

# **Environmental Waste Management Practice: Effect of Debittered-Defatted Orange Seed Flour on the Proximate, Anti-nutritional and Sensory Properties of Biscuit**

**Abstract :** Orange seeds were extracted from orange fruits and sundried at  $30 \pm 2^\circ\text{C}$  for 8 hours. The orange seeds (20kg) were steeped in water for 12 hours and cooked for 120 minutes. The boiling seeds were dehulled, oven dried at  $60^\circ\text{C}$  for 14 hours, ground and defatted with 100% ethanol, milled, and sieved. Debittered orange seed flour was used to substitute 10, 20, 30, 40, and 100% in biscuits to test its proximate composition, physical, and sensory qualities. The results revealed that the proximate composition of the biscuits ranged from 12.49% to 17.17% protein, 9.38% - 12.14% fat, 1.55 - 9.84% crude fiber, 1.07% - 4.01% ash, 6.37% - 11.00% moisture content, and 45.83% - 64.46% carbohydrate. With increased orange seed flour content, the biscuits' weight, volume, break strength, and thickness reduced, while their spread ratio and density increased. The antinutrient composition of the cookies revealed oxalate (20.06 – 77.21 mg/100g), phytate (61.03 – 99.91 mg/100g), and tannin (0.07 – 2.09 mg/100g). Biscuits made with up to 30% orange seed flour were generally acceptable throughout sensory evaluation. Orange seeds are commonly disposed improperly during the manufacturing of juice along with other orange fruit products, causing a severe environmental impact and posing a health risk. Orange seed flour production would not only provide a novel source of flour for food manufacturing, but would also serve as an environmentally friendly recycling option.

**Keywords:** *Biscuit, debittered, orange seed flour, physical properties, proximate.*

## 1. Introduction

Sweet orange has become one of the most important citrus fruit crops grown globally, representing 71% of total citrus fruit production [1]. Because the edible section of oranges is limited, processing generates enormous amounts of leftovers such as peels and seeds, having a severe impact on the environment [2]. [3]. Citrus fruits are mostly utilized for juice and pectin manufacture. However, a large amount of leftovers (seeds, peels, and pulp) are generated as trash during juice and pectin synthesis. These byproducts, however, have potential in the food business given their nutritious and technological properties. [4]. Composite flour can be defined as wheat and other flour blends for the creation of baked goods, or non-wheat blends for the same purpose. There are two reasons for combining wheat and other flours: economic and nutritional. However, raw materials for composites are chosen depending on their compatibility, availability, and cost at the point of usage. Dietary fibers, which are the indigestible, fibrous components of foods, are an important part of the diet. Fibers have a laxative effect because they retain water and help food flow through the colon more quickly [5]. Fibers give bulk to the diet and help you feel full, making you less prone to nibble on greasy foods. As a result, fiber is required daily as part of a well-balanced diet [6]. Fiber helps regulate blood glucose levels [7]. Fiber also encourages free bowel movement, and thus helps in the effortless elimination of waste from the body, improves fullness, and hence influences several aspects of weight management [8]. The report also discovered that dietary fiber may help prevent cardiovascular disease, and obesity [9]. A high fiber diet reduces the risk of developing stroke, hypertension, diabetes, and several gastrointestinal issues [10-12].

Consuming more dietary fiber raises serum cholesterol levels, lowers blood pressure, promotes regularity, supports weight loss, and appears to stimulate immune function [13].

In Nigeria, orange seed waste is recklessly discarded in the environment. This results in the release of odors, which act as an ideal habitat for insects and, in overall, generates an unpleasant atmosphere with low aesthetic appeal [14]. Nigeria, as a tropical country, cannot cultivate wheat commercially due to its weather conditions. Only 3% of the country's wheat grain consumption can be generated domestically. As a result, the food sector can only survive by utilizing available indigenous commodities such as orange seeds, which can partially substitute wheat in baked goods without compromising product quality. Debittered orange seed flour is a good source of fiber and protein. Biscuits are small, thin, crisp cakes formed from unleavened dough [15].

