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Acceptability and Storage Stability of Biscuits Produced with Orange Peel and Pulp Flours

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Abstract: *Two biscuit samples were produced by supplementing wheat flour with 10 % orange peel and 10 % orange pulp respectively. A third sample was produced with 100 % wheat flour which served as the control. The biscuit samples were stored at ambient temperature for six months. At monthly intervals samples were analyzed for moisture and peroxide values and every two months the following sensory properties were analyzed color, flavor, taste, texture and overall acceptability on a 9 - point hedonic scale (1= dislike extremely and 9 like extremely). The temperature and relative humidity of the storage environment were determined daily. Results showed that storage did not adversely affect the sensory properties of the biscuits. At the end of the storage period the sensory attributes were still rated high. There was no sign of mould growth, peroxide value was still low and there was no off flavor.*

Keywords: *Biscuit, orange, peel, pulp, sample, storage*

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I. Introduction

Sweet orange is one of the most important fruits in the tropical and sub-tropical regions of the world. The fruits are usually eaten fresh but are also used for making canned orange juice, frozen juice concentrate, jams, and jellies among others. Orange processing industries generate huge amounts of orange peel and pulp as by products from the industrial extraction of orange juices. These peel and pulp contain among other things high levels of vitamin C, dietary fibre and flavonoids. Dietary fibre has been used for the treatment of various gastrointestinal disorders and for such possible health benefits as lowering cholesterol levels, reducing risk of colon cancer and losing weight[1]. Dietary fibre has also been reported to have some nutraceutical potentials [2]. Orange peel and pulp also contain other phytochemicals such as polymethoxylated flavones (PMF) and hesperidin which have hormonal and antioxidant actions and are also involved in enzyme stimulation [3].

Biscuit is a baked confectionary, dried to very low moisture content [4]. Biscuit is a snack food which can be eaten in-between meals or at any time of the day and by any age bracket. An increasing proportion of the household food budget is spent on snacks in which convenience and quality are perceived as most important [5]. Biscuits contain fat (18.5 %), carbohydrate (78.23 %), ash (1.0 %) and salt (0.85 %) [6]. They are generally characterized by low moisture content[4], The shelf life is several months under correct storage conditions [7]. However, biscuits must be packaged in containers which prevent moisture uptake [4].

Biscuits are baked products usually produced in a large variety of shapes, sizes, texture and flavors. They are dry products, usually with golden brown crust and crispy, pale brown crumb for rapid baking. The thickness of the biscuits is usually not more than 3-4 mm [7].

Composite flours are mixtures of different vegetable flours, with or without wheat flour [8]. In most parts of the world, baked goods based on wheat flour in particular, are a popular foodstuff. Thus much research involving the use of non-wheat flours has been carried out and a good deal of success achieved. In addition nutritional enhancement is frequently another goal in the development of such materials [9]. The extent to which wheat flour could be replaced depends on the nature of the products to be baked [8]. Bread formulations have been developed using wheat flour mixed with oats, potato, cassava, peanut meal, maize, rice flour etc. Bread has also been manufactured from corn and mixtures of barley and sorghum flours. Biscuit products have also been the subject of research from the point of view of the use of non-wheat flour. Peanut flour and cassava have been used in the preparation of biscuits [9]. Composite flour from quality protein maize (QPM) flour and wheat flour has been used for the production of biscuit with the bid to increase the protein quality of biscuit and promote the utilization of quality protein maize. The biscuits produced from the composite flours were acceptable and compared favorably with the control [10].

The juice obtained from orange fruits is widely consumed while the pulp and peel are discarded. The amount of peel and pulp obtained from citrus fruit processing accounts for 50% of the original amount of the

whole fruit [11]. These Peel and Pulp contain some bioactive substances believed to have nutraceutical potentials. This work was aimed at harnessing these bioactive substances that would have been lost and carrying out sensory studies to establish its level of acceptability and its storage stability when incorporated in wheat for the production of biscuits.

