Physicochemical and Sensory Characteristics of Bread Made from Wheat-Frafra Potato (*Solenostemon rotundifolius*) Composite Flour

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ABSTRACT

Climate change threatens food security globally. This has made it necessary to explore the potential of indigenous climate-smart crops on the verge of extinction to ensure food security. This research studied the performance of Frafra potato flour (FPF) in bread production. The study was a one factor design in which wheat flour (WF) was substituted with FPF at 5%, 10%, 15% and 20% levels of incorporation. Proximate composition of WF, FPF and FPF-WF composite samples were analyzed. Composite bread made from the formulations was analyzed for sensory characteristics, instrumental texture and tri-stimulus colour (L-value). Moisture, protein, fibre and ash content of the composite flour increased with increasing FPF while carbohydrate content decreased ($p \leq 0.05$). Composite bread samples were harder than the control (100% WF) when the FPF content exceeded 5%. Tristimulus L value reduced, relative to the control, as FPF increased in composite bread samples, with 20% FPF recording the lowest L value ($p \leq 0.05$). Sensory analysis of the bread samples showed that bread with 5% and 10% FPF had overall acceptability, aroma, flavour and mouth feel scores that were comparable with bread made from 100% WF ($p \leq 0.05$). Results indicate that WF can be partially substituted with FPF to produce nutritious bread, with higher protein, fibre and ash content. Frafra potato can help address food and nutrition insecurity by increasing the use of this underutilized nutritious crop while providing food processors with a partial substitute for wheat flour in baking applications.

Keywords: Frafra potato, bread, flour, climate-smart, food security

Introduction

Frafra potato (*Solenostemon rotundifolius*) is also known by common names such as Sudan potato, Madagascar potato, Livingstone potato, Hausa potato, Salaga potato, Kaffrr potato, Country potato and Coleus potato (Abbiw, 1990). It is grown in Ghana, Nigeria, Mali and Burkina Faso. It is an important food crop in Northern Ghana, where it is mainly cultivated (Tortoe *et al.*, 2018; Akanlu *et al.*, 2005; Quainoo and Bayorbor, 2002; Tetteh and Guo, 1997). Frafra potato ranks highest in protein and some micronutrients among the tuber crops in Ghana (Quainoo and Bayorbor, 2002; Tetteh and Guo, 1997). It also serves as a good source of dietary fibre and minerals which contribute significantly towards good health (Sugri *et al.*, 2013; Akanlu *et al.*, 2005). It has been reported that the crop, with its relatively high nutritional properties, could serve as a good supplement to wheat flour in the bakery industry (Ofori *et al.*, 2009).

Research into Frafra potato has become crucial because this staple food crop in northern Ghana is now on the verge of extinction due to over dependence on its close substitutes (sweet potato and yam). With the general growing concern for improving food security, agriculture and dietary diversity (FAO, 2015), globalization is opening up new markets and creating avenues for fair trade and business. A global growing interest in organic and healthy food products has also created enormous potential which can be explored through the use of lesser known crops or indigenous food resources.

Wheat is important due to its unique characteristics that make it most suitable for pastry applications. However, the crop is imported by most developing countries and so takes a significant toll on the already deplorable economic situation in these countries. Substituting wheat flour with local food resource alternatives such as yam flour and sweet potato flour in baked foods, such as composite bread, where weaker flour is desired, has shown great potential for the utilization prospects of tuber flour, which would empower local farmers and enhance their livelihoods (Gratitude Project, 2014; Komlaga *et al.*, 2012). These improvements are aimed at reducing gluten and calories, enhancing dietary fiber content and improving the quality of baked products. Studies have shown diverse success levels with different ratios of substituted flour, and it has been established that partial substitution of wheat flour is possible (Gratitude Project, 2014; Aprianita *et al.*, 2013; Komlaga *et al.*, 2012).

Though opportunities to maximize the utilization of Frafra potato are available, there are barriers hindering the promotion and full utilization of the crop. Challenges such as limited knowledge of the nutritional and economic benefits of the crop, limited research into potential food applications, inadequate documentation of research findings and dissemination of information, discourage further investigations (Akanlu *et al.*, 2005; Tetteh and Guo, 1997). To address these barriers to utilization, this research focused on the production of new food products to widen the scope of the application of Frafra potato in food systems. The use of Frafra potato (a nutritious indigenous crop) has been investigated in some food processing applications, but not in bread making. Confirming the potential of Frafra potato flour as a partial substitute for wheat flour in bread making will improve its utilization and enhance its economic importance.

