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

ABSTRACT

The chemical, physical and sensory properties of wheat bread supplemented with orange-pineapple pomace were studied. The orange pulp flour and pineapple pomace were produced from fresh orange and pineapple and were mixed at ratio 1:1 to produce orange-pineapple pomace flour (OPPF) blend. The OPPF was substituted into wheat flour at 5, 10, 15, 20 and 25% to produce orange-pineapple -wheat flour (OPPWF) blends and 100 % wheat flour as the control. The OPPWF blends with the other ingredients [yeast(2%), sugar(7%), fat(3.5%) and salt(1%)] were mixed and fermented for 2hrs, kneaded, molded and baked at 160^{o}C to produce OPPWF blend bread. The chemical composition (phytochemical, mineral, vitamins), physical and sensory properties of the blend breads were determined using standard laboratory methods. The flavonoid, phenol, potassium, magnesium and vtamin A increased from 65.61 to 80.73 and 511.24 to 571.24, 76.93 to 188.85 and 37.345 to 39.49, 0.36 to 0.43mg/100g, respectively, with increase in added OPPF. 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 OPPF respectively. However the loaf weight, loaf volume and loaf volume index decreased from 176.00 to 149.67g, 650 to 200.00 cm$^{3/}$100g and 3.69 to 1.34, respectively with increase in the added OPPF (0 to 25%). The OPPWF blend breads were generally acceptable at respect to all assessed parameters or quality but most preferred at 20% added OPPF. The incorporation of OPPF into wheat flour had positive significant effects p= 0.05 on the chemical composition and sensory property but negative on the physical quality of blend bread.

Running Title: Effect of added 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". (Badifu et al., 2001, Abulude, 2005) 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 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, Ayo et al, 2023a). “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 orange and pineapple, is an important economic crop in many countries. In terms of annual production, sweet potato ranks as the fifth most important 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) 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” (Prasad et al., 2010, 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).

“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, Ayo et al., 2023b).

"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 contains 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, Dereje and Abera 2020).

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, Orafa et al., 2023).

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 were purchased from Wukari main Market, Wukari, Nigeria..

Preparation of samples

Production of orange Pomace flour: The fresh orange fruits were sorted, washed (using portable water), peeled (manually using knives), and the juice was extracted to obtain pomace (using Kenwood Juice Extractor). The pomace was oven dried (45-50^{o}C), milled(Attrition Mill), sieved

(0.4mm- to obtain orange pomace flour), packaged hermetically in polyethylene bag and stored at room temperature(38^oC) until usage(Khule *et al* 2019)

Production of pineapple pomace flour: The fresh matured and fully ripped pineapple fruits were washed, peeled (manually with knives), cut into slices and the juice extracted and filtered (Kenwood Jiuce Extractor) to obtain the pulp. extraction. The pulp was oven dried($45\text{-}50^oC$), milled (attrition Mill), sieved to obtain pomace flour. The flour was packaged and stored at room(38^oC) temperature (Thivani *et al* 2016)

Production of OPPW Flour Blends and Bread: The orange flour and the pineapple pomace were mixed together at ratio 1:1 to obtain OPPF blend**.** The OPPF substitute at 0, 5, 10, 15, 20, and 25 % into the wheat flour to produce OPPWF blends and were mixed with salt(1%), baking yeast(2%), and baking fat(3.5%) using Kenwood food mixer (120 rpm) for 10 minutes. The dough was 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 chemical composition of the OPPWF blend bread

Pproximate Composition

Determination Proximate Composition

The **OPPWF blend breads** were analyzed for moisture, crude protein, ash, crude fat, fiber and carbohydrate.

Moisture Content: The moisture content was determined as according to AOAC (2012) methods. A two (2.0) gram of sample was accurately weighed into a previously dried and weighed glass crucible. It was then dried in a thermostatically controlled forced convection oven (Gallenkamp, England) at 50°C for 18 hours. The glass crucibles were removed and transferred into desiccators for cooling and weighed. Moisture content was determined by difference and expressed as a percentage.

$$\%\ \text{Moisture content (M)} = \frac{W2 - W3}{W2 - W1} \times 100$$

W1 = Initial weight of crucible

W2 = Weight of crucible + sample before drying

W3 = Weight of crucible + sample after drying

Ash Content: "A two (2.0) gram of sample was accurately weighed into a pre-ignited and previously weighed crucible, placed in a muffle furnace (Gallenkamp, England) and heated for 2 hours at 600°C. After ashing, the crucibles were cooled below 200°C in a furnace for 20 minutes and further cooled to room temperature in a desiccator. The crucibles and their contents were weighed, and the weight was reported as percentage ash content" (AOAC, 2012)

$$\% \text{ Ash (dry basis)} = \frac{W3 - W1}{W2 - W1} \times 100.$$

Where:
W1 = Initial weight of empty crucible
W2 = Weight of crucible + sample before Charring and ashing
W3 = Weight of crucible + white ash

