Food and Nutrition Sciences, 2021, 12, 332-341
https://www.scirp.org/journal/fns
ISSN Online: 2157-9458
ISSN Print: 2157-944X

Quality Evaluation of Novel Biscuits Made from Wheat Supplemented with Watermelon Rinds and Orange Pomace Flour Blends

A. O. Ogo[1,2*], D. J. Ajekwe[1], D. E. Enenche[1], G. O. Obochi[1,2]

[1]Department of Biochemistry, College of Health Sciences, Benue State University, Makurdi, Nigeria
[2]Center for Food Technology and Research, Benue State University, Makurdi, Nigeria
Email: *oogo@bsum.edu.ng

How to cite this paper: Ogo, A.O., Ajekwe, D.J., Enenche, D.E. and Obochi, G.O. (2021) Quality Evaluation of Novel Biscuits Made from Wheat Supplemented with Watermelon Rinds and Orange Pomace Flour Blends. *Food and Nutrition Sciences*, **12**, 332-341.
https://doi.org/10.4236/fns.2021.123026

Received: September 14, 2020
Accepted: March 27, 2021
Published: March 30, 2021

Abstract

This study was designed to bridge gap in nutritionally skewed available biscuits and the high volume of agricultural waste generated by investigating the quality of biscuits prepared from wheat base, supplemented with waste from watermelon rinds and orange pomace as possible nutritious alternatives. Biscuit samples were respectively produced from blends of wheat, watermelon rind and orange pomace in the following ratio 100:0:0; 90:5:5; 80:10:10; 70:15:15 and 60:20:20, labelled samples A, B, C, D and E. Functional, proximate, mineral and sensory properties of the formulated biscuit samples were carried out using standard analytical procedures. The results showed that proximate composition of samples B - E significantly increased ($p < 0.05$) except for carbohydrate content when compared with sample A used as control. There were also significant increases ($p < 0.05$) in mineral contents of supplemented samples compared to control. The result of the sensory evaluation showed that wheat flour can be substituted with watermelon rind and orange pomace flours up to 10% without adversely affecting the overall quality attributes of the biscuits. These results indicate the robustness of food value addition as an effective means of improving nutritional quality of biscuits while contributing to waste management in the agricultural value chain.

Keywords

Biscuit, Watermelon Rind, Orange Pomace, Nutritional Value, Value Addition, Waste Management

1. Introduction

Recent estimates put Nigeria's biscuit consumption at about five hundred metric tons annually, which is mainly derived from wheat flour. Additionally, 25% - 30% of waste produced from the processing of fruits and vegetables is in the form of pomace, peels, and seeds [1] and is grossly underutilized [2]. However, these by-products are important sources of sugars, minerals, organic acids, fibre, and phenolic compounds that have a wide range of nutritional sensory qualities [3].

Many fruits including watermelon (*Citrillus lanatus*) and oranges (*Citrus sinensis*) are only consumed in part with the fleshy portions of eaten raw processed into juice while the rinds, seeds and pomace are often thrown away. During orange juice production for instance, only around half of the fresh orange weight is transformed into juice [4], generating huge amounts of residues (peel, pulp, seeds) known as orange pomace which is rich in nutrients and fibre. This high volume of waste is in most cases, spread on soil in areas adjacent to the production site for use as a raw material in animal feeds or just burnt away. The latter method of waste handling significantly contributes to environmental pollution with its attendant health hazards. Interestingly, these by-products from both watermelon and orange pomace can be used to value-add wheat as composite flour for quality improvement.