II. Materials And Methods

Material Procurement: The sweet orange fruits were purchased from Nkwo-Ibagwa market in Igboeze-South Local Government Area of Enugu State, Nigeria. Wheat flour, sugar, margarine, eggs and baking powder were purchased from Ogige market in Nsukka Township, Enugu State, Nigeria.

Preparation of Orange Peel and Pulp Flours: The fruits were washed thoroughly with water to remove dirt and adhering extraneous materials, peeled manually with a sharp kitchen knife. Kitchen juice extractor was used to extract the juice and the seeds removed. The peel was separated from the pulp cut into tiny pieces and then sun dried to constant weight, milled in attrition mill and sieved with muslin cloth to obtain the flour samples.

Production of Biscuit: The ingredients were weighed out. Dry ingredients were mixed together. The fat was rubbed in till it looked like breadcrumbs. Then mixed with the liquid ingredients until dough was formed. The resultant dough was kneaded and rested for about 5 minutes. The rested dough was rolled out into sheets and cut into 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. The flow diagram for the production of biscuit is shown in Figure 1.

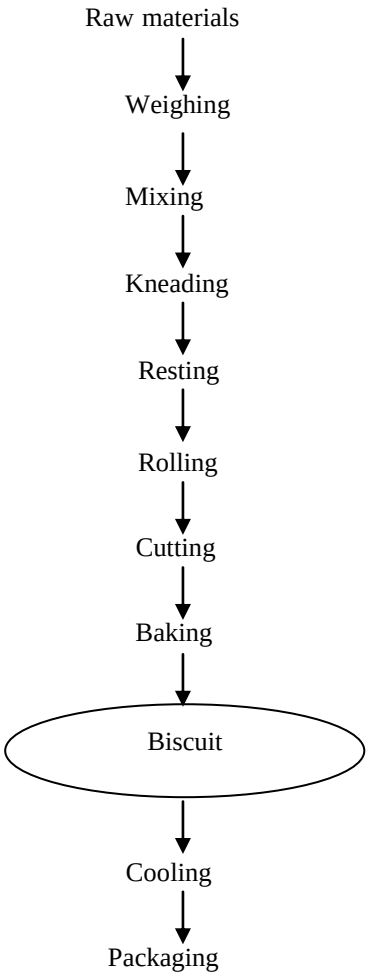

Figure no 1: Flow chart for the production of biscuit

Storage Stability Studies: The biscuits were stored at ambient temperature for six months. At monthly intervals, samples were analyzed for pH, moisture content, peroxide value, and every two months sensory properties were analyzed. The temperature and relative humidity of the storage environment were determined daily.

Determination of pH: The pH was determined by the use of a pH meter. Two grams of the sample was homogenized in 20 ml of de-ionized water in a beaker. The pH meter was standardized using buffer solutions of pH 4 and 9. The electrode was rinsed with de-ionized water and dipped into the homogenate and allowed sufficient time for stabilization before the reading was taken.

Determination Of Moisture Content: Moisture content was determined by the hot air oven method described by AOAC (2010) [12]. Two grams of the sample was weighed into crucible of known weight and placed in the oven at 105 ^{o}C for 4 hours. The samples were removed from the oven and placed in a desiccator to cool before weighing. The crucible was put back into the oven and weighed again until constant weight was recorded. The loss in weight from the original sample weight was calculated as the moisture content.

$$\%\,Moisture\,content = \frac{Weight\,loss}{Weight\,of\,sample} \times \frac{100}{1}$$

Determination Of Peroxide Value: The titrimetric method of AOAC (2010)12 was used. About 5 g of the sample and 30 ml glacial acetic chloroform solution was added in a flask and swirled to dissolve. About 0.5 ml of saturated potassium iodide was added to react with the peroxides After one minute, 30 ml of H_2O was titrated with 0.1N sodium thiosulfate ($Na_2S_2O_3$) with vigorous shaking, 0.5 ml of 1 % starch indicator added and the titration continued until the blue colour disappeared. A blank titration was carried out. The peroxide value was calculated as:

$$Peroxide\,Value = \frac{S \times M \times}{Weight\,of\,Sample} \times \frac{100}{1}$$