Crude fat Content: "A two (2.0) gram of sample was transferred into a paper thimble plugged at the opening with glass wool to evenly distribute the solvent as it drops on the sample during extraction and placed into a thimble holder. The sample packet was placed in the butt tubes of the soxhlet extraction apparatus. The extraction flask was placed on an oven for about 5min at 110°C then cooled and weighed. The fat was extracted with petroleum ether for 2-3hours by gentle heating. The extraction flask was dismantled and allowed to cool. The ether was evaporated on steam or water bath until no odour of ether remains. It was then allowed to cool to room temperature and the extraction flask and its extract were recorded" (AOAC, 2012).

$$\% \text{ Fat} = \frac{(W2 - W1) \times 100}{W}$$

Crude Fibre Content: "The sample from the crude fat determination was transferred into a digestion flask. A 200ml of boiling sulphuric acid (H_2SO_4) solution and anti- foaming agent (asbestos) was added to the flask and immediately connected to a digestion flask with a condenser and heated. The sample was boiled for 30 min during which the entire sample was allowed to become thoroughly wetted while any of it was prevented from remaining on the sides of the flask and out of contact with the solvent. After 30 min, the flask was removed; its contents filtered through linen cloth in a funnel and washed with boiling water until the washings were no longer acidic. The sample with asbestos was washed back into the flask with 200 ml boiling sodium hydroxide (NaOH) solution. The flask was reconnected to the condenser and boiled for 30 min. The content were again filtered through linen cloth in a funnel and washed thoroughly with boiled water, then with 15ml of 95% ethanol. The residue was transferred into previously dried and weighed porcelain, in an oven at 110^{o}C to a constant weight. It was then cooled in a desiccator and weighed. The crucible and its contents were ignited in a muffle furnace at 550^{o}C for 30 min until the carbonaceous matter has been consumed. Cooled in a desiccator and weighed" (AOAC, 2012).

% Crude fibre = the loss in weight after incineration x 100.

Protein content: 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". (AOAC, 2012)

%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.

Carbohydrate Content: Carbohydrate content was obtained by the difference: 100 - (MC + Ash + Crude protein + Fat + Crude fibre (Obinna-Echem and Robinson, 2019).

Determination of Phyto-chemical Composition of OPPWF blend bread

Flavonoids: The total flavonoids contents of sample was estimated by aluminium chloride colorimetric method as described by Hossain *et al.* (2011).0.5mL of sample was taken in a test tube and added water (10mL) and 5% sodium nitrate (0.5mL) were mixed together then 10% aluminium chloride (0.3mL) was added into the test tube and kept for 10 min for complete reaction. Finally, 5% sodium hydroxide (1 mL) and distill water (10 mL) was added to the test tube. The absorbance was measured at a fixed wavelength 510 nm (UV/VIS spectrophotometer T60U, Leicestershire, UK). The estimation of total flavonoids contents in sample was carried out in duplicate and the results was averaged. The total flavonoids were calculated using equation6.

X= (A. mo) / (Ao. m)............6

Where "X" is the flavonoid content, mg/g plant extract, "A" is the absorption of plant crude extract solution, "Ao" is the absorption of standard quercetin solution, "m" is the weight of crude drug extract in mg and "mo" is the weight of quercetin in the solution in mg.

Total carotenoids: The chlorophyll*a*, chlorophyll*b* and total carotenoids will be determined by the method described by Branisa *et al.*, (2014). Acetone-water mixture (4:1,v/v) will be used as a solvent. The absorbance maxima were read at 663.6 nm for chlorophyll*a*, 646.6 nm for chlorophyll*b*and470.0 nm for carotenoids. Contents of chlorophyll*a*, chlorophyll*b* and total carotenoids will be calculated using Equations 1, 2 and 3 respectively

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

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

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

Total phenolic: The method of Mahloko (2019) was adopted to determine the total phenolic content of the samples. The extracts were first prepared by refluxing 2 g of each sample with 20 ml of methanol containing 1 % HCl for 2 h at 60 °C, centrifuged for 20 min at 5000 centrifugal force (Centrifuge, CFGR-B580, China), supernatants acidified, added to Folin-Ciocalteu's reagent and 7.5 ml 15 % sodium carbonate solution and absorbance taken using spectrophotometer (Konica, XYLEM PerkinElmer) at 760 nm. The total phenolic content of each biscuit sample was obtained from the curve as gallic acid equivalent per gram of the sample