Methods

Source of Raw Materials

Four sacks (approximately 50 Kg each) of Frafra potatoes were purchased from Wa, Upper-West region, Ghana. Hard wheat flour was obtained from a local market in Accra, Ghana.

Flour Preparation

Frafra potato tubers were washed and blanched in hot water at 95 °C for 5 minutes to minimize microbial load. They were sliced into 2-3 cm strips. The strips were blanched in hot water at 95 °C for 2 minutes to prevent browning. They were oven dried at 60 °C for 12 hours. The dried strips were milled with a hammermill (containing a vertical rotating shaft on which hammers are mounted; the hammers are free to swing on the ends) and sieved (212 μm, US Standard Mesh No. 70) to obtain Frafra potato flour. Hard wheat flour (WF) was substituted with Frafra potato flour (FPF) at 5%, 10%, 15% and 20% levels of incorporation. The moisture content of WF and FPF was 13.54 % and 7.99 % respectively. The formulations were designated as F0, F5, F10, F15, and F20 flour samples respectively.

Colour Analysis of Flour

The colour of the flour blends was determined using a Hunter Lab Colour Analyzer (CR310 Chroma meter, Konica Minolta, Tokyo, Japan 76981007) to obtain the L^* (lightness), a^* (redness) and b^* (yellowness) values. Total colour change was calculated using $\Delta E^* = [\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}]^{1/2}$.

Proximate Composition

Proximate composition of the flour blends was determined according to AOAC methods (AOAC, 2005). Carbohydrate content was determined as the difference between 100% and the sum of the moisture, crude fat, protein and crude ash content.

pH

Ten percent (10%) suspension of each flour blend was prepared and the pH determined using a pH meter (Mettler Toledo model: SC220).

Water and Oil Absorption Capacity

Water absorption capacity was determined using the AACC method 56-20 (AACC, 2000) with modifications. Ten grams of flour (from each formulation) was mixed with 100 ml distilled water or oil in a weighed 200 ml centrifuge tube. The mixtures were agitated on a vortex mixer for two minutes, allowed to stand at 30.7 °C for 30 minutes, and then centrifuged at 500 x g for 20 minutes. The clear supernatant was poured out and discarded. The adhering drops of water were removed, the tube was weighed and the weight of water/oil absorbed by one gram of flour was calculated and expressed as water absorption capacity.

Brabender Viscoamylograph Studies

Pasting properties of the flour blends were determined using the Brabender Viscoamylograph. Forty grams of flour was weighed and then mixed with 200 mL distilled water in a canister. The canister was fitted into a Brabender (Viscograph – E, Brabender GmbH & Co. KG. 803301, 803301E000-02, Germany). The suspension was heated till the temperature of the resulting paste reached 92 °C, then left at this temperature for 15 minutes, cooled to 50 °C and held for 15 minutes at 50 °C. The heating and cooling were done at 3.0 °C per minute. Parameters such as peak viscosity (PV), peak temperature (PT) and pasting temperature (PT) were expressed in terms of Brabender Units (BU).

Bread Preparation

Main ingredients used were flour (hard wheat and Frafra potato), whole milk, margarine, water and yeast. The composite flour formulations (F5, F10, F15, and F20) were used. Flour and yeast were measured into a mixing bowl. They were mixed gently by hand, then water was measured and added to the mixture. The ingredients were combined with a dough scraper until they formed together. The dough formed was placed on a bench and kneaded for 2 minutes, after which it was hand-shaped into a ball and allowed to rest for 2 minutes (this was repeated 4 times). It was then divided into hundred gram (100 g) pieces. The pieces of dough were hand-shaped into balls and proofed. Bread was baked at 180 °C for 30 minutes, cooled to 25 °C after baking and stored in plastic bags.

Baking Loss

Baking loss was determined using the change in weight of composite dough before and after baking. This was expressed as percent weight loss.

