CHEMICAL COMPOSITION, PHYSICAL AND SENSORY PROPERTIES OFSWEET ORANGE PULP-PINEAPPLE POMACE- WHEAT FLOUR BLEND BREADS

ABSTRACT

The nutritional, physical and organoleptic properties of the bread supplemented with orange-pineapple pomace were studied. The orange pulp flour was mixed with pineapple pulp flour at ratio 1:1 to produce orange-pineapple pomace flour blend. The orange-pineapple pomace flour blend was substituted into wheat flour at 5, 10, 15, 20 and 25% to produce orange-pineapple flour blends and 100 % wheat flour as the control. The blend flour with the other ingredients [yeast(6g), sugar(28g), fat(14g) and salt(4g) were mixed and fermented for 1-2hrs, kneaded, molded and baked at 160^{o}C to produce orange-pineapple pomace bread. The chemical composition (phytochemical, mineral, vitamins), physical and sensory properties of the flour blend breads were determined using standard laboratory methods. The flavonoid and phenol increased from 65.61 to 80.73 and 511.24 to 571.24mg/100g respectively, with increase in added orange-pineapple flour blend. The potassium and magnesium content increased from 76.935 to 188.85 and 37.345 to 39.495 mg/100g respectively, with increase in added orange-pineapple flour blend, the vitamin A increased from 0.36 to 0.43mg/100g respectively, with increase in added orange-pineapple flour blend, The average mean scores of the taste, color, odor, texture, and general acceptability of the blend breads ranged from 7.95 – 6.85, 7.95 – 6.96, 7.95 – 6.50, 8.55 – 6.85 and 8.55 – 7.30 with increase in added orange pomace flour respectively,The loaf weight decreased from 176.00 to 149.67g, while the loaf volume and loaf index decreased from 650 to 200.00 cm^3, and 3.69 to 1.34, respectively with increase in the added orange pineapple flour (0 to 25%). The wheat-orange pulp/pineapple flour blend was generally acceptable at allassessed levels but most preferred at 20% added orange-pineapple pomace flour. The orange-pineapple pomace incorporation had significant effects p= 0.05 on the nutrient compositionand sensory property of the flour blend bread.

Running Title: Effect of sweet orange and pineapple pomace on the quality of wheat-based bread.

Key Words: Sweet orange, pineapple pomace, wheat, quality

Introduction

Bread is a major staple wheat-based food product which has gained wide acceptance among consumers in the world especially Nigeria for many years (Badifu*et al.*, 2001, Abulude, 2005). This Bread is basically made from hard wheat flour, yeast, fat, sugar, salt and water. It is predominantly rich in carbohydrates and it is an appropriate vehicle for food fortification of essential macronutrients such as protein and micronutrients such as vitamins and minerals. There is a growing interest in using composite flour for bread making owing to some economic, social, and health reasons. However, the partial substitution of wheat flour by other flour types presents

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considerable technological difficulties because their proteins lack the ability to form the necessary gluten network for holding the gas produced during the fermentation.

Wheat is the choice cereal for manufacture of bread because it contains a large amount of gluten, which produces raised loaves (Badifu and Aka, 2001). Besides, cereal flours generally are limiting in lysine, an essential amino acid. Supplementation of cereal based foods with other protein sources such as legumes has gained considerable attentions in the recent time among researchers (Dhingra et al 2011, 2002, Oluwole and Olapade, 2011, Olapade *et al.*, 2011). This is because legume proteins are good sources of lysine. The critical criteria for use of any food material in processing are its availability and cost. The main problem facing the bakery industry in developing nation like Nigeria is overdependence on importation of wheat to sustain it, since her climate does not favour cultivation of wheat. Therefore, any effort geared towards substituting whole or part of wheat flour with readily available cereal flours in bread making will be a welcome idea.Sweet orangeand pineapple, is an important economic crop in many countries. In terms of annual production, sweet potato ranks as the fifth mstimportant food crop in the tropics and the seventh in the world food production after wheat, rice, maize, potato, barley, and cassava (FAO 2016).

Sweet orange (*Citrus sinensis*) is one of the variety of citrus fruit which is highly nutritious and rich in minerals such as potassium, phosphorus, calcium, iron, magnesium, sodium and sulphur; proteins, carbohydrates, fat as well as vitamins such as folic acid, vitamin B (thiamine) (Prasad *et al*., 2010) and are mainly used by the juice processing industries where the juice yield is less than half of the fruit weight and large amount of orange by-product wastes; such as pulps, peels among others are formed every year (Manthey and Grohmann, 2001). Nigeria produces 3% of fresh citrus in the World (FAO, 2004) where the pulp and the seeds of this fruit contribute to the bulk weight comprising about 46% and 44% while peel constitutes about 10%. The endocarp (pulp) is rich in soluble sugar and contains significant amounts of vitamin C, pectin, different organic acids and potassium salt which give the fruits its characteristic “citrus flavour” (Ezejiofor*et al*., 2011).