Determination of Mineral and Vitamin Composition of OPPWF blend bread

Magnesium content determination: Determination of Magnesium was done according to the method of AOAC (2016). Ash sample (2 g) was transferred into 3 test tubes and 3 ml of water added; 2ml of 10 % sodium tungstate, 2 ml of 0.67 N sulphuric acid were added, centrifuged for 5 minutes. Five (5 ml) of the supernatant was taken and 1 ml of water was added, 1 ml of 0.5 % titan yellow, and 1 ml of 0.1 % gum ghatti. 2 ml of 10 % sodium hydroxide was added and the absorbance taken at 520 nm against a blank.

Determining of Potassium content: Potassium content was determined as described by Ndubuisi (2009). 2 mL of sample was mixed with 2 mL of sodium cobalt nitrate, allowed to stand for 45 minutes, 2 mL of water was added and centrifuged for 15minutes. The supernatant was mixed with 2 mL of 70 % ethanol, centrifuged (5 min), supernatant boiled (10 min), 1 ml of 1 % choline hydrochloride with 1 ml potassium ferro-cyanide and 2 mL of distilled water was added to the extract and absorbance was determined at 620 nm(colorimeter). The potassium 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 concentrated of standard solution, $D_{f\ is}$ Dilution factor, A_{ss} is absorbance of standard solution and S_v is sample volume.

***Determination of vitamin* A content**: Vitamin A content was determined using the scalar analyzer method (AOAC, 2016). Five grams of each sample was homogenized in 5 ml normal ethanoic sodium hydroxide solution. The homogenate was filtered and made up to 100 ml with the extract solution. A10 ml aliquot of the extract was dispensed into a flask and 10mls of potassium dichromate solution added. The resultant solution was incubated for 15mins at room temperature (25-33^{0}C). The absorption was read from the spectrophotometer at 360nm using a reagent blank to standardize the instrument at zero.

Determination of Physical Properties of OPPWF blend bread

Determination of loaf volume: Loaf volume of the blend bread 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 clean 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):

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

Weight of loaf sample

Evaluation of Sensory Properties of OPPWF blend bread

The bread samples were evaluated for colour, taste, odour and texture by twenty (20) untrained 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 bread. 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.

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

Chemical Composition of OPPWF blend bread

Proximate Composition: The mean values of the proximate composition of the OPPWF 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%, respectively, with increase in added OPPF. The effect of the added OPPF 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% OPPF flour blend (75:25) had the highest moisture content value (34.41%). All samples generally had relatively low moisture content, which suggest improved shelf life of the produces bread. The moisture content of the OPPWF blend was higher compared with the 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 relative increase in the moisture content with increase in the added OPPF could be due to the relatively high fibre content peculiar to pulps from fruits. This effect could also negatively affect the storage shelf life of the OPPWF bread as the presence of moisture could encourage the growth of microorganisms and biochemical reactions including hydroxyl rancidity.

The protein content of the OPPWF 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 relative decrease in the level of protein content with increase in the added OPPF could be due to the low level of protein content in pulps of fruits.

The fat content of OPPWF blend bread decreased from 8.35 to 7.94% with increase in the added OPPF blend. The effect of the substitution was not significant on the fat content, $p<0.05$. The decrease in the level of fat content with increase in the added OPPF could be due to the low level of fat content generally in pulps of fruits. The low level of fat content could be an advantage as it reduces the possibility of rancidity, hence improve the shelf life of the product.

The ash content of the OPPWF 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 and could add value to the product. 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 OPPF. 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 OPPWF bread decreased with increasing OPPF blend from 79.78 to 58.07%. The 100% wheat flour (100:0) bread had the highest carbohydrate content. The effect of the added OPPF blend was significant on the carbohydrate content of the products, $p<0.05$. The relative decrease could be due to the low carbohydrate content of pulps from fruits.