Composite flour refers to the mixture of different concentrations of non-wheat flours from cereals, legumes, roots and tubers with wheat flour or can be a mixture of flours other than wheat flour [5]. The concept of using composite flour in bakery industry is not particularly new giving that the practice has been the subject of several studies [6]. Baked foods especially, biscuits are ready to eat foods used at home. Biscuits are popular baking products, consumed by a wide range of populations, due to their ready-to-eat nature, varied taste, affordability and more importantly, the ability to supply instant energy required for activity [7]. Because of the advantages that have been derived from these composite flours, such as improved fibre content, there is continuous clamour among food scientists to utilize more flours that are obtained from these by-products with the commonly known wheat flour in other to reduce waste, improve biscuit nutritional and health benefits and reduce cost of biscuits production since these flours are relatively cheaper than the commonly used wheat flour. This study was aimed at investigating the nutritional cum functional properties of biscuit made from combining underutilized materials of water melon rind and orange pomace with wheat base for improved utilization of by-products.

2. Materials and Methods

2.1. Sample Collection and Preparation of Flour

Watermelon rinds and orange pomace were obtained from watermelon (*Citrullus lanatus*) and orange (*Citrus sinensis*) fruits purchased from the popular Railway Market (also called fruit market) in Makurdi Benue State, Nigeria. The watermelon rinds were separated from the fresh and ripe watermelon fruits, cut into small pieces with a sharp stainless-steel knife and washed thoroughly with distilled water to remove dirt. The cleansed rinds were sliced into smaller sizes for ease of drying. The sliced rinds were oven dried at 50˚C for 24 h to a constant weight, and ground with a blender. The powder was sieved through a 40 mm mesh sieve, packed in an air tight container and stored till further use. Similarly, fresh orange fruits were washed to remove dirt and juice extracted using juice extractor after which the pomace was obtained. The pomace was dried in an oven at 50˚C for 24 h ground, sieved using 40 mm mesh sieve and packed in an airtight container till further use. This study was carried out at the Food Laboratory, Center for Food Research and Technology, Benue State University, Makurdi, between October and November, 2019.

2.2. Blend Formulation and Preparation of Biscuits

The blend ratios for the biscuit were formulated using the modified methods previously described by Monisha *et al.* [8]. The wheat flour, watermelon rind flour and orange pomace flour were weighed using a digital weighing balance and made in the following ratio: 100:0:0 (sample A, regarded as control sample), 90:5:5 (sample B), 80:10:10 (sample C), 70:15:15 (sample D) and 60:20:20 (sample E) respectively. Biscuits were produced according to Nwosu and Akubo protocol [9] by weighing and mixing the ingredients (composite flour, sugar, salt and baking powder, milk, egg and water) together until dough was formed. The resultant dough was kneaded and rested for about 5 min. The rested dough was rolled out into sheets and cut into different shapes, using round biscuit cutters of 3 cm diameter. The dough was placed on well-greased baking trays and baked for 20 minutes in an oven pre-heated to 160˚C, allowed to cool, packaged in high density polyethylene bags in an air tight container for analysis.

2.3. Determination of Proximate Composition

Proximate analysis was carried out according to standard procedures of AOAC [10]. Moisture content was determined in a hot-air circulating oven (Gallenkamp, UK). For total ash content, samples of known weights were incinerated at 550˚C in a muffle furnace (Gallenkamp, UK). Crude fat determination was done by completely extracting a known weight sample in petroleum ether while protein content was determined using the micro Kjeldahl method. The carbohydrate content was obtained by difference [11] using the formula:

$$\begin{aligned}&\%\ \text{Carbohydrate}\\&=100-\left(\text{Moisture}+\text{Ash}+\text{Crude protein}+\text{Crude fat}+\text{Crude fibre}\right)\end{aligned} \tag{1}$$

2.4. Determination of Mineral Composition

Mineral elements were determined using atomic absorption spectrophotometer as described by Shahidi *et al.* [12]. The samples were ashed in a muffle furnace at 550˚C and digested using 5 ml $HNO_3/HCl/H_2O$ (1:2:3). The concentration of each element in the sample was calculated as percentage of dry matter.

Phosphorus content of the digest was determined colorimetrically according to the method described by Fila *et al.* [13]. To 0.5 ml of the diluted digest, 4 ml of demineralised water, 3 ml of 0.75 M H_2SO_4, 0.4 ml of 10% $(NH_4)6MO_7O_{24}\cdot 4H_2O$ and 0.4 ml of 2% (w/v) ascorbic acid were added and mixed. The solution was allowed to stand for 20 minutes and absorbance reading was recorded at 660 nm.