Colour Analysis of Bread Crumb

The colour of the bread was determined using a Hunter Lab Colour Analyzer (CR310 Chroma meter, Konica Minolta, Tokyo, Japan 76981007) to obtain the L^* (lightness), a^* (redness) and b^* (yellowness) values. Total colour change was calculated using $\Delta E^* = [\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}]^{1/2}$.

Volume of Bread

Volume of composite bread samples was determined using a BVM Volume Meter (Model 6610, SE-12653 Hägersten, Sweden).

Texture of Bread

Texture analysis of the Crumb was performed on three slices taken from the centre of each loaf using a TA.XT2 Texture Analyzer (Stable Macro System, UK). The bread Crumb samples (20 x 20 x 20 mm) from the centre of each slice were compressed two times using a pre-set speed of 1.5 ms^{-1}, a contact force of 5 g, a distance of 8 mm and a data acquisition rate of 100 pps. The parameters assessed include hardness, cohesiveness and gumminess.

Sensory Evaluation

A panel made up of 60 judges was used to assess the sensory attributes of the bread samples. Parameters such as flavour, mouth feel, aroma, crust colour, difference and general acceptance were assessed. The test consisted of a 10 cm scale, ranging from "dislike very much" to "like very much", for each parameter (Blay, 2012). The bread formulations were designated as B0, B5, B10, B15, and B20, and used for the sensory assessment.

Data Analysis

A Completely Randomised Design was used to study the effects of the different levels of FPF incorporation on the product properties. One-way Analysis of Variance (ANOVA) and where necessary, the Least Significance Difference (LSD) was used to determine the differences between levels of supplementation of WF with FPF on product characteristics. A Randomised Complete Block Design (where assessors were the blocks and flour supplementation levels were the treatment) was used in the sensory evaluation and the results analysed using two-way ANOVA without replication.

Results and Discussion

Proximate composition of the samples is shown in Table 1. The moisture content of the flour samples ranged from 7.99% for WF to 13.54% for FPF. The protein content of flour samples ranged from 8.72% to 12.62%. Significant differences ($p < 0.05$) existed in the protein content among the flour samples, with the highest and lowest values being WF and FPF respectively. The ash content of the flour samples ranged from 0.69% to 6.42%, with FPF having the highest and WF having the lowest values. Significant differences ($p < 0.05$) existed in the proximate composition of the flours. The carbohydrate content ranged from 71.71 to 76.65%. Significant differences ($p < 0.05$) existed in the carbohydrate content of the flours with the highest and lowest values being WF and FPF respectively. The differences in flour proximate composition, is a result of the combination of two flours (WF and FPF) with different composition, at different levels of incorporation. This is very useful as it allows for the use of composite flours made with climate-smart local food resources to promote varied diets and address food security challenges in underdeveloped communities (Tortoe *et al.,* 2018; Baah *et al.*, 2005).

pH values of the flour samples ranged from 4.95 - 6.38, with FPF (100%) and WF (100%) having the highest and lowest values respectively. No significant difference ($p > 0.05$) existed amongst composite flour samples. The proximate composition, especially the protein and fat content of the flours and the flour ratios used, contributed to the changes in pH. Ageing can significantly reduce the pH of wheat flour and this positively affects baking taste (Jahed *et al.*, 2007). Since WF is imported into Ghana, it is evident that WF in the local markets has significantly aged. This explains why WF had the lowest pH. Low pH levels in the flours means improved baking taste and overall sensory appeal.

Table 1: Proximate composition of the flour samples

FWF	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Carbohydrates (%)
0%	13.54 ± 0.14^{a}	0.44 ± 0.04^{a}	12.62 ± 0.02^{a}	0.69 ± 0.07^{e}	72.71 ± 0.21^{c}
5%	13.48 ± 0·16^{a}	0.45 ± 0.03^{a}	11.53 ± 0.03^{b}	1.37 ± 0.09^{d}	73.17 ± 0·54^{b}
10%	13.20 ± 0.09^{a}	0.46 ± 0.04^{a}	10.88 ± 0.08^{c}	2.82 ± 0.01^{c}	72.64 ± 0.33^{c}
15%	12.77 ± 0·36^{b}	0.48 ± 0.07^{a}	10.23 ± 0.11^{d}	3.41 ± 0.18^{b}	73.11 ± 0·52^{b}
20%	12.61 ± 0·15^{b}	0.48 ± 0.09^{a}	9.67 ± 0.06^{e}	3.47 ± 0.34^{b}	73.77 ± 0·43^{b}
100%	7.99 ± 0.28^{c}	0.22 ± 0.02^{a}	8.72 ± 0.13^{f}	6.42 ± 0.29^{a}	76.65 ± 0·61^{a}

0%, 5%, 10%, 15%, 20%, and 100% are Frafra potato flour percentages in composite flour formulations. Values are means and standard deviations of triplicates

Means in same column with different superscripts are significantly different ($p \leq 0.05$)

The values were reported as % dry matter, except for moisture content values.