Table 1: Nutritional Composition of OPPWF 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	8.35^{a}±1.21	9.05^{a}±0.12	68.25 ^{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	66.66^{a}±1.34	2.90^{a}±0.17	4.69^{a}±0.13	276.83
85:15	34.29^{a} ±0.40	8.04^{a}±0.38	8.90^{a}±2.58	64.60 ^{a}±2.60	2.94±0.07^{a}	4.75 ^{a}±0.06	278.31
80:20	34.35^{a}±0.43	8.00^{a}±0.27	8.70^{a}±1.36	62.40^{a}±2.17	2.96^{a}±0.08	5.25^{a}±1.02	273.70
75:25	34.41^{a}±0.47	7.94 ^{a}±0.17	8.60^{a}±0.14	58.07 ^{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

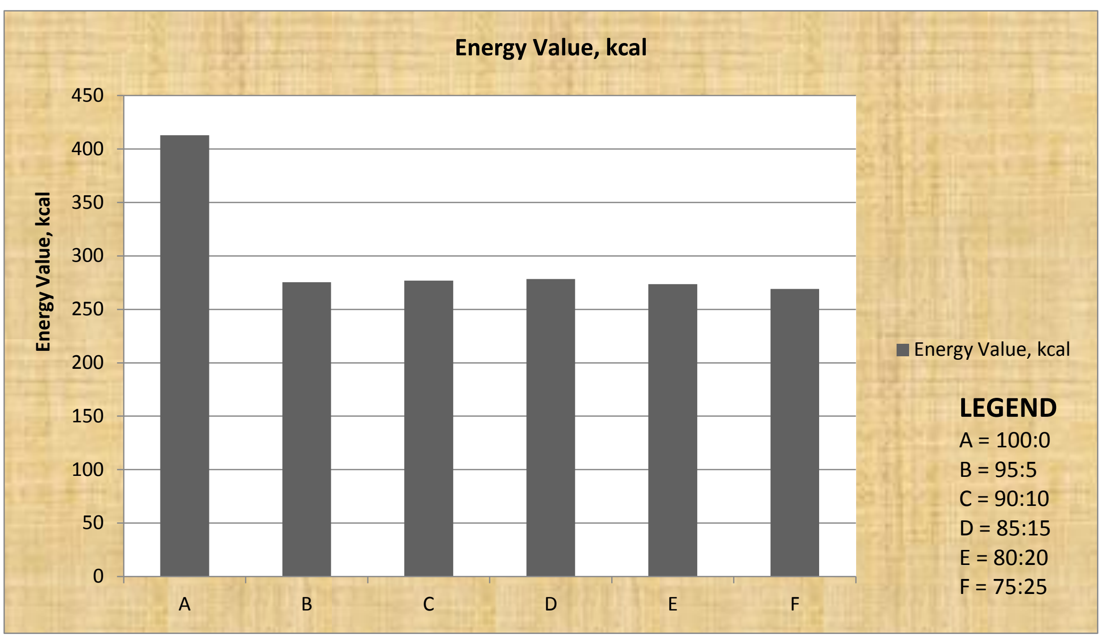


Figure 1: Energy content of OPPWF blend bread.

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

Phytochemical Composition of OPPWF blend bread.

The phytochemical composition of OPPWF blend 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 OPPF blend flour.

The relative increase these phytochemicals with added OPPF could be due to their inherent presence in fruits and could add value to the food products. Carotenoid has been identified to improve the recovery of night blindness and loss of appetite. Flavonoids are anti-oxidants, and could lower cholesterol, inhibit tumor formation and protect against cancer and heart disease (Adebowale et al., 2008). Phenols such as tannins form insoluble complexes with proteins and could reduce their digestibility and palatability (Shahidi and Naczk, 2004, Ayo et al., 2023a).

Table 2.: Phytochemical Composition of OPPWF blend bread

Sample Wheat:OPPF	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

- **OPPF:** Orange-pineapple flour

Mineral (mg/100g) and Vitamin A composition of OPPWF blend breads.

The mineral composition of wheat orange pomace flour blend bread is shown in Table 3. The potassium and magnesium content of the OPPF blend bread increased from 76.935 to 188.85 and 37.345 to 39.495mg/100g, respectively, with increase in added OPPF blend flour. The increase is significant, p< 0.05.

The increase in the minerals could be due to the relatively high mineral content inherent in OPPF blends. The relative increase in the potassium and magnesium level could be an advantage to the consumer of the blend food products. Potassium has been noted to improve the development of bone and blood composition in man (Mason, 2016, Ayo et al., b) aid in moving nutrients into cells and waste products out of cell and helps regulate heartbeat while magnesium helps in regulating muscle, nerve function, blood sugar levels and blood pressure.

The vitamin A content of the OPPWF blend bread increased from 0.35 to 0.43mg/100g, with increase in the added OPPF flour blend. The increase is significant, p=0.05. The increase in the vitamin A, could be due the its relative high content generally in fruits and fruit by-products. Vitamin A could add value to the food products as it could help in maintaining healthy vision, normal function of immune system, and also in the proper growth and development of babies in the womb.