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These by-products from orange juice extraction have potential use as sources of dietary fibre and are rich in soluble and insoluble fibre, as well as being in abundant and low in cost (Grigelmo-Miguel and Martín-Belloso, 1999; Santana, 2005; Topuz *et al.,* 2005). Grigelmo-Miguel and Martín-Belloso (1999) demonstrated that orange juice extraction waste is an excellent potential source of dietary fibre, as this material is rich in pectin and is available in large quantities. Citrus dietary fibre is of high quality when compared to other forms of dietary fibre, due to the presence of associated bioactive compounds, such as flavonoids and other polyphenols, and carotenoids (Fernández-Ginés *et al.,* 2003; Wolfe and Liu, 2003).

Pineapple (*Ananas comosus)*, fruit is good source of carotene (vit. A) and ascorbic acid (vit. C) And is fairly rich in vitamin B and B12, it also contain carbohydrate, protein, fat, fiber, calcium and iron. Pomace or marc is solid remains of grapes, olives or other fruit after pressing for juice or oil. It contains the skin pulp, seeds, and stems of the fruit. Pineapple pomace is a primary by-product of the pineapple juice industry. It has been estimated that about 25 per cent of the fresh fruit is lost as pomace (Ayo et al., 2010).

In recent years the cost of importation and dependency on wheat for baking, pasta and other confectionaries is increasing and these have increased cost of production. Acha grains relatively available at cheaper cost were under-utilize due to poor information as to its nutrient potentials (Ayo et al 2014, Ayo et al 2010, Lasekan 1994). Fruits pomace abundantly available, is often regard as waste despite its high dietary fiber content, it is therefore underutilized.

Orange and pineapple pomace can be an alternative means of diversifying the use of non-wheat composite flour. It has been proven that the blending of pineapple pomace with wheat in composite flour can be used as a medium for dietary fiber, calcium, phosphorus and iron enrichment (Tivari and Pandey, 2007).Incorporation of orange and pineapple pomace in wheat products also has both economic and environmental advantages as it helped reduce reliance on imported expensive wheat flour and also reduce environmental waste. The incorporation of either orange and pineapple pomace flour in bread aims at improving the β-carotene content of bread (kamal *et al* 2013; Bonsi*et al* 2014).

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The objective of this study is to determine the effect of added orange and pineapple pomace on the physical and nutritional quality of wheat based bread.

Materials and Methods

The raw material used in this work include: orange pomace (*Citrus sinensis)*,pineapple**(***Ananas Comosus***)**, wheat flour(*Triticum aestivum*), baking fats (stk royal active), salts,water,yeast. These materials were purchased from Wukari main Market, Taraba State.

Preparation of samples

Production of orange Pomace flour: The orange fruit was sorted and washed (using tap water), peeled (manually using knives), juice was extracted to obtain pomace (using juice extractor), dried (using laboratory oven at 45-50^{o}C), milled, sieved (using 0.4mm aperture size) to obtain orange pomace flour, packaged hermetically in polyethylene bag and stored in room temperature until usage(Khule *et al* 2019)

Production of pineapple pomace flour: The fresh pineapple was washed to remove sand particles that is attached to the bark, peeled (manually with knives), and cut into slices to facilitate juice extraction, the slice pomace was drained and oven dried at 45-50^{o}C, for 6hr,milled into flour and sieved to obtain pomace flour. The flour was packaged and stored at room temperature (Thivani*et al* 2016)

Composite Flour Formulation and production of Bread: The orange flour and the pineapple pomace were mixed together at ratio 1:1 to obtain orange-pomace flour blend**.** The orange-pineapple flour was substitute at 0, 5, 10, 15, 20, and 25 % into the wheat flour and salt, baking yeast, and baking fat were added. The flour blends were mixed using food mixer (120 rpm) for 10 minutes, fermented(45^oC) for 2hrs, mixed, kneaded, molded, cut, panned, proved (50^oC) and baked(180^oC), cooled and packaged in polyethylene package (Khule *et al* 2019).

Analytical Methods

Determination of Proximate Compositionof wheat-orange/pineapple flour blend bread

Determination of protein: The protein content of the samples was determined according to AOAC (2012). Half (0.5) gram of a finely grounded samples were weighed into a digestion flask and one kjeldahl catalyst tablet was added, 10ml of conc. H_2SO_4 was added and digested for 4 hours until a clear solution is obtained. The digest was cooled and transferred into 100ml volumetric flask and made up to mark with distilled water. 20ml of boric acid were dispensed into a conical flask and 5 drops of indicator and 75ml of distilled water was added to it 10 ml of the digest were dispensed into Kjedahl distillation flask, the conical and the distillation a flask were fixed in place and 20ml of 2% NaOH was added through the glass funnel into the digest. The steam exit was closed and timing started when the solution of the boric acid and indicator turned green. The distillation was done for 15 minutes and the distillate was titrated with 0.05NHCl.