Where S = $McNa_2S_2O_3$ (blank)

M= Molarity of $Na_2S_2O_3$ solution

Sensory Evaluation: The stored biscuits were assessed by a twenty member untrained panel made up of students and staff of the department of food science and technology University of Nigeria, Nsukka. Quality attributes such as colour, flavour texture taste and overall acceptability were evaluated on a 9-point hedonic scale (1= dislike extremely and 9 like extremely) as described by [9]. A total of 60 samples were served per session, which comprises 20 samples each from the three different samples served (sample containing 10 % orange peel flour and 90 % wheat flour, 10 % orange pulp flour and 90 % wheat flour and a third sample made from 100 % wheat flour which served as the control). These samples were served in saucers using coded labeling corresponding to the codes in the score sheets given to the panelists. Portable water was also provided to ensure there were no biased judgments. The test was conducted in a laboratory (at room temperature) in the department of food science and technology, university of Nigeria, Nsukka. Adequate lighting and ventilation was ensured.

Experimental Design: The experimental design that was employed for the study was Complete Randomized Design (CRD). Data was subjected to analysis of variance (ANOVA) as described by [13]. Means where significant was separated by Duncan's New Multiple Range Test (DNMRT). Significance was accepted at 5 % level of significance ($p<0.05$).

III. Results

Sensory Properties Of Biscuit Samples During Storage: Sensory evaluation of biscuits containing 10 % orange peel and pulp as compared to the control biscuits stored for six months are shown in Tables 1, 2, 3 and 4.

Table no 1: Mean sensory scores of biscuits evaluated after production

Biscuits	Colour	Texture	Flavour	Taste	Overall acceptability
Wheat-orange peel	7.95^{ab}±1.09	7.95^{bc}±0.76	7.80^{ab}±0.89	7.25^{c}±1.25	8.25^{a}±1.07
Wheat-orange pulp	7.30^{b}±1.46	6.10^{d}±1.37	6.15^{c}±1.27	6.30^{d}±1.22	6.40^{b}±1.39
Wheat	8.80^{a}±0.41	8.75^{a}±0.44	8.50^{a}±0.61	8.75^{a}±0.44	8.65^{a}±0.67

Values are mean ± SD of 20 replications. Values within the same column with different superscripts are significantly different ($p<0.05$). Biscuits were evaluated on a 9 point Hedonic scale (1= extremely disliked and 9 = extremely liked)

Table no 2: Mean sensory scores of biscuits evaluated after two months of storage

Biscuits	Colour	Texture	Flavour	Taste	Overall acceptability
Wheat- orange peel	8.65^{a}±O.49	8.50^{a}±0.51	8.35^{a}±0.93	7.00^{b}±1.12	7.85^{b}±1.31
Wheat- orange pulp	8.15^{b}±0.75	7.45^{b}±0.69	7.35^{b}±0.59	8.00^{a}±0.92	7.85^{b}±0.88
Wheat	8.50^{ab}±0.69	8.60^{a}±0.59	8.50^{a}±0.89	8.50^{a}±0.89	8.75^{a}±0.79

Values are mean ± SD of 20 replications. Values within the same column with different superscripts are significantly different ($p<0.05$). Biscuits were evaluated on a 9 point Hedonic scale (1= extremely disliked and 9 = extremely liked)

Table no 3: Mean sensory scores of biscuits evaluated after four months of storage