Biscuits are manufactured from ingredients including wheat flour, water, oil, and sugar. Biscuits can be classified according to their degree of enriching and processing, as well as the technique used to shape them. Depending on the enrichment criteria, biscuits can be formed from hard dough, soft dough, or batters [15]. However, the nutritional composition of biscuits varies depending on the flour used. If possible, using debittered orange seed flour in the preparation of baked goods such as biscuits will assist to reduce reliance on wheat flour while also delivering nutritional fiber and important phytochemicals. As a result, this study examined the influence of including debittered orange seed flour on the proximate composition, physical, and sensory qualities of biscuits. This study would secure the conversion of orange seed waste into a usable product.

## **2. Materials and methods**

**2.1 Materials:** Oranges got purchased from a local market in Nsukka, Enugu State. Wheat flour, baking fat, sugar, powdered milk, eggs, baking powder, and table salt were obtained from the Ogige main market in Nsukka.

## 2.2 Preparation of debittered orange seed flour

The orange seed flour was produced according to the method of [16]. Figure 1 depicts a flow chart for preparing debittered orange seed flour.

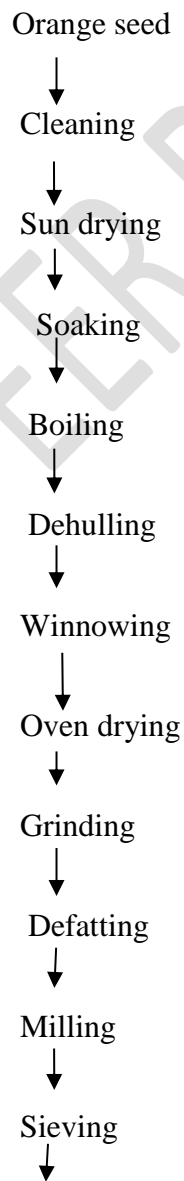
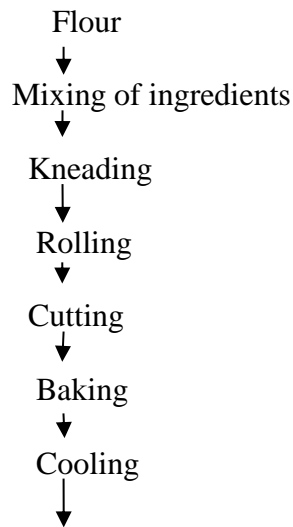


Fig 1. Processing of debittered orange seed flour

### 2.3 Preparation of biscuits

The best acceptable debittered orange seed flour was used to substitute 10, 20, 30, and 40% wheat flour in a food blender that was run at full speed (120 rpm) for 10 minutes. The biscuits were made using the procedure described in [17]. The oil and sugar were mixed together using a mixer before adding the remaining dry ingredients. The eggs were then added. This was followed by the addition of water (5 mL). The doughs were combined in a dough mixer for 30 minutes. The doughs were cut into shapes with a manual biscuit cutter. Cut out doughs were placed on oiled trays and baked at 200°C for 20 minutes. The hot baked biscuits were cooled for 15 minutes before being wrapped in HDPE bags. The 100% wheat flour biscuit was used as a control. Figure 2 depicts the flow chart for producing biscuits.



## Packaging

Fig 2: The production of biscuit  
Source: Okaka (1997)

### **2.4 Determination of proximate composition**

The moisture content was determined using the oven method, as described in [18]. The crude protein was measured using the Kjeldahl technique [18]. The fat content, ash, and crude fiber were determined using the procedures described in [18]. Carbohydrate was determined using the difference [18] formula:  $100 - (\% \text{ Moisture} + \% \text{ Crude protein} + \% \text{ Crude fiber} + \% \text{ Ash} + \% \text{ Crude Fat})$ .

### **2.5 Analysis of Antinutrients**

Phytate content was assessed using the technique described in [19]. The amount of oxalic acid in the sample was determined using the titration procedure described in [20]. Tannin was detected using the Folin-Denis spectrophotometric approach, as described in [19].

### **2.6 Sensory evaluation**

Twenty trained panelists from the University of Nigeria, Nsukka, evaluated the biscuit samples for taste, color, flavor, texture, and overall acceptability. In a sensory evaluation laboratory, the items were served at room temperature on clean coded white plastic plates in individual booths with enough fluorescent lighting. The sample presentation to the panelists was randomized. The panelists rated the biscuit sample on a 9-point Hedonic scale, with 1 indicating extreme dislike and 9 indicating extreme like.