%Total Nitrogen = Titre Value x Atomic mass of nitrogen × Normality of HCl used ×4

Therefore, the crude protein content is determined by multiplying percentage Nitrogen by a constant factor of 6.25

i.e. %crude protein = %N x 6.25.

Determination of crude fiber: The sample from the crude fat determination was transferred into a digestion flask. A 200ml of boiling sulphure(iv) oxide acid (H_2SO_4) solution and anti- foaming agent (asbestos) was added, boiled for 30 min, filtered, washed with boiling water to remove acid. Asbestos was added to the sample, l boiled with sodium hydroxide (NaOH) solution, filtered,

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washed with boiled water, washed with 15ml of 95% ethanol, residue dried (at 110^{o}C), cooled ignited in a muffle furnace at 550^{o}C for 30 min, cooled in a desiccator and weighed (AOAC, 2012).

Determination of Phtyochemical Compositionof wheat-orange/pineapple flour blend bread

Determination of flavonoids: Flavonoid of the blend bread were determined by the method described by Okwu (2005). Ten (10g) of the blend bread was extracted repeatedly using 80 % aqueous methanol 100ml at room temperature. Solution was filtered, evaporated to dryness percentage was calculated using equation (1).

$$\% \text{ flavonoid content} = \frac{\text{weight of residues}}{\text{weight of sample taken}} \times 100$$

Determination of carotenoids: The carotenoids wasdetermined as described by Branisaet al., (2014). Acetone-water mixture (4:1, v/v) was used as a solvent. The absorbance maxima were read for carotenoids Contents. Total carotenoids were calculated using Equations 1, 2 and 3 respectively

$$\text{chlorophyll a } (\mu g/ml) = 12.25A_{6636} - 2.25A_{6466} \text{...1}$$

$$\text{chlorophyll b } (\mu g/ml) = 20.31A_{6466} - 4.91A_{6636} \text{...2}$$

$$\text{total carotenoids } (\mu g/ml) = \frac{1000A_{470} - 2.27 \text{ (chl a)} - 81.4 \text{ (chl b)}}{227} \text{....................3}$$

Determination of Mineral Composition of wheat-orange/pineapple flour blend bread

Determining ofIron Content: Phenanthroline method as described in AOAC (2012) was used. 5ml of the digested sample was added to 3ml of phenanthroline solution with 2ml of HCl and the mixture and boiled (steam bath at 600oC for 2 minute). 9ml of ammonium acetate buffer solution was added absorbance taken at 510nm and readings marched with calibration curve to read off the value of iron.

Determining of Potassium: Potassium content was determined as described by Ndubuisi (2009). 2 mL of sample was mixed with 2 mL of sodium cobaltonitrate, allowed to stand for 45 minutes, 2 mL of water was added and centrifuged for 15minutes. The supernatantwas mixed with 2 mL of 70 % ethanol,centrifuged (5 min), supernatant boiled(10 min), 1 ml of 1 % choline hydrochloride with 1 ml potassium fericyanide and 2 mL of distilled water was added to the extract and absorbance was determined at 620 nm(colorimeter). Thepotassium content was calculated using equation (3.3).

$$\text{Potassium} = \frac{A_s \times C_{ss} \times D_f}{A_{ss} \times S_v} \times 100 \qquad (3.3)$$

Where A_s is absorbance of sample, C_{ss} is concencentration of standard solution, D_f is Dilution factor, A_{ss} is aborbance of standard solution and S_v is sample volume.

Determining ofphosphorus content: The Vanado Molybdate method was used from phosphorus determination. Four (4) drops of ammonia, 2.5 ml vanadyl molybdate and 2.5 ml of distilled water was added to 5 ml of mineral ash sample solution and absorbance was taken at 470nm using colourimeter (AOAC, 2012). Phosphorus was calculated as follows:

$$\frac{\text{Absorbance of sample x Concentration of standard solution x Dilution factor}}{\text{Absorbance of standard solution x Sample volume}}$$

Determination of Vitaminsof wheat-orange/pineapple flour blend bread

Determining the Vitamin,A (Retinol): The method described by Romeu-Nadal *et al.*, (2006) was adopted. Using the liquid chromatography with psectrophotometric and gas chromatography technique

Determination of Physical Propertiesof wheat-orange/pineapple flour blend bread

Determination of loaf volume: Loaf volume was measured by seed displacement method as described by Hallen *et al*. (2004). The loaf was put in a metallic container with known volume (*VC*). The container was topped up with sorghum grains. The loaf was removed and the volume of the sorghum noted(*VR*). Loaf volume (*VL*) was then as:

$$VL(cm^3) = VC - VR$$

Loaf weight.: Loaf weight was measured 30 minutes after the loaves were removed from the oven using a laboratory scale (CE- 410I, Camry Emperors, China) and the readings recorded in grams.