2.5. Determination of Functional Properties

2.5.1. Determination Bulk Density

Bulk density was determined for each of the formulated samples using the method described by Onabanjo and Ighere [14]. The mass of empty 10 ml measuring cylinder was weighed. Then, each sample was slowly filled into the l0 ml measuring cylinder. The bottom of the cylinder was gently tapped on a laboratory bench to a constant volume; the mass of the cylinder with sample was also weighed. The bulk density was calculated as mass per unit volume of the sample (g/ml):

$$\text{Bulk density}\left(\text{g/ml}\right)=\frac{W_2-W_1}{V} \tag{2}$$

where;

W_1 = weight of empty cylinder (g)

W_2 = weight of cylinder + sample (g)

V = Volume of cylinder occupied by the sample (ml)

2.5.2. Determination of Water Absorption Capacity

Water absorption capacities of the formulated samples were determined using the method reported by Adeoyo *et al.* [15]. One gram (1 g) of the flour sample was weighed into conical graduated centrifuge tube of known weight and mixed with 10 ml of distilled water and allowed to stand for one minute. The tube was centrifuged at 5000 rpm for 30 min. The volume of free water (the supernatant) was discarded and the tube with its content was reweighed as water absorbed per gram of sample. The gain in mass was the water absorption capacity of the flour sample. Absorption capacity was expressed in grams of water absorbed per gram of sample.

$$\text{WAC}=\frac{\text{Density of water}\times\text{Volume absorbed}}{\text{Weight of sample}} \tag{3}$$

2.5.3. Determination of Oil Absorption Capacity

Oil absorption capacity (OAC) was determined using the method reported by Oyeyinka *et al.* [16]. One gram of flour sample was mixed with 10 ml of refined soybean oil and the mixture was allowed to stand at room temperature for 30 min and then centrifuged at 2000 g for 30 min. The oil absorption capacity was calculated as gram of oil bound per gram flour.

2.6. Sensory Evaluation

Sensory evaluation of the biscuits was carried out in a Sensory Evaluation Laboratory under appropriate conditions by a 20-member trained panellist. The panel members were trained on the meaning of the sensory descriptors or terms such as general appearance, flavour, colour, taste, texture and overall acceptability for biscuits. These selected terms were used during a mock evaluation on a 9-point Hedonic Scale, with the corresponding descriptive terms ranging from 9 "like extremely" to 1 "dislike extremely". The biscuit samples were 3-digit coded and served in a randomized order, and tap water was presented to the judges to rinse their mouth in between testing [17].

2.7. Statistical Analysis

Data obtained were analysed using analysis of variance (ANOVA) at 95% significance level and multiple comparisons with Fisher's LSD test using IBM SPSS 20 statistical software. Significance was accepted at $p < 0.05$.