### 3. Result and discussion

#### 3.1 Chemical composition of biscuits

The proximate composition of biscuits prepared from blends of debittered orange seed flour and wheat flour are shown in Table 1.

**Table 1: Chemical composition (%) of biscuits prepared from blends of debittered orange seed flour and wheat flour**

Wheat: debittered orange seed Flour	Moisture	Protein	Fat	Ash	Crude fiber	Carbohydrate
100:00	8.72 <sup>b</sup> ±0.51	12.49 <sup>f</sup> ±0.26	11.70 <sup>ab</sup> ±0.44	1.07 <sup>c</sup> ±0.07	1.55 <sup>d</sup> ±0.55	64.46 <sup>a</sup> ±0.99
90:10	8.15 <sup>b</sup> ±0.74	13.30 <sup>e</sup> ±0.33	11.28 <sup>ab</sup> ±0.22	1.86 <sup>b</sup> ±0.87	2.76 <sup>cd</sup> ±0.64	62.68 <sup>ab</sup> ±0.57
80:20	7.90 <sup>bc</sup> ±0.90	14.35 <sup>d</sup> ±0.13	10.06 <sup>bc</sup> ±0.84	2.47 <sup>b</sup> ±0.66	4.02 <sup>c</sup> ±0.41	61.18 <sup>b</sup> ±0.32
70:30	7.20 <sup>cd</sup> ±0.21	15.74 <sup>c</sup> ±0.36	10.74 <sup>bc</sup> ±0.74	3.66 <sup>a</sup> ±0.86	7.11 <sup>b</sup> ±0.25	55.96 <sup>c</sup> ±1.75
60:40	6.37 <sup>d</sup> ±0.30	16.21 <sup>b</sup> ±0.25	9.38 <sup>c</sup> ±0.12	3.87 <sup>a</sup> ±0.03	8.21 <sup>b</sup> ±0.44	55.54 <sup>c</sup> ±0.14
00:100	11.00 <sup>a</sup> ±0.46	17.17 <sup>a</sup> ±0.80	12.14 <sup>a</sup> ±0.62	4.01 <sup>a</sup> ±0.90	9.84 <sup>a</sup> ±0.40	45.83 <sup>d</sup> ±1.84

Means within a column with the same superscript were not significantly different ( $P>0.05$ ).

Means  $\pm$  S.D of 3 replications.

Table 1 shows the approximate composition of biscuits made from blended debittered orange seed flour and wheat flour. The moisture values of the biscuits ranged from 6.37% to 11.00%, with the 100% orange seed biscuit having the greatest moisture content (11.00%), which was higher than the 8.72% for the 100% wheat flour. However, enriched biscuits exhibited reduced moisture content, ranging from 6.37 to 8.15%. Low moisture content improves shelf stability of biscuits when placed in moisture-proof containers [21]. Biscuits are often more resistant to

microbial deterioration than cakes and bread [22]. A high moisture content suggests high water activity ( $a_w$ ) and a greater risk of degradation caused by mould formation [23].

The protein content of the biscuits ranged from 12.49% to 17.17%, with significant differences ( $p < 0.05$ ) between them. The protein level was lower than the 13.27% to 54.58% reported by [24], most likely due to the added effect of processing, but comparable to the 14.79 to 19.24% reported by [25] for biscuits made from orange seed flours. The 100% wheat flour biscuit has the lowest protein level at 12.49%. Adding more orange seed flour considerably enhanced the protein content of the biscuit ( $p < 0.05$ ). The debittered orange seed flour contained more protein than wheat flour. The protein composition of the biscuit containing 40% debittered orange seed flour was 16.21%, equivalent to the orange seed biscuit's 17.17%. Proteins are a broad class of substances that serve critical structural and functional roles in biological systems [21]. Protein supplies energy and is the only source of vital amino acids required for survival and growth [21]. The fat percentage of the biscuits varied from 9.38% to 12.14%. Significant disparities existed in the fat content of the biscuits. The 100% wheat and 100% orange seed flour biscuits had more fat than the enhanced biscuits. However, the 100% orange seed biscuit contained more fat (12.14%) than the 100% wheat biscuit (11.70%). Fat softens texture, aids moisture retention, and enhances taste in baked goods [21]. Fat improves the mouthfeel and palatability of biscuits.