Loaf volume index : Loaf weight was determined by dividing the volume of loaf sample volume by bread weight of loaf sample by the bread as described by Ayo et al(2010) :

$$\text{Volume index } (cm^3/g) = \frac{\text{Volume of loaf sample}}{\text{Weight of loaf sample}}$$

Evaluation of Sensory Propertiesof wheat-orange/pineapple flour blend bread

The bread samples were evaluated for colour, taste, odour and texture by twenty (20) trained panelists who were randomly selected from staff and students of the Department of Food Science and Technology, Faculty of Agriculture and Life sciences, Federal University Wukari, , Nigeria based on their familiarity with breads. The bread samples were presented on 3 digits coded white plastic plates at 29±3°C. The samples were evaluated on 9-point Hedonic scale where 1 = disliked extremely and 9= like extremely. The order of presentation of the sample to the panelist was randomized. The evaluation was done in the Dept of Food Science and Technology Sensory laboratory.

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Statistical Analysis

Data will be carried out by two-way analyses of variance (ANOVA) in completely randomized design using statistical package for social science (SPSS) version 23.00. the statistically significant difference ($p<0.05$) were separated using the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Proximate Composition of wheat-orange/pineapple flour blend breads

The mean values of the proximate composition of the wheat orange-pineapple flour blend bread are presented in Table 1. The moisture, fat fiber and ash content of the flour blend breads increased from 30.20 to 34.41, 7.76 to 8.54, 3.9 to 5.76 and 2.26 to 2.99%, respectively, while the carbohydrate and protein content decreased from 77.78 to 38.07 and 9.15 to 8.60% with increasing addition of orange-pineapple pomace flour. The effect of the added orange-pineapple blends on the proximate composition of the blend breads is significant, $p<0.05$..

The moisture contents increased from 30.20 to 34.29% with increasing level of orange-pineapple pomace flour blend. Bread formulated with 25% orange-pineapple flour blend (75:25) had the highest value (34.41%). All samples generally had relatively low moisture content, which suggest improvedshelf life of the produces bread. The moisture content of the orange-pineapple pomace flour blend was higher when compared with 9.47% reported by Arosemena *et al.* (1995).The difference could be due to the method of drying or the pre-treatment method given to the flours. The wheat flour had lower moisture content than orange-pineapple pomace blend flour which indicated that the orange-pineapple pomace blend would have shorter storage stability than the wheat flour used.

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The protein content of the orange-pineapple pomace flour blend bread decreased from 9.15 to 8.60%. The lowest protein content was observed in 75: 25% sample The decrease was significant, p<0.05. The protein content of the wheat flours agreed with earlier reports on Nigerian wheat flours (9–14.5%) as observed by Keswet *et al,*. 2003. The higher protein content could therefore be of great importance in human nutrition (Mayo *et al*., 2011) as it could help in the repair of worn out tissues and building of body systems.

The fat content of wheat-orange/pineapple flour blend bread increased from 7.76 to 8.54% with increase in the added orange-pineapple blend. The effect of the substitution is significant on the fat content, p<0.05. The findings agreed with the early work of Akubor(2020), that the fat content of bread containing CMC (7.89%) was significantly (p<0.05) higher than the 6.26% for the 100% wheat flour bread. The fat could serve as a source of heat to the body, and as well contribute significantly to the energy level of the consumer

The ash content of the wheat-orange/pineapple flour bread increased from 2.26 to 2.99%. The highest ash content was observed in bread formulated with 25% orange-pineapple flour blend (75:25). The relative high level of ash content could be due to high content of the ash in the pomace. Ash is an indication of high mineral content which could be of importance in the development of bone, metabolism of food and effectiveness of the hormones system.

The fiber content of the produced bread increased from 3.90 to 5.76% with increase in addition of the pomace. The effect on the fiber content is significant, p<0.05. Gropper *et al., (*2008) reported that fiber attracts water and forms a viscous gel during digestion, slowing the emptying of the stomach and intestinal transit, and is important for the removal of waste from the body thereby preventing constipation and many health disorders.

The carbohydrate content of the bread produced decreased with increasing orange-pineapple flour blend from 79.78 to 38.07%. Bread formulated with only wheat flour (100:0) showed the highest

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carbohydrate content. The effect of the added orange-pineapple pomace flour blend was significant on the carbohydrate content, $p<0.05$. The carbohydrate contents of the breads (45.65 – 47.77%) were significantly lower. The relative decrease in the carbohydrate content could be due to the low content of the same in orange and pineapple flours.