Water absorption capacities of the flour samples ranged from 0.81g to 4.46g of water absorbed per 1 g of flour, with FPF and WF having the highest and lowest values respectively (Table 2). Oil absorption capacities of the flour samples ranged from 118.88% to 150.62%, with FPF and WF having the highest and lowest values respectively (Table 2). Significant differences ($p < 0.05$) existed between water and oil absorption capacities of composite flour and WF samples. Flavour, aroma and texture are important sensory characteristics of flour products and major factors affecting sensory perception and consumer acceptance of flour products (Ohimain, 2014; Jacob and Leelavathi, 2007). These sensory characteristics are influenced by the water and oil absorption capacity of the flour used for the products (Pomeranz, 1998). Products made with flour with higher oil absorption capacity are likely to have good flavour and aroma which are imparted by the relatively high fat absorbed into the product (Popov-Raljić *et al.*, 2013; Olliver *et al.*, 2003). Water absorption on the other hand tends to influence the volume of the product (Pasha *et al.*, 2011).

Table 2: Percent water and oil absorption capacity of flour samples

Frafra potato/wheat flour	Water (%)	Oil (%)
0%	81.85 ± 0.03	118.88 ± 0.02
5%	97.55 ± 0.04	120.58 ± 0.02
10%	101.50 ± 0.07	129.49 ± 0.05
15%	112.48 ± 0.05	133.62± 0.03
20%	115.02 ± 0.02	133.98 ± 0.02
100%	445.85 ± 0.05	150.62 ± 0.01

0%, 5%, 10%, 15%, 20%, and 100% are Frafra potato flour percentages in composite flour formulations.
Values are means and standard deviations of triplicates

Table 3: Pasting properties of flour samples

Flour	P_{Time} (min)	P_{Temp} (°C)	PV	BD	SB	FV
0%	5.25 ± 0.10^{d}	64.0 ± 1.01^{c}	348.0 ± 0.72^{a}	123.2 ± 0.48^{a}	186.3 ± 0.1^{a}	434.1 ± 0.4^{a}
5%	5.35 ± 0.27^{c}	64.1 ± 0.92^{c}	354.0 ± 1.03^{b}	117.9 ± 1.02^{b}	178.3 ± 1.05 ^{b}	410.4 ± 1.4^{b}
10%	5.40 ± 0.91^{c}	65.7 ± 1.03^{b}	310.0 ± 1.04^{c}	120.0 ± 0.71^{c}	160.4 ± 1.5 ^{c}	345.7 ± 1.1^{c}
15%	5.50 ± 1.02^{bc}	66.1 ± 0.81^{b}	274.3 ± 1.04^{d}	105.8 ± 0.82^{d}	137.1 ± 1.2 ^{d}	300.9 ± 1.6^{d}
20%	6.05 ± 3.71^{b}	66.5 ± 0.41^{b}	239.0 ± 1.08^{e}	91.7 ± 1.05^{e}	125 ± 0.9 ^{e}	267 ± 1.4^{e}
100%	14.40 ± 0.10^{a}	93.2 ± 0.71^{a}	28.7 ± 0.50^{f}	0 ± 0.01^{f}	18 ± 1.0 ^{f}	49.6 ± 1.1^{f}

Values are means of triplicate determinations. Means in the same columns with different superscripts differ significantly ($p \leq 0.05$). $P_{Temp.}$ = Pasting temperature; P_{Time} = Pasting time (min); PV = Peak Viscosity; FV = Final Viscosity; BD = Break Down; SB = Set Back