The ash percentage of the biscuits varied from 1.07% to 4.01%. The control biscuit had the least amount of ash (1.07%), most likely because wheat flour had less ash than orange seed flour, whereas the 100% orange seed biscuit had the maximum ash (4.01%). The ash level of all supplemented biscuits rose dramatically as the proportion of orange seed flour raised. The

biscuits had a large amount of ash, signifying high mineral content [26]. This implied that debittered orange seed flour could include the mineral content of biscuits. Ash content is a measure of mineral content [27]. Minerals are inorganic elements that originate in the ground and cannot be synthesized in the body.

They play crucial roles in different bodily activities and are required for life and optimal health, making them essential nutrients [27]. The majority of minerals in the human diet are derived either directly from plants and water or indirectly via animal meals. Minerals support bone and tooth structure, as well as energy production, protein synthesis, blood creation, and a variety of other metabolic activities [28]. Based on its ash content, orange seed flour, when utilized in composite flour, would increase the mineral content of food products.

The crude fiber levels of the biscuits ranged from 1.55 to 9.84%. The biscuit made entirely of wheat flour had the lowest crude fiber content, measuring 1.55%. The crude fiber content of the biscuit mixtures differed significantly ( $p < 0.05$ ). The 100% orange seed biscuit has the greatest crude fiber level, 9.84%. With the addition of orange seed flour to the biscuits, the crude fiber content rose. The ability of fiber to take up oil is an important feature in food formulation since oil serves as a flour retainer and optimizes mouthfeel. The carbohydrate content of the biscuits fluctuated between 45.83% to 64.46%. The control sample had the greatest percentage, 64.46%. The values were slightly similar to 48.18 to 54.60% carbohydrate reported by [29] for noodles made with wheat and African bean flour mixes.

The inclusion of orange seed flour, which has a lower carbohydrate content than wheat flour (64.46%), could account for the lower carbohydrate level in the formed samples. Carbohydrates provide a rapid supply of metabolizable energy and aid in fat metabolism [30].

### 3.2 Antinutritional composition of biscuit

Table 2 displays the antinutrient content of biscuit.

**Table 2:** Antinutritional composition of biscuits prepared from debittered orange seed flour and wheat flour blends.

Ratio	Oxalate mg/100g	Phytate mg/100g	Tannins mg/100g
100:00	20.06±0.02 <sup>f</sup>	61.03±0.01 <sup>f</sup>	0.07±0.03 <sup>e</sup>
90:10	24.05±0.01 <sup>e</sup>	69.95±0.03 <sup>c</sup>	0.09±0.01 <sup>d</sup>
80:20	38.16±0.01 <sup>d</sup>	75.12±0.01 <sup>d</sup>	1.02±0.06 <sup>c</sup>
70:30	51.87±0.01 <sup>c</sup>	84.77±0.01 <sup>c</sup>	1.25±0.08 <sup>c</sup>
60:40	65.28±0.03 <sup>b</sup>	92.08±0.02 <sup>b</sup>	1.95±0.03 <sup>b</sup>
00:100	77.21±0.01 <sup>a</sup>	99.91±0.1 <sup>a</sup>	2.09±0.02 <sup>a</sup>

Means within a column with the same superscript were not significantly different ( $P>0.05$ ).

When compared to the supplemented biscuits, the biscuit made entirely of wheat flour had fewer oxalate, phytate and tannins. Adding more orange seed flour to the mixes resulted in a substantial increase ( $p<0.05$ ) in antinutrient levels in the biscuits. The biscuits' oxalate concentrations ranged from 20.06 to 77.21 mg/100g, with the wheat (100%) biscuit having the lowest amount (20.06 mg/100g). The highest oxalate level was found in 100% orange seed biscuit (77.21 mg/100g). The oxalate concentration was nearly identical to the 23.82 to 85.87 mg/100g reported by [31] for biscuits made from orange seed flour. The increasing level of orange seed flour in the biscuits increased the biscuits' oxalate content.