3. Results and Discussion

3.1. Proximate Composition

The proximate composition of the biscuit samples is given in **Table 1**. Moisture content of the biscuit samples ranged from 10.27% - 14.20% (B - E) compared to 9.27% of the control sample A. This significant ($p < 0.05$) increase in moisture of formulated biscuit could be attributed to the increase in fibre content as this has the ability to bind water molecules and promote retention of water but prevent evaporation during baking. The values in the present study are similar to previous findings [18], which attributed the difference to the higher level of moisture content in watermelon rinds and orange pomace. The ash content which is indicative of the level of mineral content of a food material significantly increased ($p < 0.05$) from 4.11% - 14.75% as substitution with water melon rind and orange pomace flours was made in samples B - E compared to A of 1.31%. These results which are in agreement with those of [19] [20] suggest that the blends of watermelon rinds and orange pomace must have been responsible for the improved mineral content of the novel biscuit products in contrast to the sample made from wheat flour alone. Interestingly too, addition of blends of water melon and orange pomace flours significantly decreased ($p < 0.05$) carbohydrate content from about 66% in sample A to below 20% as the ratio of the substitutes increased in a manner reported by Olaitan and colleagues [21]. In the same vein, crude fat content significantly increased ($p < 0.05$) in samples that were substituted with water melon and orange pomace compared to biscuits made from wheat flour only. This increment may be advantageous in compensating for the decrease in carbohydrate contents of substituted samples in terms of energy supply to consumers. Crude fibre contents increased up to 21.22% in samples made from wheat flour supplemented with blended water melon and orange pomace flours from 1.30% in sample A biscuit made with only wheat flour, making these products potentially beneficial for use as after meal for control of postprandial glucose response akin to what was previously reported [22]. In contrast, increase in substitution with the formulated blends resulted in marginal reduction in crude protein content of the biscuits from 11.80% in sample A to about 10% among samples B - E. The protein contents here are low but comparable with those obtained from similar biscuit products, which were made from orange pomace and wheat flour only [23].

3.2. Mineral Composition

The result of mineral analysis of biscuit samples is presented in **Table 2**. The values obtained for Ca, Fe, P and Na showed significant increases while Zn and Mg decreased marginally as the ratios of substituted materials increased. These elements play significant roles in metabolic processes relevant to survival of living organisms, thus inclusion in the biscuits has greatly improved the nutritional value necessary for optimal health. Although the control sample made with only wheat flour had the highest amount of zinc, however, the concurrent presence of anti-nutritional factors in wheat may inhibit bioavailability and proper utilization of the recorded levels. These results are similar to the findings of Vanin *et al.* [24], which showed lower values of mineral composition embedded in the ash content. The difference in the results may be attributed to the use of additional water melon rind flour in this study, which is known to be rich in some elements as opposed to the use of only orange pomace and wheat in preparation of biscuit cookies.

Table 1. Proximate composition of biscuit samples prepared from a blend of wheat flour, watermelon rinds and orange pomace.

	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)	Carbohydrate (%)
A	$9.27^{a} \pm 0.00$	$1.31^{a} \pm 0.02$	$8.39^{a} \pm 0.02$	$11.80^{b} \pm 0.16$	$1.30^{a} \pm 0.01$	$66.91^{e} \pm 0.23$
B	$10.27^{b} \pm 0.00$	$4.11^{b} \pm 0.19$	$8.53^{a} \pm 0.00$	$11.79^{b} \pm 0.21$	$1.67^{a} \pm 0.02$	$62.44^{d} \pm 0.43$
C	$11.44^{c} \pm 0.02$	$9.61^{c} \pm 0.44$	$8.94^{b} \pm 0.14$	$10.73^{a} \pm 0.00$	$9.71^{b} \pm 0.45$	$42.79^{c} \pm 1.07$
D	$13.64^{d} \pm 0.15$	$13.62^{d} \pm 0.17$	$9.20^{c} \pm 0.00$	$10.60^{a} \pm 0.01$	$17.50^{c} \pm 0.0$	$30.30^{b} \pm 0.35$
E	$14.20^{e} \pm 0.45$	$14.75^{e} \pm 0.24$	$12.78^{d} \pm 0.15$	$10.44^{a} \pm 0.00$	$21.22^{d} \pm 0.00$	$17.63^{a} \pm 0.87$
LSD	0.56	0.66	0.24	0.31	0.53	1.74

Values are means ± standard deviation of 3 replications. Means within a column with different superscripts are significantly different at $p < 0.05$ by Duncan Multiple range test.

Table 2. Mineral contents of biscuits produced from blends of wheat, watermelon rinds and orange pomace flours.