Pasting properties of the flour samples showed significantly different ($p \leq 0.05$) peak viscosity values, with WF having the highest peak viscosity score (348.0 BU) and FPF having the lowest peak viscosity score (28.7 BU). FPF had the lowest peak and break down viscosity (Table 3). Factors that might have contributed to the lower viscosities in this study include the components such as protein, which interfere with the pasting process, and the lower amount of amylose and starch or the activity of amylose in the composite flour (Aprianita *et al.,* 2013). Another factor is the effect of storage time. Disulphide-bond formation in protein networks, which increases during starch aging as a result of increased storage time, could lower the pasting viscosity of starch. The low setback value of these composite flour samples shows their low retrogradation tendency, which is important for foods that require cold storage or freezing. Low breakdown viscosity of these samples, as compared with that of wheat flour, reflects the stability of these materials toward heat and mechanical processing. This property is crucial for food production that involves heat and mechanical treatment in bread making (Tortoe *et al.,* 2018; Aprianita *et al.,* 2013).

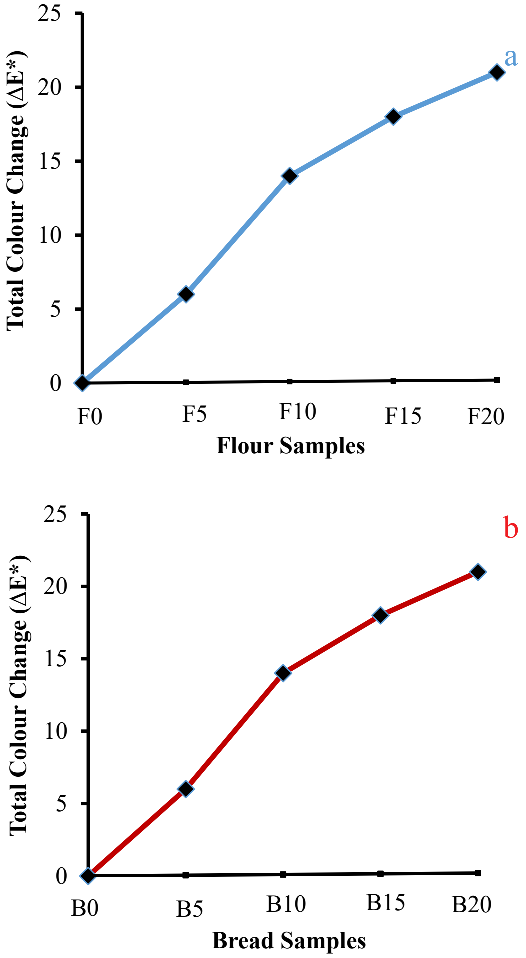

Fig. 1: Effect of Frafra potato flour incorporation on the colour of (a) Flour and (b) Bread Samples.

F0, F5, F10, F15, F20 are flour and B0, B5, B10, B15, B20 composite bread samples with 0%, 5%, 10%, 15%, and 20% Frafra potato flour, respectively.

Total colour change (ΔE*) of flour samples ranged from 6.72 - 21.89, with 5% Frafra potato-wheat composite flour and 20% Frafra potato-wheat composite flour having the lowest and highest values respectively (Figure 1a). Significant differences ($p < 0.05$) existed between the colour of flours and bread samples. Total colour change (ΔE*) of bread samples ranged from 6.58 - 23.30, with 5% Frafra potato-wheat composite bread and 20% Frafra potato-wheat composite bread having the lowest and highest values respectively (Figure 1b). The effect of colour change increased with increasing levels of FPF substitution in the samples. Significant differences ($p < 0.05$) existed between flour and bread samples. Hence it can be deduced that increased addition of FPF made the samples turn darker relative to the control. There were relatively higher b* values in the composite bread samples compared with their respective flour formulations. This may be due to the introduction of fat (margarine) in making the bread. The brand of margarine used has a bright yellowish colour which may have contributed to the higher b* values recorded.