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Table 1: Nutritional Composition of wheat-orange-pineapple flour blend bread

Sample wheat:opf	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Ash (%)	Crude Fibre (%)	Energy kcal
100:0	30.20 ^{a}±0.42	7.76^{a}±0.39	9.15^{b}±0.00	79.78^{b}±0.11	2.26^{b}±0.00	3.9^{b}±0.111	412.935
95:5	31.66 ^{a}±0.83	8.135±1.21	9.05^{a}±0.12	38.25 ^{a}±0.08	2.58±0.28^{b}	4.64^{b}±0.20	275.32
90:10	33.03^{a}±0.61	8.15^{a}±0.38	8.95^{a}±1.35	41.66^{a}±1.34	2.90^{a}±0.17	4.69^{a}±0.13	276.83
85:15	34.29^{a} ±0.40	8.34^{a}±0.38	8.90^{a}±2.58	41.60 ^{a}±2.60	2.94±0.07^{a}	4.75 ^{a}±0.06	278.31
80:20	34.35^{a}±0.43	8.40^{a}±0.27	8.70^{a}±1.36	41.40^{a}±2.17	2.96^{a}±0.08	5.25^{a}±1.02	273.70
75:25	34.41^{a}±0.47	8.54 ^{a}±0.17	8.60^{a}±0.14	38.07 ^{a}±1.75	2.99±0.01^{b}	5.76^{ab}±0.96	269.15
LSD	0.031	0.204	0.456	0.814	0.018	0.098	

Values are means +SD of triplicate determinations Means differently superscripted along the vertical columns are significantly different ($p<0.05$) **Sample ratio** – Wheat and orange pomace flour .

- **OPF:** Orange-Pineapple flour

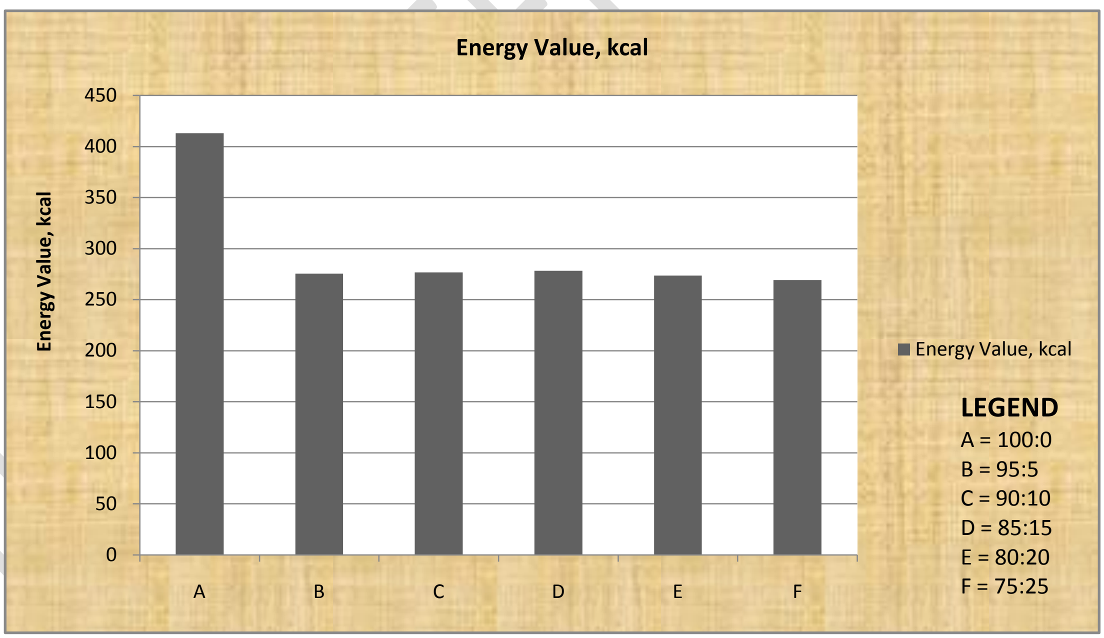

Figure 1: Energy content of wheat-orange/pineapple flour blend bread.

The energy content of the blend breads decreased slightly from 275.32 to 269.15cal/g with increase in the added orange-pineapple pomace (Fig 1). The energy content of the blend breads(269.15 -295.93cal/g) are far lower than that of 100% wheat bread(412.935cal/g).

Phytochemical Composition of wheat-orange/pineapple flour blendsbread.

The phytochemical composition of wheat-orange/pineapple pomace flour bread is shown in Table 2. The flavonoid, carotenoid and phenol contents of the flour blend bread increased from 49.71 to 80.73, 2.05 to 7.50 and 511.24 to 571.24 mg/100g, respectively, with increase in added orange-pineapple pomace blend flour.