The biscuits with 100% orange seed flour biscuit had the greatest phytate content of 99.91 mg/100g, while wheat flour had the lowest mean phytate content of 61.03 mg/100g, which was lower than the biscuits supplemented with debittered orange seed flour which ranged from 69.95 to 99.91 mg/100g. Significant differences ( $p < 0.05$ ) were observed in the phytate content of the biscuits. The increased quantity of phytate in the biscuits could be attributable to the addition of orange seed flour, which contains more phytate than wheat flour.

The tannin content of the biscuits went from 0.07 mg/100g to 2.09 mg/100g, as shown in Table 2. The tannin concentration varied substantially within biscuit samples ( $p < 0.05$ ). The tannin concentration in 100% wheat cookies was the lowest (0.07), while entirely orange seed flour biscuits had the most tannin amount (2.09 mg/100g). The findings were fewer than the previously reported 4.21 to 5.29 mg/100g for composite flour paste [32]. The tannin level of the biscuits increased proportionally with the volume of orange seed flour utilized.

### 3.3 Sensory properties of biscuits

**Table 3: Sensory properties of biscuits prepared from blends of debittered orange seed flour and wheat flour**

WF : OSF120	Appearance	Flavour	Taste	Aftertaste	Texture	Crispiness	General Acceptability
100 : 00	8.4 <sup>a</sup> ±0.84	8.0 <sup>a</sup> ±0.66	8.2 <sup>a</sup> ±0.63	7.8 <sup>a</sup> ±0.78	7.7 <sup>a</sup> ±0.82	8.1 <sup>a</sup> ±0.87	8.3 <sup>a</sup> ±0.84
90 : 10	8.5 <sup>a</sup> ±0.84	8.1 <sup>a</sup> ±0.87	7.5 <sup>a</sup> ±1.42	7.3 <sup>a</sup> ±1.56	7.4 <sup>a</sup> ±1.56	7.4 <sup>a</sup> ±1.17	7.9 <sup>a</sup> ±0.79
80 : 20	6.7 <sup>b</sup> ±1.63	7.3 <sup>ab</sup> ±1.1	7.1 <sup>a</sup> ±1.37	5.8 <sup>b</sup> ±1.54	6.7 <sup>ab</sup> ±1.1	6.6 <sup>b</sup> ±1.58	7.8 <sup>ab</sup> ±0.78
70 : 30	4.9 <sup>c</sup> ±1.59	6.3 <sup>b</sup> ±1.25	4.9 <sup>b</sup> ±0.99	4.1 <sup>c</sup> ±1.59	6.6 <sup>ab</sup> ±1.3	4.4 <sup>c</sup> ±2.01	5.0 <sup>c</sup> ±1.15
60 : 40	4.4 <sup>cd</sup> ±1.83	6.6 <sup>b</sup> ±1.34	5.0 <sup>b</sup> ±1.24	3.7 <sup>c</sup> ±1.33	5.7 <sup>b</sup> ±1.7	4.3 <sup>c</sup> ±2.01	3.5 <sup>d</sup> ±1.26

00 : 100    3.2<sup>d</sup>±2.34    6.2<sup>b</sup>±1.54    3.6<sup>b</sup>±2.54    3.3<sup>c</sup>±2.31    6.0<sup>b</sup>±1.15    4.3<sup>c</sup>±1.94    2.6<sup>d</sup>±1.87

---

Means within a column with the same superscript were not significantly different ( $p>0.05$ ). The biscuits were evaluated on 9-point Hedonic scale (1 = dislike extremely and 9 = like extremely)

Table 3 summarizes the biscuits' sensory qualities. There were no significant variations in all of the sensory qualities of the biscuits tested between those made entirely of wheat flour (control) and those made with up to 10% orange seed flour. The evaluations for the biscuits' look, flavor, taste, aftertaste, texture, and crispiness declined as the amount of orange seed flour in the biscuits increased. There were no significant differences ( $p>0.05$ ) in flavor, taste, aftertaste, texture, or overall acceptability between the control and the biscuits enhanced with 20% orange seed flour. However, there were significant differences ( $p<0.05$ ) in the color, aftertaste, and crispiness of the biscuits. This could be linked to orange seed flour's low gluten content, as gluten is important for dough extensibility. Flour for biscuit production should be more extensible but less elastic, so that when masticated, the biscuits are crisp [33].

