and phytochemical (isoflavone) content, improvement of the organoleptic properties and hence acceptability of Soy-enriched breads. Public enlightenment on the nutritional benefits of the Soy-supplemented functional foods would help to improve the sensory acceptability of the soy supplemented bread.

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