Table 3: Mineral and Vitamin Composition of OPPWF Blend Bread

Sample Wheat: OPPF	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 OPPWF blend breads

The physical property of the OPPWF blend bread is shown in Table 4. The loaf weight of the 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 OPPF (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 OPPF. The findings agreed with work of Akubor (2016) who observed decrease in loaf volume and attributed it to low protein contents of the flours due to dilution of wheat flour which resulted in low gluten content (Adeboye *et al.*, 2013). Gluten is responsible for dough volume increase as a result of its extensibility. During bread production, gluten form networks which increases the volume of dough as a result of action of yeast breaking down of the sugar to produce CO_2 which cause rising or increase in volume (Hallen *et al*. 2004).

The addition of the OPPF the wheat flour causes the gluten to be diluted, hence weaking its elasticity ability and resulting low volume of the product as seen in the Plate 1. The OPPWF blend breads (Plate 1 samples B - F) are relatively smaller in volume compared to the 100% wheat bread (Plate 1 sample A). The dilution effect of the added OPPF is also been observed to cause the production of air spaces and irregular particles within the crumb of the OPPWF loaf as shown in Plate 2(Samples B-F).

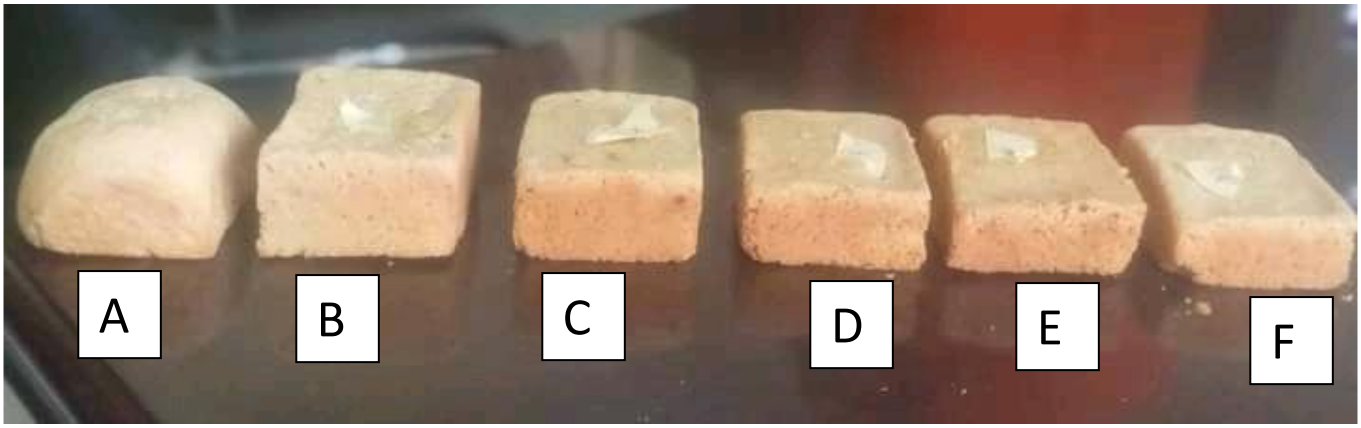
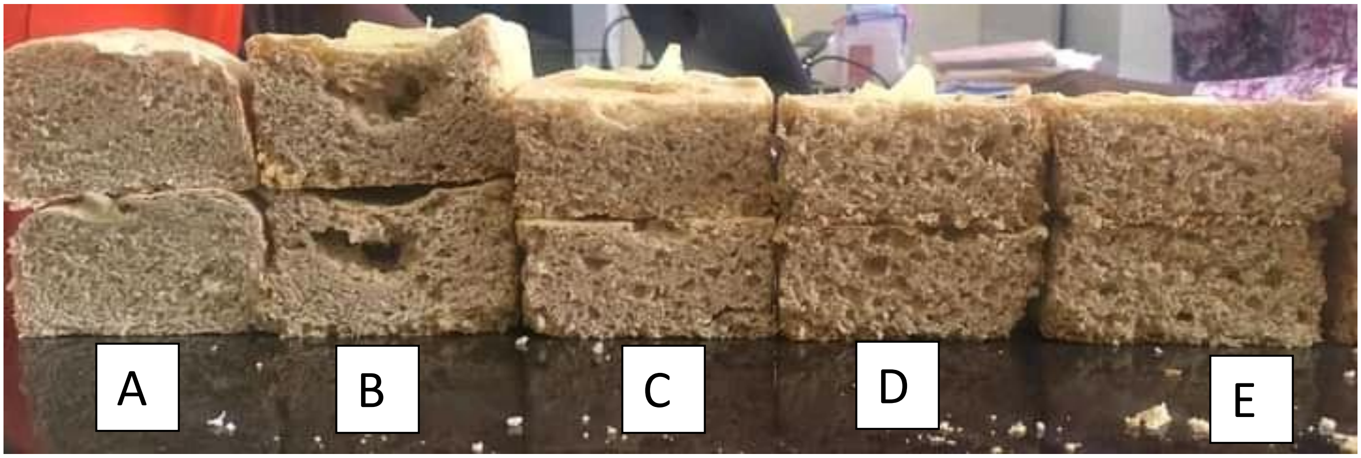