#### 4. Conclusion

The findings of this study demonstrated that debittered orange seed flour could be used to replace wheat flour in biscuits up to 20% without changing the chemical composition, physical qualities, or sensory attributes of the biscuits. The use of debittered orange seed flour in biscuit production will not only increase the value of orange seed, but it will also reduce the cost of importing wheat flour for the production of food products such as biscuits with improved nutritional value, reducing dependence on wheat importation, conserving foreign exchange, and productively engaging the youth.

## Reference

- [1] A. N. Siddiqu, D. N. Kulkarni, K. D. Kulkarni, and M. Z. Mulla, Studies on debittering of sweet orange juice, *World Journal of Dairy and Food Sciences* 8, 2013, 185 – 189.
- [2] G. Laufenberg, K. Kunz, and M. Nystroem, Transformation of vegetable waste into value added products: (A) the upgrading concept; (B) practical implementation, *Bioresources Technology*, 87, 2003, 167-198.
- [3] R. Montgomery, Development of biobased products, *Bioresource Technology*, 91, 2004, 1–29.
- [4] B. A. Mohamed, and G. M. El shanawi, Functional properties and in vitro digestibility of bitter orange (*citrus aurantium*) seed flour. *Merit Research Journal of Agricultural Science and Soil Sciences* 1, 2013, 042 – 047.
- [5] H. M. Youssef, and M. A. Mousa, Nutritional assessment of wheat biscuits and fortified wheat biscuits with citrus peel powders. *Food and Public Health*, 2(1), 2012, 55-60.
- [6] M. K. Youssef, *Foods that fight cancer*. Paper presented at the sixth Conference of Woman and Scientific Research and Development at Assiut University, Upper Egypt, 2007.
- [7] J. W. Anderson, P. Baird, R. H. Davis, S. Ferreri, M. Knudtson, A. Koraym, W. Valerie, and C. L. Williams, Health benefits of dietary fiber. *Nutrition Reviews* 67, 2009, 188 – 205.
- [8] O. Mickelson, D. D. Makdani, R. M. Cotton, S. T. Titcomb, J. C. Colney, and R. Gatty, Effect of a high fiber diet. *American Journal of Clinical Nutrition* 32, 1979, 87 – 76.
- [9] G. A. Spiller, *Handbook of dietary fiber in human nutrition*. 3rd Edition. (CRC Press Florida, 2001) 363 – 365.
- [10] F. Marangoni, and A. Poli, The glycemic index of bread and biscuits is markedly reduced by the addition of a proprietary fiber mixture to the ingredients. *Nutrition Metabolism and Cardiovascular Diseases*, 18, 2008, 602 – 605.
- [11] K. A. Meyer, L. H. Kushi, D. R. Jacobs, J. Slavin, T. A. Sellers, and A. R. Folsom, Carbohydrates dietary fiber and incident type 2 diabetes in older women. *American Journal of Clinical Nutrition* 71, 2000, 921 – 930.