	Calcium (ppm)	Iron (ppm)	Magnesium (ppm)	Zinc (ppm)	Phosphorus (ppm)	Sodium (ppm)
A	$26.95^{a} \pm 1.06$	$88.12^{a} \pm 0.17$	$138.45^{e} \pm 0.21$	$148.43^{e} \pm 0.02$	$35.22^{a} \pm 0.35$	$3.30^{a} \pm 0.14$
B	$27.14^{a} \pm 0.03$	$90.72^{b} \pm 0.17$	$136.75^{d} \pm 0.21$	$145.81^{d} \pm 0.02$	$36.63^{b} \pm 0.35$	$27.14^{a} \pm 0.03$
C	$28.75^{b} \pm 0.35$	$91.45^{bc} \pm 0.35$	$135.25^{c} \pm 0.21$	$144.10^{c} \pm 0.14$	$38.32^{c} \pm 0.35$	$3.60^{ab} \pm 0.14$
D	$29.34^{b} \pm 0.03$	$92.25^{d} \pm 0.35$	$134.05^{b} \pm 0.21$	$143.20^{b} \pm 0.14$	$39.42^{d} \pm 0.35$	$3.70^{bc} \pm 0.14$
E	$32.25^{c} \pm 0.35$	$92.05^{cd} \pm 0.35$	$131.50^{a} \pm 0.21$	$140.30^{a} \pm 0.14$	$40.72^{e} \pm 0.35$	$3.80^{c} \pm 0.14$
LSD	1.35	0.76	0.55	0.28	0.09	0.36

Values are means ± standard deviation of 3 replications. Means within a column with different superscripts are significantly different at $p < 0.05$ by Duncan Multiple range test.

3.3. Functional Properties

Functional properties of biscuit samples are presented in **Table 3**. The results show that the bulk densities of the flours ranged between 0.6889 and 0.755 g/ml comparable to that reported by Oyeyinka *et al.* [16] but lower than that reported by Oppong *et al.* [25]. The wheat flour had the highest bulk density and the lowest for the (60:20:20) wheat-watermelon rinds-orange pomace composite flour ratio. Bulk density is related to the particle sizes and determines the extent of compactness of the flours as well as giving indication of the relative volume of packaging material required [26].

The Water Absorption Capacity (WAC) ranged between 2.15 g/g and 4.62 g/g. The 60:20:20 ratio had the highest water holding capacity while the 100:0:0 ratio had the lowest. The result of 70:15:15 wheat-watermelon rinds-orange pomace composite flour was similar to previous findings [27]. The WAC of flour is an important property of foods that represents the ability of a product to associate with water under conditions where water is limited. The difference in water absorption capacity of the samples could be due to difference in the granule size of the various formulations, which may enhance the ability of the flours to absorb water [28], being important in bulking and consistency. Oil absorption capacity (OAC) ranged between 1.04 g/g and 1.98 g/g. It is an important parameter of flour used in baking that reflects its emulsifying capacity [29].

3.4. Sensory Properties

The sensory properties of the biscuit samples as presented in **Table 4** shows that, the blend with highest wheat ratio was the most preferred by the panellists for all the of sensory attributes considered. There were significant differences ($p < 0.05$) among samples A, B and E but no significant difference ($p > 0.05$) between samples C and D. Colour is an important sensory attribute of any food because of its influence on acceptability. There was no significant difference ($p > 0.05$) among the experimental samples except for sample A which was significantly different. The taste was liked up to the sample with 80% wheat flour, 10% watermelon rinds flour and 10% orange pomace flour (80:10:10). The texture scores showed decrease with the increase level of supplementation with a slight increase in sample D which is similar to that of sample B. The scores for crispness of the biscuits ranged from 8.20 to 6.4 with the sample B having the highest score. There was no significant difference ($p > 0.05$) among samples A, C, D and E in crispness. Sample B had the highest overall acceptability score (8.50 ± 0.52). This was expected since the sample was the most preferred in terms of appearance, flavour, colour, taste, texture and crispness. Closest to sample B in overall acceptability were samples C and A with acceptability scores of 7.90 ± 0.94 and 7.84 ± 0.51, similar to the findings of Yetunde *et al.* [30]. Low sensory scores in taste may result from phytochemicals present in orange pomace and which could be improved upon with appropriate pre-treatments. Refining the compositions and assessing the impact on nutritional status of consumers would be the focus of future endeavours.