Percent weight loss of bread samples after baking ranged between 8.34% to 20.35% with 20% Frafra potato-wheat composite bread and WF bread having the lowest and highest values respectively (Table 4). Significant differences ($p < 0.05$) existed between the weights of the bread samples after baking. Higher water absorption capacity of FPF indicates the tendency for a relatively high water retention capacity of composite flour dough even after baking. It is not surprising that composite bread samples were relatively heavier than the control. Weight is an important quality of bread, especially in Ghana where consumers associate bread quality with weight (Tortoe *et al.*, 2018)

The volume of bread samples ranged between 357.60cm^3 to 447.31cm^3 with 20% Frafra potato-wheat composite bread and wheat bread having the lowest and highest values respectively (Table 4). Significant differences ($p < 0.05$) existed between bread samples. Since fermentation is involved in bread making, there was an obvious loss in bread volume as levels of FPF substitution increased. This is due in part to poor CO_2 production in composite dough, but largely the result of inadequate gluten-activity in composite dough. Thus, Frafra potato flour is ideal for baked foods which do not require proofing or rising such as unleavened bread, cake and cookies (Aprianita *et al.*, 2013).

Table 4: Percent weight loss and volume of bread samples

Bread sample	% weight loss	Volume (cm³)
B0	20.35 ± 0.19^{a}	447.31 ± 1.19^{a}
B5	16.10 ± 0.09^{b}	424.65 ± 0.82^{b}
B10	15.12 ± 0.05^{c}	402.30 ± 0.25^{c}
B15	9.27 ± 0.24^{d}	379.95 ± 0.94^{d}
B20	8.34 ± 0.51^{e}	357.60 ± 1.51^{e}

B0, B5, B10, B15, B20, are composite bread samples with 0%, 5%, 10%, 15%, and 20% Frafra potato flour respectively. Values are means and standard deviations of triplicates. Means with different superscripts are significantly different ($p \leq 0.05$)

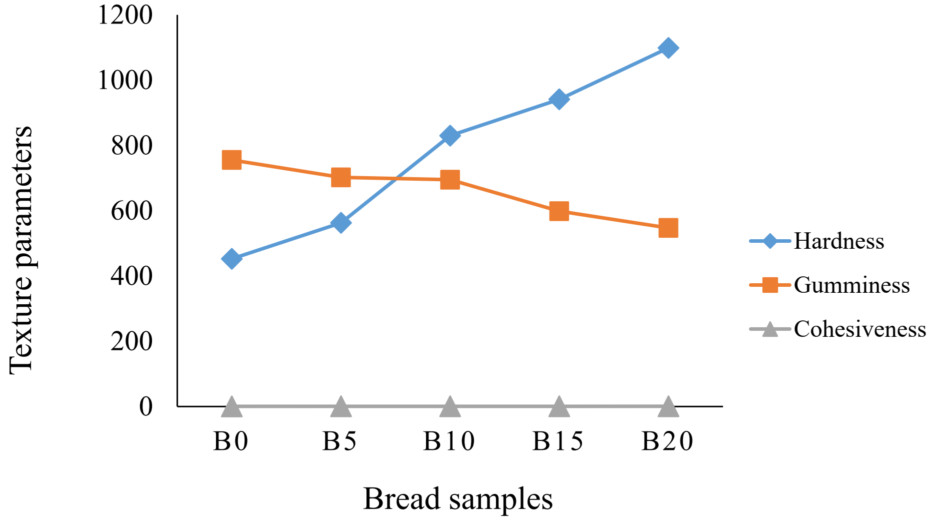

Fig. 2: Texture of bread samples

B0, B5, B10, B15, B20, are composite bread samples with 0%, 5%, 10%, 15%, and 20% Frafra potato flour respectively.
Values for hardness and gumminess in the text are multiplied by 100 and 1,000 respectively.

Texture analysis of bread samples showed that peak force (hardness) of composite bread samples ranged from 5.52N - 10.77N, with 20% Frafra potato-wheat composite bread and wheat bread having the highest and lowest values respectively. Significant differences ($p < 0.05$) existed between bread samples. Gumminess values ranged between 0.603 to 0.744, with wheat and 20% Frafra potato-wheat composite bread having the highest and lowest values. No significant differences ($p < 0.05$) existed between the bread samples for the texture parameters gumminess and cohesiveness. As seen in Figure 2, composite bread samples became harder, relative to the control, as FPF increased. Nonetheless, the highest peak force (10.77 N) recorded, indicating peak hardness of bread from composite flour with 20% FPF, was within the reported range of instrumental texture of bread (Mandala *et al.,* 2006). This is an indication that composite bread samples are still likely to appeal to consumers even though they were relatively harder than the control. Hardness in composite bread can be attributed to the reduced activity of gluten. Also, the water absorption capacity of the flour plays a significant role in textural hardness since it gives an estimate of the volume occupied by starch granules after swelling in excess water, which in turn is an index for gelatinization or hardness (Mandala *et al.,* 2006).