- [12] L. J. Karhunen, K. R. Juvonen, and S. M. Flander, A psyllium fiber-enriched meal strongly attenuates postprandial gastrointestinal peptide release in healthy young adults. *Journal of Nutrition* 140, 2010, 737 – 744.
- [13] S. Sharma, S. Rana, C. Katare, T. Pendharkar, and G. B. Prasad,. Evaluation of fiber enriched biscuits as a healthy snack. *International Journal of Scientific and Research Publications* 3, 2013, 1 – 4.
- [14] E. I. Oikeh, K. Oriakhi, and E. S. Omoregie, Proximate analysis and photochemical screening of *Citrus sinensis* fruit wastes. *The Bioscientist*, 2, 2013, 164-170.
- [15] P. O. Fayemi, *Home Economics Teacher Guide*, (Macmillian Publisher Ltd. Ibadan, Nigeria, 1981) 201.
- [16] **Emojorho, E.E** and Akubor P.I (2016). Effect of Debittering Methods on the Proximate Composition Sensory and Functional Properties of Orange (*Citrus Sinensis*) Seed Flour/*IOSR Journal of Environmental Science, Toxicology and Technology* (IOSR-JESTFT), 10(9)134-139. DOI: 10.9790/2402-1009010916
- [17] J. C. Okaka, *Cereals and Legumes Storage and Processing Technology*, (Data and Microsystem Publishers, Enugu, Nigeria, 1997) 111-124.#
- [18] AOAC, *Official methods of analysis 18th Edition*, (Association of Official Analytical Chemists, Washington, D.C. USA, 2010).
- [19] I. A. Ihekoronye, and P. O. Ngoddy, *Integrated Food Science and Technology for the Tropics*, (Macmillan Publishers Limited. London, 1985).
- [20] Pearson, D. (1979). *Chemical and Analysis of Foods*. 9thEdition. Livingstone London, Churchill. pp. 33
- [21] R. Macrae, R. K. Robinson, and M. J. Sadler, *Encyclopaedia of Food Science Food Technology and Nutrition*, (Academic Press inc., San Diego, CA, 1993). 5: 3126 – 3131.
- [22] P. Wade, *Biscuits cookies and crackers: the principles of craft*, (Elsevier Applied Science Publisher, London, 1988) 1: 1 – 4.
- [23] E. T. Akintayo, A. A. Oshodi, and K. O. Esuoso, Effects of NaCl, ionic strength and pH on the foaming and gelation of pigeon pea (*Cajanuscajan*) protein concentrates, *Food Chemistry* 66, 1999, 51 – 56.

- [24] **Emojorho, E. E.** and Okonkwo, T.M. (2022). Effect of Debittering Methods on the Chemical and Physiochemical Properties of Defatted and Undefined Sweet Orange Seed Flours. *Fruits*, 77 (6): 1-10
- [25] **Emojorho, E. E.**, Okonkwo, T.M. and Eze, J.I. (2023). Chemical Physical Shelf-Life and Sensory Properties of Biscuits Produced From Defatted and Undefined Debittered Orange Seed Flours. *Fruits* 78(1), art. 02 *Fruits* 78(1-10).
- [26] M. C. Bunde, F. O. Osundahunsi, and R. Akinoso, Supplementation of biscuit using rice bran and soyabean flour, *African Journal of Food Agriculture Nutrition and Development* 10 (9), 2010, 47 – 59.
- [27] L. Ajala, The Effect of Boiling on the Nutrients and Anti-Nutrients in Two non Conventional Vegetables, *Pakistan Journal of Nutrition* 8 (9), 2009, 1430-1433
- [28] H. Wardlaw, and M. Gordom, *Perspectives of nutrition*. (Boston McGray - hill Publishers, New York, 1999) 1773.
- [29] **Emojorho, E. E.**, Reuben-Okoye, M., Aphiar , A., Nwosu , A. N., Anene , M. N., Avbundiogba, E., Ochimana , T. O., & Ekpekpo , L. D. (2024). Assessing the Quality and Potential of Fried Noodles: An Analysis of Wheat and Afzelia africana Flour Blends in Chemical, Functional, Physical, and Sensory Dimensions. *Asian J. Adv. Res. Rep.*, 18(6), 41–53. <https://doi.org/10.9734/ajarr/2024/v18i6652>
- [30] G. O. Ogunlakin, M. O. Oke, G. O. Babarinde, and D. G. Olatunbosun, Effect of drying methods on proximate composition and physicochemical properties of cocoyam flour, *American Journal of Food Technology* 7, 2012, 245 – 250.#
- [31] **Emojorho, E.E**, Anene M.N. and Udeh C.C. (2023). Minerals Vitamins and Anti-Nutritional Properties of Biscuits Produced from Defatted and Undefined Debittered Orange Seed Flours. *American Journal of Food Sciences and Nutrition*, 5(2): 67 – 82
- [32] Chiedu, U.C., Abiodun, M.S, Steve, I. O., Eguono, E.E. and Joy, A.T. (2023).Physicochemical, Nutritional and Functional Properties of Composite Flour Blends from Whole Wheat, Sweet Potato, Defatted Peanut and Rice Bran. *Eur. J. Nutr. Food. Saf.*, 15, (12): 41-55.
- [33] N. L. Kent, (1985) *Technology for Cereals*, 2nd edition, (Pergamon Press, Oxford, 1985) pp 166.