Plate 1: Various appearances of Breads
A=100% wheat, B=95% wheat, C=90% wheat, D=85% wheat, E=80% wheat, F=75% wheat



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 OPPWF Bread

Sample Wheat:OPPF	Loaf Weight (g)	Loaf Volume (cm^3)	Loaf Index
100:0	176.00 ^{d}±5.29	650.0 ^{f} ±10.00	3.69 ^{f}±0.06
95:5	175.33 ^{d}±3.06	563.33 ^{c}±15.28	3.21 ^{e}±0.04
90:10	168.67 ^{c}±1.53	350.33 ^{d}±4.51	2.08 ^{d}±0.01
85:15	162.33 ^{b}±2.52	261.33 ^{c}±4.16	1.61 ^{c}±0.01
80:20	154.00 ^{a}±3.61	220.00 ^{b}±5.00	1.41 ^{b}±0.01
75:25	149.67 ^{a}±4.04	200.00 ^{a}±5.00	1.34 ^{a}±0.01
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 OPPWF blend breads

The sensory quality of the OPPWF blend bread is shown in Table 5. 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 – 6.95, 7.95 – 6.50, 8.55 – 6.85 and 8.55 – 7.30 with increase in added OPPF, respectively. The blended bread products were generally accepted, but most preferred at 20% added OPPF blend. The relatively high average means scores for the color could be due to attractive color and flavor imparted on the crumbs of OPPWF blend bread by the added OPPF.

General acceptability of the breads ranged from 7.30 to 8.55with the incorporation of OPPF blend into wheat flour. Generally, there was slight improvement in sensory quality with increase orange-pineapple flour blend into wheat flour. The findings not agreed with Okpala and Akpu (2014) who reported decrease in sensory quality with increased orange peel flour which could be due to the stringent component inherent to orange.

The mean scores of the crumb texture decreased from 7.95 to 6.95 with increase in the added OPPF blend (0–25%). The effect was significant ($p<0.05$). The absence of gluten-protein has been identified as the cause of poor formation of the crumb as observed by Ayo and Nkama (2007).

Table 5: Sensory Evaluation of Wheat Orange Pomace Flour Bread

Sample Wheat:OPPF	**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	$7.85^{b}\pm1.18$	$7.40^{a}\pm1.273$	$7.30^{bc}\pm1.261$	$7.20^{a}\pm1.056$	$7.35^{a}\pm1.461$
90:10	$7.70^{b}\pm1.03$	$7.05^{a}\pm1.669$	$6.95^{ab}\pm1.118$	$6.95^{a}\pm1.050$	$7.40^{a}\pm0.940$

85:15	$7.25^{ab}\pm1.02$	$7.20^{a}\pm0.951$	$7.10^{ab}\pm1.252$	$6.95^{a}\pm1.538$	$7.45^{a}\pm0.887$
80:20	$7.30^{ab}\pm0.92$	$6.85^{a}\pm1.268$	$7.25^{abc}\pm0.967$	$7.50^{a}\pm1.000$	$7.50^{a}\pm0.827$
75:25	$6.85^{a}\pm1.42$	$6.95^{a}\pm1.191$	$6.50^{a}\pm1.147$	$6.85^{a}\pm1.089$	$7.30^{a}\pm0.923$
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 ($p<0.05$)

- **OPPF:** Orange-pineapple flour blend

Conclusion

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

REFERENCES

Abulude, F.O. (2005). Distribution of selected minerals in some Nigerian white bread. Nigerian *Nigerian Food Journal* Vol. 23 2005: 139-143

Adeboye AS, Babajide JM, Shittu TA, Omemu AM and Oluwatola OJ. (2013). Effect of honey as partial sugar substitute on pasting, consumer preference and shelf stability of cassava-wheat composite bread. ***Nigerian Food Journal*** **31(1):13-22 DOI: 10.1016/S0189-7241(15)30051-5**

Adebowale AA, Sanni LO, Awonarin SO. (2008). Effect of texture modifiers on the phytochemical and sensory properties . **Food Science and Technology International. 2008;11:373-382**