The carotenoid content of the orange-pineapple flour blend breads increased from 2.05 to 7.50 mg/100g.with increase in orange-pineapple flour (0- 25%).Carotenoid has been identified to improve the recovery of night blindness and loss of appetite.

The flavonoid content of the orange-pineapple flour blend bread increased from 49.71 to 80.73mg/. Flavonoids are anti-oxidants, and could lower cholesterol, inhibit tumor formation and protect against cancer and heart disease (Adebowale et al., 2008)

The phenol content of the orange-pineapple flour blend bread increased from 511.20 to 571.24 mg/100g, with increase in the added orange-pineapple pomace flour blend.Phenols such as tannins form insoluble complexes with proteins and could reduce their digestibility and palatability (Shahidi and Naczk, 2004).

Table 2.: Phytochemical Composition of Wheat- orange-pineapple flour blend bread

Sample Wheat:OPF	Flavonoid Mg/100g	Carotenoid Mg/100g	Phenol Mg/100g
100:0	49.71[c]±0.67	2.0550[d]±0.62	511.2[a]±27.82
95:5	65.61 [a]±8.23	3.3275 [a]±0.82	525.0 [a] ±0.86
90:10	69.21[a]±13.26	3.4425[b]±0.49	529.83[a]±29.61
85:15	72.81 [a]±18.29	4.600 [a]±1.02	548.42[a]±31.40
80:20	76.77 [a]±14.16	4.8300 [a]±0.37	559.83[a]±29.61
75:25	80.73 [a]±10.03	7.50[b]±0.05	571.24[a]±27.82
P-value	0.218	0.05	0.185

Data represents mean + SD (n=3)

Means differently superscripted along the vertical column are significantly (P<0.05) different

- **OPF:** Orange-pineapple flour

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4.3 Mineral(mg/100g) composition of wheat-orange-pineapple flour blend breads.

The mineral composition of wheat orange pomace flour blend bread is shown in Table 3.

The potassium and magnesium content of the blend bread increased from 76.935 to 188.85, and 37.345 to 39.495mg/100g, respectively, with increase in added orange-pineapple blend flour. The increase is significant, $p< 0.05$.

The increase in the minerals could be due to the relative high mineral content inherent in orange-pineapple flour blend, which agreed with the findings by Wardlaw and Hampi(2007) who observed that wheat flour bread contained higher amounts of potassium, magnesium and phosphorus but lower level of zinc contents. Potassium has been noted to improve the development of bone and blood composition in man (Mason, 2016). Magnesium helps in regulating muscle, nerve function, blood sugar levels and blood pressure while potassium aid in moving nutrients into cells and waste products out of cell and helps regulate heartbeat.

4.4 Vitamin Composition (Mg/100g) of Wheat-Orange-Pineapple Flour Blend Breads

The vitamin A content of the wheat orange pomace bread increased from 0.35 to 0.43mg/100g, with increase in the added orange-pineapple flour blend. The increase in significant, $p=0.05$. The increase in the vitamin A, could be due the its relative high content in the orange flour blend. Vitamin A aid in maintaining healthy vision, normal function of immune system, and also in the proper growth and development of babies in the womb.

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Table 3: Mineral and Vitamin Composition of Wheat Orange Pomace Flour Bread

Sample	Potassium (K) Mg/100g	Magnesium (Mg) Mg/100g	Vitamin A Mg/100g
100:0	87.12^{a}±0.00	36.93^{a}±1.06	0.35^{a}±0.007
95:5	76.935^{a}±9.89	37.34^{a}±2.74	0.36^{a}±0.11
90:10	90.925^{a}±9.89	37.622^{a}±1.54	0.37^{a}±0.09
85:15	104.915^{b}±9.89	37.90^{b}±0.34	0.39^{b}±0.07
80:20	146.882^{a}±9.89	38.697^{a}±1.05	0.40^{b}±0.10
75:25	188.85^{c}±0.00	39.495^{b}±1.77	0.43^{b}±0.14
P-value	0.02	0.03	0.02

Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at ($p<0.05$).

Physical Properties of wheat-orange/pineapple flour blend breads

The physical property of the Wheat orange pomace bread is shown in Table 4

The loaf weight of the flour blend breads decreased from 176.00 to 149.67g, while the loaf volume and loaf index decreased from 650 to 200.00 cm^3, and 3.69 and 1.34, respectively with increase in the added orange pineapple flour (0 to 25%). These effects are significant, p=0.005. The loaf index of the blended bread is significantly different ($p<0.05$) from that of 100% wheat bread (3.69).The pictures of the product are shown in Plate 1 and 2. The significant reduction in the loaf volume and loaf index could result in production of heavy bread. This could be due to absence of gluten in the added orange and pineapple flour blend. The findings agreed with former work of Akubor (2016)who observed decrease in loaf volume and attributed it to low

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protein contents of the flours due to dilution of wheat flour which resulted in low gluten content (Adeboye *et al.*, 2013). Gluten is also responsible for dough volume increase as a result of its extensibility. During bread production, gluten form networks which increases the volume of dough along with the action of yeast. Hallen *et al*. (2004).