Table 3. Functional properties of wheat, watermelon rinds and orange pomace composite flour.

	Bulk Density (g/ml)	WAC (g/g)	OAC (g/g)
A	$0.755^{d} \pm 0.00$	$2.15^{a} \pm 0.00$	$1.04^{a} \pm 0.00$
B	$0.757^{e} \pm 0.00$	$2.50^{b} \pm 0.00$	$1.12^{b} \pm 0.00$
C	$0.750^{c} \pm 0.00$	$3.23^{c} \pm 0.00$	$1.38^{c} \pm 0.00$
D	$0.703^{b} \pm 0.00$	$3.98^{d} \pm 0.00$	$1.68^{d} \pm 0.00$
E	$0.688^{a} \pm 0.00$	$4.62^{e} \pm 0.00$	$1.98^{e} \pm 0.00$
LSD	0.01	0.01	0.01

Values are means ± standard deviation from triplicate determinations. Means within the same column with same superscript are not significantly different at $p < 0.05$.

Table 4. Mean sensory scores of biscuit prepared from wheat-watermelon rinds-orange pomace flours.

	Appearance	Flavour	Colour	Taste	Crispness	Overall acceptability
A	$7.40^{a} \pm 0.51$	$7.40^{b} \pm 0.84$	$8.10^{a} \pm 0.91$	$7.40^{b} \pm 0.69$	$6.80^{a} \pm 1.03$	$7.84^{b} \pm 0.51$
B	$30^{b} \pm 0.48$	$8.40^{ab} \pm 0.48$	$6.80^{b} \pm 0.56$	$8.50^{a} \pm 0.52$	$8.20^{b} \pm 0.78$	$8.50^{a} \pm 0.52$
C	$7.10^{a} \pm 0.56$	$7.10^{ab} \pm 0.87$	$6.90^{a} \pm 0.99$	$6.50^{ab} \pm 1.17$	$6.30^{a} \pm 0.94$	$7.90^{b} \pm 0.94$
D	$6.90^{a} \pm 0.99$	$6.80^{ab} \pm 1.03$	$6.60^{a} \pm 1.17$	$5.90^{a} \pm 1.37$	$6.30^{a} \pm 1.15$	$6.50^{a} \pm 1.17$
E	$6.60^{a} \pm 1.42$	$6.50^{a} \pm 0.84$	$6.70^{a} \pm 1.33$	$5.90^{a} \pm 1.59$	$6.40^{a} \pm 1.26$	$6.00^{a} \pm 1.15$
LSD	0.79	0.75	0.92	1.03	0.94	0.82

Values are means ± standard deviation from triplicate determinations. Means within the same row with same superscript are not significantly different ($p < 0.05$).

4. Conclusion

The study established that watermelon rind and orange pomace, which are usually discarded after consumption and processing of the other parts are capable of being utilised in food production to improve the nutritional quality of finished products. Incorporation of watermelon rinds flour and orange pomace flour in biscuit up to the level of 10 per cent could be considered optimum with respect to sensory quality. Put together, these results lend credence to the concept of food value addition as a sustainable practice necessary to reduce the environmental impact of the huge amount of agricultural wastes often generated in the food chain. A limitation of the study was non-assessment of the underutilised raw materials before blend formations in order to determine the impact of the processes on the nutritional as well as functional parameters of the finished products.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Nora, S.M., Ashutosh, S. and Vijaya, R. (2017) Potential Utilization of Fruit and Vegetable Wastes for Food through Drying or Extraction Techniques. Review arti-

cle Novel Techniques in Nutrition and Food Science.
http://www.crimsonpublishers.com

[2] Nassar, A.G., AbdEl-Hamied, A.A. and El-Naggar, E.A. (2008) Effect of Citrus By-Products Flour Incorporation on Chemical, Rheological and Organolepic Characteristics of Biscuits. *World Journal of Agricultural Sciences*, **4**, 612-616.