Akubor, P.I. (2020). Chemical composition, physical and sensory properties of bread incorporated with raw and boiled African fan palm (Borassus aethiopum) root flours. ***International Journal of Agriculture Veterinary Science*****,2(3):125-136**

Akubor, P.I. and Obiegbuna, J.E. (2014). Effect of processing methods on the quality of flour and bread from African breadfruit kernel flour. **Food Science and Quality Management, 24:32-41.**

Akubor, P.I (2016). Functional properties and biscuit making potential of soybean and cassava flour blend. ***Plant Foods for Human Nutrition*, 56:1-12.**

AOAC. Official Methods of Analysis (2012). 17th Ed. Association of Analytical Chemists Washington D.C. pg 345

AOAC. (2016). Official Method of Analysis. Association of Official Analytical Chemists, International 20th Edition, Washington D.C., U.S.A.

Arosemena, A.; DePeters, E. J. and Fadel, J. G. (1995). Extent and variability in nutrient composition within selected by-product feedstuffs. **Animal Feed Science Technology, 54:103-120.**

Ayo, J.A. and Agen, E. (2020). Quality Evaluation of Sweet Potato Acha Flour Blend Biscuits. *Asian Food science Journal* 16(4): 24-32.

Ayo, J.A., Ibrahim, A.N. and Duku, N.A (2023). Production and Quality Evaluation of Acha-Orange Fleshed Sweet Potato-Based Biscuit Enriched with Grasshopper (*Zonocerus Variegatus*) Flour. Vol. 41(2): 47 – 57

Ayo J.A; Ayo V.I; Oyedele D.S; Ankeli J.A and Joshua N (2023).Quality Evaluation of Sorghum-Malted Cowpea flour Blend for Biscuit Making Using Albino Rat to Test its Suitability for Consumption. *Asian Journal of Food Research and Nutrition Volume 2(4): 635-651*

Ayo J,A; Ojo M.O; Ayo V.I; Ankeli J.A and Vongfa A.C (2023). Effects of Acha-Cowpea-Carrot Based Couscous on the Hematological and Liver profile of Wistar Rat, *Asian Journal of Food Research and Nutrition Volume 2(4): 593-611*

Ayo JA, Ayo VA, Popoola C, Omosebi M,Joseph M. (2014). Production and evaluation of malted soybean-acha composite flour bread and biscuits. **African Journal of Food Science and Technology;5(1):21-28.**

Ayo JA, Ikuomola DS, Sanni, TA Esan YO, Ayo VA, Ajayi G (2010). Evaluation of nutritional quality of acha composite bread. **Nigerian Food Journal. 28(2):132 138**.

Ayo JA, Nkama I (2007). Effect of acha flour on the quality of bread. **Int. J. Food Properties. 7:561-569.**

Badifu, I.O., Chima, C.E., Ajayi, Y.I. and Ogoro, A.F. (2005). Influence of mango mesocarp flour Supplementation on micronutrient, physical and organoleptic qualities of wheat based bread. **Nigerian Food Journal 23: 59 – 68.**

Bonsi E., Chibuzo E., Robert Z. (2014) the preliminary study of the acceptability of Ghana bread made with orange sweet potato puree. **J Hum Nutr Food Sci.;2(4):1-5. doi:10.13140/RG.2.1.2776.5523.**

Dereje, B. and Abera, S. (2020). Effects of pre-treatment and drying Methods on quality of dried mango(*Magnifera indica* L.) slices. *Journal of cogent Food and Agriculture* 6:174-181.

Dhingra, D.; Michael, M.; Rajput, H.; Patil, R. T. (2011). Dietary fibre in foods: A review. **Journal of Food Science and Technology** 4:34-45

Eddy, N. O., Udofia, P. G. and Eyo, D. (2007). Sensory evaluation of wheat/cassava composite bread and effect of label information on acceptance and preference. **African Journal of Biotechnology, 6(20): 2415 – 2418.**

Ezejiofor, T.I.; Eke, N.V.; Okechukwu, R.I.; Nwoguikpe, R.N. and Duru, C.M., (2011). Waste to wealth: Industrial raw materials potential of peels of Nigerian sweet orange (*Citrus sinensis*). ***African Journal of Biotechnology*** **10(33):6257-6264**.

FAO, (2004). Food and agriculture statistics data 2005. Food and Agricultural Organisation of the United Nations, 00100, Rome, Italy..

FAO. (2016) Definition and classification of commoditie: Cereals and cereal products. **http://www.fao.org/es/faodef/fdef01e.htm. Published 1994. Accessed April 23**.