Table 5: Sensory evaluation of bread samples

Attribute	(Control) F0	F5	F10	F15	F20	SSE
Overall acceptability	8.23^a	8.26^a	8.05^a	6.46^b	5.99^b	1.393
Colour	8.08^a	8.02^a	7.23^b	6.15^c	5.23^d	1.165
Aroma	7.77^a	8.08^a	7.78^a	6.77^b	6.30^b	0.991
Flavour	8.15^a	8.31^a	8.23^a	6.83^b	6.45^b	1.709
Mouth feel	8.85^a	8.54^a	8.30^a	5.54^b	5.28^b	1.147
Aftertaste	8.54^a	8.69^a	7.38^b	6.15^b	5.84^c	1.113

10 ≤ Like Extremely; 5 ≤ Neither Like nor Dislike; 0 ≤ Dislike Extremely; SSE: Sum of Squared Error. F0, F5, F10, F15, and F20 represent bread with 0%, 5%, 10%, 15% and 20% respectively of FPF in the bread. Means in the same row with different superscripts are significantly different ($p \leq 0.05$).

Sensory scores ranged from 5.23 - 8.85, which is an indication of different levels of likeness. Significant differences ($p < 0.05$) existed for the sensory attributes studied (Table 5). Panellists' preference for overall acceptability was comparable for wheat bread (100%), 5% and 10% Frafra potato bread followed by 15% and 20% Frafra potato bread (Table 5). For colour, significant differences existed between bread samples, but there was no significant difference ($p > 0.05$) between 5% Frafra potato bread and wheat bread, which were the most preferred, with 20% Frafra potato bread being the least preferred. No significant difference ($p > 0.05$) was observed between wheat bread and 5% - 10% Frafra potato bread in terms of aroma, flavour and mouth feel (Table 5). For aftertaste, significant differences existed between bread samples, but there was no significant difference ($p > 0.05$) between 5% Frafra potato bread and wheat bread. Frafra potato bread (5%) was comparable to 100% wheat bread for all the sensory attributes evaluated (Table 5). Frafra potato bread 10% had overall acceptability, aroma, flavour and mouthfeel that was comparable with 100% wheat bread and 5% Frafra potato bread, but had lower values for colour and aftertaste. The lower liking scores for composite bread samples with increasing addition of FPF (15-20%) may be due to the rather strong unfamiliar aroma of FPF which was not properly masked by the mixture of ingredients used to make the composite bread. Overall, panellists preferred composite bread samples made from composite flour with 5% and 10% Frafra potato flour more than the control (Table 5). This finding suggests that substituting bread formulations with 5% - 10% FPF would produce composite bread that will be preferred over WF bread.

Table 6: Correlation between Overall Acceptability and other Sensory Attributes of Bread Samples

Correlation Between	Correlation Coefficient (R)
Overall acceptability and Colour	0.98765
Overall acceptability and Aroma	0.95321
Overall acceptability and Flavour	0.83474
Overall acceptability and Mouth feel	0.96304
Overall acceptability and Aftertaste	0.72882

Regression analysis of the data obtained showed that overall acceptability correlated strongly with colour, aroma, flavour, mouth feel and aftertaste for the bread samples (Table 6). This implies that overall acceptability of the bread was influenced strongly by these sensory attributes. Thus, in developing bread from composite flour, attributes of colour, aroma, flavour, aftertaste and mouth feel should be taken into consideration.

Conclusion

Substituting WF with FPF positively affected the pH, percentage water and oil absorption capacity and negatively affected tristimulus colour and pasting property of the composite flour formulations. Frafra potato-wheat composite flours which had lower pasting property, but higher water and oil absorption capacity, gave harder and darker bread with lower overall acceptability, whereas composite flours with higher pasting property gave bread with higher overall acceptability. The study has shown that the overall acceptability of bread produced using 5% to 10% Frafra potato-wheat composite flour was comparable to bread made from 100% wheat flour. Thus, further optimization of bread formulation and processing conditions may promote the use of Frafra potato in the production of Frafra potato-wheat composite bread with attributes comparable to already existing ones.

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