[3] Cláudia, M.D., Celeste, M.P., Juliana, M.F., Estela, R.Q. and Marcelle, M.M (2014) Chemical Characterization of the Flour of Peel and Seed from Two Papaya Cultivars. *Food Science and Technology*, **34**, 353-357.
https://doi.org/10.1590/fst.2014.0048

[4] Matouk, A.M., El-Kholy, M.M., Mohamed, A.T. and El-Far, S. (2017) Maximizing the Benefit of Orange Pomace. *Journal of Soil Science and Agricultural Engineering, Mansoura University*, **8**, 451-457. https://doi.org/10.21608/jssae.2017.38058

[5] Hyelsinta, L.K. and Maijalo, A.I. (2016) Physicochemical and Acceptability of Biscuits as Affected by Cereals and Legume Type. *University of Maiduguri Faculty of Engineering Seminar Series*, **7**, 62-66.

[6] Kohajdova, Z., Karovicova, J., Jurasova, M. and Kukurova, K. (2011) Application of citrus Dietary Fibre Preparations in Biscuit Production. *Journal of Food and Nutrition Research*, **50**, 182-190.

[7] Monisha, C., Ankita, M. and Sandeep, J. (2016) Development and Acceptance Analysis of Mixed Fruit Pomace Fortied High-Fibre Biscuits. *International Journal of Advances in Science Engineering and Technology*, **4**, 35-39.

[8] Zaker, M.A., Sawate, A.R., Patil, B.M., Kshirsagar, R.B. and Sadawarte, S.K. (2016) Studies on Exploration of Orange Pomace Powder on Physical, Sensory and Nutritional Quality of Cookies. *International Journal of Processing and Post-Harvest Technology*, **7**, 184-188. https://doi.org/10.15740/HAS/IJPPHT/7.2/184-188

[9] Nwosu, A.N. and Akubor, P.I. (2018) Acceptability and Storage Stability of Biscuits Produced with Orange Peel and Pulp Flours. *Journal of Environmental Science, Toxicology and Food Technology*, **12**, 8-15

[10] Association of Official Analytical Chemists (2010) Association of Official Analytical Chemists Official Methods of Analysis. 18th Edition, Association of Official Analytical Chemists, Washington DC.

[11] Iwe, M.O., Van Zauilichaem, D.J., Ngoody, P.O. and Ariahu, C.C (2001) Residence Time Distribution in a Single Screw Extruder Processing Soy-Sweet Potato Mixtures. *LWT-Food Science and Technology*, **34**, 478-483.
https://doi.org/10.1006/fstl.2001.0785

[12] Shahidi, F., Chavan, U.D., Bal, A.K. and Mckenzie, D.B. (1999) Chemical Composition of Beach Pea (*Lathyrus maritimus* L). Plant Parts. *Food Chemistry*, **64**, 39-44.
https://doi.org/10.1016/S0308-8146(98)00097-1

[13] Fila, W.A., Itam, E.H., Johnson, J.T., Odey, M.O., Effiong, E.E., Dasofunjo, K. and Ambo, E.E. (2013) Comparative Proximate Compositions of Watermelon Citrullus Lanatus, Squash *Cucurbita Pepo'l* and Rambutan Nephelium. *International Journal of Science and Technology*, **2**, 81-88.

[14] Onabanjo, O.O. and Ighere, D.A. (2014) Nutritional, Functional and Sensory Properties of Biscuit Produced from Wheat-Sweet Potato Composite. *Journal of Food Technology Research*, **1**, 111-121.
https://doi.org/10.18488/journal.58/2014.1.2/58.2.111.121

[15] Adeoye, I.B., Olajide-Taiwo, F.B., Adebisi-Adelani, O., Usman, J.M. and Badmus, M.A. (2011) Economic Analysis of Watermelon Based Production System in Oyo

State. *Nigeria Journal of Agricultural and Biological Science*, **6**, 53-59.