Fernández-ginés, J.M., Fernádez-lópez, J., Sayas-barberá, E., Pérez-alvarez, J.A (2003). Effects of storage conditions on quality characteristics of bologna sausages made with citrus fibre. **Journal Food Sciience, 68:710-715**.

Hallén, E.; İbanoğlu, Ş.; Ainsworth, P. (2004) Effect of flour addition on the rheological and baking properties of wheat flour. **J. Food Eng.,** ***v.63, n.2, p.177-184, 2004***.

Kamal M. S., Islam M. N., Aziz M. G. (2013) Effect of variety and effect of sweet potato flour of two lo cal varieties on quality of breads. **J Bangladesh Agril Univ. x; 11(2):301-306. doi:10.1007/s13197-010-0217-8.**

Keswet, L.M.; Ayo, J.A.; Bello, C.B. The effect of four Nigerian wheat flours on the loaf volume and sensory quality of bread. **Journal of Nutrition and Food Science 2003, 33 (1), 27–45**.

Khule, G.D., Khupase S.P. and Giram K.K. (2019). Development and quality evaluation of orange pomace fortified biscuits. *Journal of Pharmacognosy and Phytochemistry*, 8(3), 3695-3701.

Lasekan, O. (1994). Chemical composition of acha (Digitaria exilis) flour. **Nigerian Food Journal 12: 19 – 23.**

Manthey, A. and Grohmann, K. (2001). Phenols in citrus peel byproducts: concentrations of hydroxycinnamates and polymethoxylated flavones in citrus peel molasses, **Journal Agriculture Food Chemistry,49:3268.**

Mayo, B., Rodríguez, J., Vázquez, L., and Flórez, A. B. (2021). Microbial interactions within the cheese ecosystem and their application to improve quality and safety. *Foods* 10:602.

Mahloko, L.M., Silungwe, H., Mashau, M.E. and Kgatla, T.E. (2019). Bioactive compounds, antioxidant activity and physical characteristics of whaet-prickly pear and banana biscuits. *Heliyon,* 5(1): 1- 10.

Ndubuisi LC. 2009. Evaluation of food potentials of tigernut tubers (*Cypers esculentus*) and its products (milk, coffee and wine). University of Nigeria, Nsukka, Nigeria. pp 76-84. Google

Okpala, L. C. and Akpu, M. N. (2014). Effect of Orange Peel Flour on the Quality Characteristics of Bread. **British Journal of Applied Science and Technology,4(5):823-830.**

Olapade A.A, Aworh, OC ,Oluwole OB(2011). Quality attributes of biscuit from acha *(Digitaria exilis)* flour supplemented with cowpea (*Vigna unguiculata)* flour African Journal of Food Science and Technology., 2 (2011), pp. 198-203

Orafa, P.N, Ogundele, O.O, Ayo, J.A. and Zephaniah, A. (2023). Quality Evaluation of Acha-based Biscuit incorprated with defatted melon seed cotlydon, FUW Trends in Science & Technology Journal, Vol. 8(2): 247 – 253

Oluwole and Olapade, 2011. Effect of extrusion cooking of white yam *(Dioscorea rotundata)* and bambara nut *(Vigna subterranean)* blend on some selected extrudate parameters Food and Nutrition Science, 2 (2011), pp. 599-605

Prasad, K.N.; Chew, L.Y.; Khoo, H.E.; Kin Weng Kong; Azrina A. and Ismail, A. (2010). Antioxidant Capacities of Peel, Pulp, and Seed Fractions of *Canarium odontophyllum* Miq. Fruit**. Journal Biomedical Biotechnology 4: 45-62**

Shahidi F, Naczk M. (2004) Extraction and Analysis of Phenolics in Food. Journal of Chromatography, 1054, 95-111.

Thivani,M, Mahendran, T, Kanimoly M (2016).Study on the physico-chemical properties, sensory
attributes and shelf life of pineapple powder incorporated biscuits. RUHUNA JOURNAL OF SCIENCE Vol. 7: 32- 42,

Tiwari, RK and Pandey J.P (2012). Effect of Some Botanicals on Hemocytes and Molting of *Papilio demoleus* Larvae. *Journal of Entomology, 9: 23-31.*

Topuz ,A, Topakci, M , Canakci M, Akinci I, Ozdemir F(2005), Journal of Food Engineering 66 (2005) 519–523

Wardlaw, H.M and Hampin, J.J.(2007). Perspectives in nutrition.7thedn. New York. McGraw Hill

Wolfe, K.E and Liu, R.H. (2003). Apples peels as value added food ingredient. *J. Agric and Food Chem* 51:1676-1683.