The wheat contains gluten which when mixed with water is added forms a network in the dough,The addition of the orange-pineapple pomace to the wheat flour causes the gluten to be diluted(reduce) which lead to different rising in the bread as seen in the Plate 1. This is relatively lower than that of 100% wheat bread that has the highest rising (loaf volume).The dilution effect of the added orange-pineapple pomace could be cause of abnormal air spaces in the produce blended bread (Plate 2).

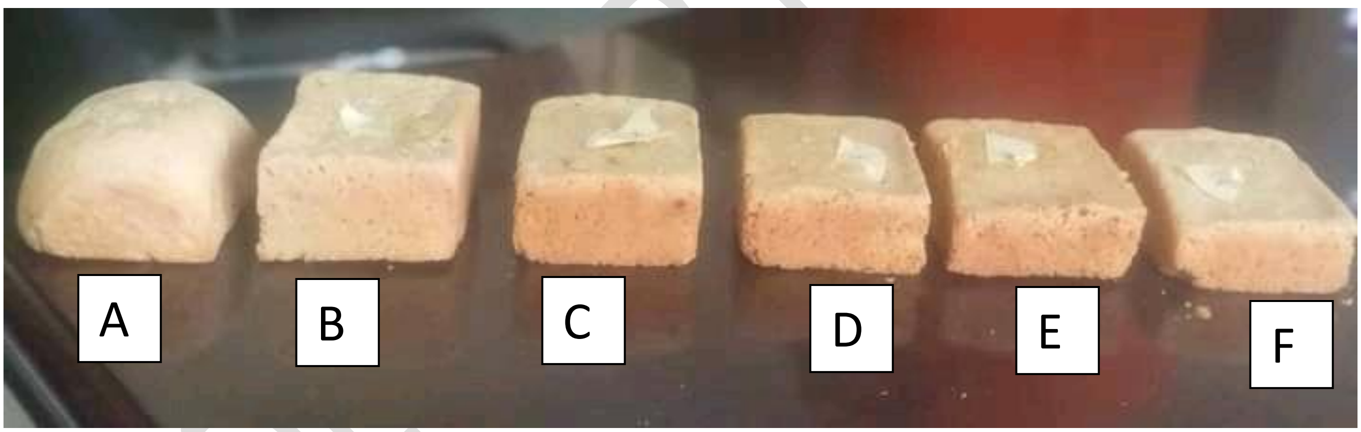

Plate 1: Various appearances of Breads
A=100% wheat, B=95% wheat, C=90% wheat, D=85% wheat, E=80% wheat, F=75% wheat

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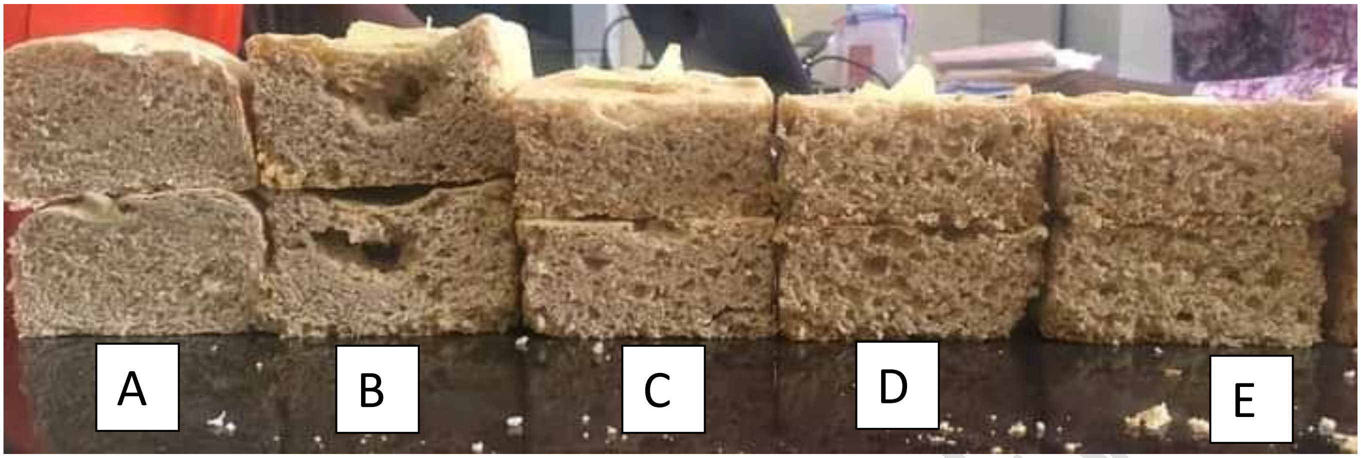