[16] Oyeyinka, S.A., Oyeyinka, A.T., Karim, O.R., Toyeeb, K.A., Olatunde, S.J. and Arise, A.K. (2014) Biscuit Making Potentials of Flours from Wheat and Plantain at Different Stages of Ripeness. *Croatian Journal of Food Science and Technology*, **6**, 36-42.

[17] Lee-Hoon, H. and Nadratul, W.A. (2016) Nutritional Composition, Physical Properties, and Sensory Evaluation of Cookies Prepared from Wheat Flour and Pitaya (*Hylocereus undatus*) Peel Flour Blends. *Cogent Food and Agriculture*, **2**, Article ID: 1136369. https://doi.org/10.1080/23311932.2015.1136369

[18] Okpala, L.C. and Akpu, M.N. (2014) Effect of Orange Peel Flour on the Quality Characteristics of Bread. *British Journal of Applied Science & Technology*, **4**, 823-830. https://doi.org/10.9734/BJAST/2014/6610

[19] Banji, A. and Adebayo, O. (2016) Physiochemical Properties and Mineral Compositions of Pawpaw and Watermelon Seeds Oils. *Pakistan Journal of Nutrition*, **15**, 23-27. https://doi.org/10.3923/pjn.2016.23.27

[20] Feumba, D.R., Ashwini, R.P. and Ragu, S.M. (2016) Chemical Composition of Some Selected Fruit Peels. *European Journal of Food Science and Technology*, **4**, 12-21.

[21] Olaitan, N.I., Eke, M.O. and Agudu, S.S. (2017) Effect of Watermelon (*Citrullus lantus*) Rind Flour Supplementation on the Quality of Wheat Based Cookies. *The International Journal of Engineering and Science*, **6**, 38-44.

[22] Huang, Y., Park, E., Replogle, R., Boileau, T., Shin, J.-E., Burton-Freeman, B. and Edirisinghe, I. (2019) Enzyme-Treated Orange Pomace Alters Acute Glycemic Response to Orange Juice. *Nutrition & Diabetes*, **9**, Article No. 24. https://doi.org/10.1038/s41387-019-0091-z

[23] 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**, 3695-3701.

[24] de Castro, L.A., Miranda Lizi, J., das Chagas, E.G.L., de Carvalho, R.A. and Vanin, F.M. (2020) From Orange Juice By-Product in the Food Industry to a Functional Ingredient: Application in the Circular Economy. *Foods*, **9**, Article No. 593. https://doi.org/10.3390/foods9050593

[25] Oppong, D., Eric, A., Kwadwo, S.O., Badu, E. and Sakyi, P. (2015) Proximate Composition and Some Functional Properties of Soft Wheat Flour. *International Journal of Innovative Research in Science, Engineering and Technology*, **4**, 753-758.

[26] Oludumila, O.R. and Adetimehin, A.M. (2016) Quality Characteristics of Cookies Produced from Composite Flours of Unripe Plantain, Wheat and Watermelon Seed. *Indian Journal of Nutrition*, **2**, Article No. 117.

[27] Suresh, C. and Samsher, S. (2013) Assessment of Functional Properties of Different Flours. *African Journal of Agricultural Research*, **8**, 4849-4852.

[28] Ikpeme-Emmanuel, C.A., Osuchukwu, N.C. and Oshiele, L. (2010). Functional and Sensory Properties of Wheat (*Asetium triticuim*) and Taro Flour (*Colocasia esulanta*) Composite Bread. *African Journal of Food Science*, **4**, 248-253.

[29] Onimawo, I.A. and Asugo, S. (2004) Effects of Germination on the Nutrient Content and Functional Properties of Pigeon Pea Flour. *Journal of Food Science and Technology*, **41**, 170-174.

[30] Yetunde, E.A. and Chiemela, E.C. (2015) Proximate Composition, Physical and Sensory Properties of Cake Prepared from Wheat and Cocoyam Flour Blends. *Journal of Food Research*, **4**, 181-188. https://doi.org/10.5539/jfr.v4n5p181