Plates 2: Longitudinal section of bread
*A=100% wheat, B=95% wheat, C=90% wheat, D=85% wheat, E=80% wheat, F=75% wheat

Table 4: Physical Properties of Wheat Orange Pomace Flour Bread

Material	**Loaf Weight (g)**	**Loaf Volume (cm^3)**	**Loaf Index**
100:0	$176.00^{d}\pm5.29$	$650.0^{f}\pm10.00$	$3.69^{f}\pm0.06$
95:5	$175.33^{d}\pm3.06$	$563.33^{c}\pm15.28$	$3.21^{e}\pm0.04$
90:10	$168.67^{c}\pm1.53$	$350.33^{d}\pm4.51$	$2.08^{d}\pm0.01$
85:15	$162.33^{b}\pm2.52$	$261.33^{c}\pm4.16$	$1.61^{c}\pm0.01$
80:20	$154.00^{a}\pm3.61$	$220.00^{b}\pm5.00$	$1.41^{b}\pm0.01$
75:25	$149.67^{a}\pm4.04$	$200.00^{a}\pm5.00$	$1.34^{a}\pm0.01$
P-Value	0.000	0.000	0.000

Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at (p=0.05)

Sensory Properties of wheat-orange/pineapple flour blend breads

The sensory quality of the wheat orange pomace bread is shown in Table 6. The average mean scores of the taste, color, odor, texture, and general acceptability of the blend breads ranged from

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7.95 – 6.85, 7.95 – 6.95, 7.95 – 6.50, 8.55 – 6.85 and 8.55 – 7.30 with increase in added orange pomace flour respectively. The blended bread products were generally accepted, but most preferred at 20% added orange-pineapple flour blend. The relatively high average means scores for the color could be due to attractive color of orange and pineapple flour blend.

General acceptability of the breads ranged from 7.30 to 8.55with the incorporation of orange-pineapple flour blend into wheat flour. Generally, there was slight improvement in sensory quality with increase orange-pineapple flour blend into wheat flour. The findings agreed with Okpala and Akpu(2014)who reported decrease in sensory quality with increased orange peel flour.

The mean scores of the crumb texture decreased from 7.95 to 6.95 with increase in the added orange-pineapple flour blend (0–25%). The effect was significant ($p<0.05$). The decrease could be due to development of closed or collapse crumbs as a result increase fiber content of the dough. The absence of gluten-protein has been identified as the cause of poor formation of the crumb (Ayo and Nkama 2007).

The average mean scores for the color decreased from 7.95 to 6.85 as shown in Table 5 The decrease was significant $p=0.05$. The low average mean scores of the color at high percentage of added orange-pineapple flour blend could be due to poor color development(pale white) as a result of too high moisture content which do not favor browning reaction.

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Table 5: Sensory Evaluation of Wheat Orange Pomace Flour Bread

Sample Wheat:OPF	**Colour**	**Texture**	**Odour**	**Taste**	**General Acceptability**
100:0	$7.95^{b}\pm1.156$	$7.95^{a}\pm1.1209$	$7.95^{c}\pm0.826$	$8.55^{b}\pm0.686$	$8.55^{b}\pm0.759$

95:5	7.85^{b}±1.18	7.40^{a}±1.273	7.30^{bc}±1.261	7.20^{a}±1.056	7.35^{a}±1.461
90:10	7.70^{b}±1.03	7.05^{a}±1.669	6.95^{ab}±1.118	6.95^{a}±1.050	7.40^{a}±0.940
85:15	7.25^{ab}±1.02	7.20^{a}±0.951	7.10^{ab}±1.252	6.95^{a}±1.538	7.45^{a}±0.887
80:20	7.30^{ab}±0.92	6.85^{a}±1.268	7.25^{abc}±0.967	7.50^{a}±1.000	7.50^{a}±0.827
75:25	6.85^{a}±1.42	6.95^{a}±1.191	6.50^{a}±1.147	6.85^{a}±1.089	7.30^{a}±0.923
P-Value	0.021	0.251	0.002	0.000	0.001

Values are means ± SD of triplicate determinations.
Means differently superscripted along the vertical columns are significantly different ($p<0.05$)

- **OPF:** Orange-pineapple flour blend

Conclusion

The result of the study showed that the addition of orange-pineapple pomace flour to wheat flour improved the nutrient content and sensory property of the produced bread. The wheat and orange-pineapple pomace flour blend breads though are generally acceptablebut the most preferred is that of 20% orange-pineapple flour blend, with corresponding increase in phenol, flavonoid and carotenoid at 6.3,62.4 and 134.7%, respectively.

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