Biscuits	Colour	Texture	Flavour	Taste	Overall Acceptability
Wheat- orange peel	8.65^{a}±0.67	8.65^{a}±0.49	8.60^{a}±0.59	6.85^{c}±0.37	7.25^{c}±0.79
Wheat-Orange pulp	8.40^{a}±0.50	7.60^{b}±0.82	7.15^{b}±0.59	8.45^{b}±0.69	8.20^{b}±0.62
Wheat	8.45^{a}±0.60	8.80^{a}±0.52	8.55^{a}±0.60	8.85^{a}±0.37	8.90^{a}±0.31

Values are mean ± SD of 20 replications. Values within the same column with different superscripts are significantly different ($p<0.05$). Biscuits were evaluated on a 9 point Hedonic scale (1= extremely disliked and 9 = extremely liked)

Table no 4: Mean sensory scores of biscuits evaluated after six months of storage

Biscuits	Colour	Texture	Flavour	Taste	Overall acceptability
Wheat- Orange peel	8.00^{a}±0.79	7.80^{ab}±0.77	8.10^{a}±1.17	4.85^{c}±0.75	7.00^{c}±0.86
Wheat- Orange pulp	7.70^{a}±0.98	7.30^{b}±1.17	7.25^{b}±1.07	7.30^{b}±0.98	8.05^{b}±0.60
Wheat	7.85^{a}±1.14	8.05^{a}±0.94	8.05^{a}±0.69	8.35^{a}±0.75	8.70^{a}±0.57

Values are mean ± SD of 20 replications. Values within the same column with different superscripts are significantly different ($p<0.05$).Biscuits were evaluated on a 9 point Hedonic scale (1= extremely disliked and 9 = extremely liked)

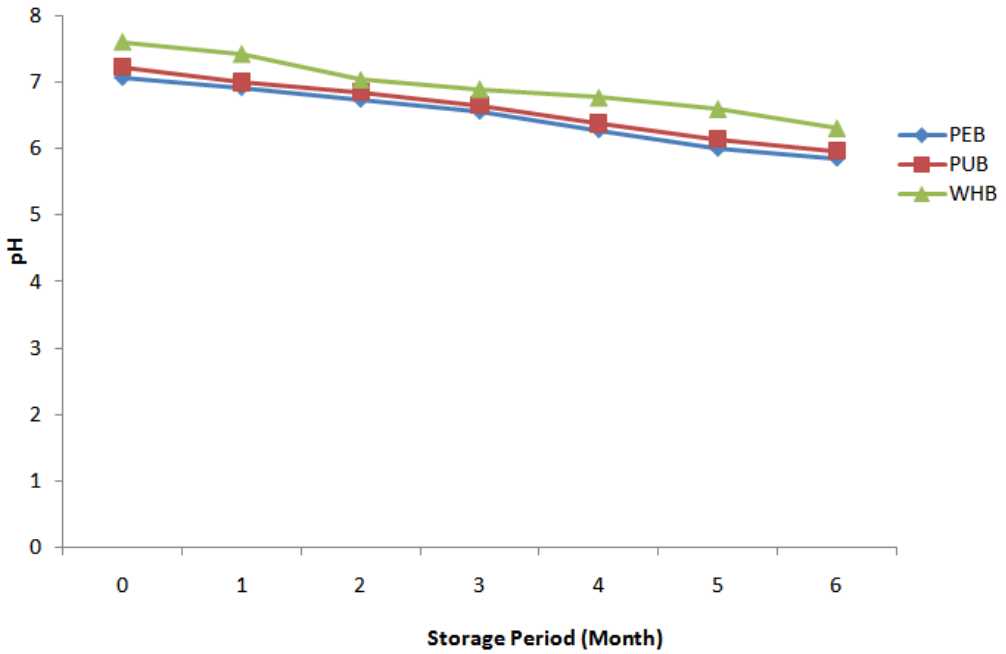

Figure no 2: Changes in pH of biscuits supplemented with orange peel and pulp flours during storage
PEB = Biscuit prepared with 10 % orange peel and 90 % wheat flour.
PUB = Biscuit prepared with 10 % orange pulp and 90 % wheat flour.
WHB = Biscuit prepared with 100 % wheat flour.

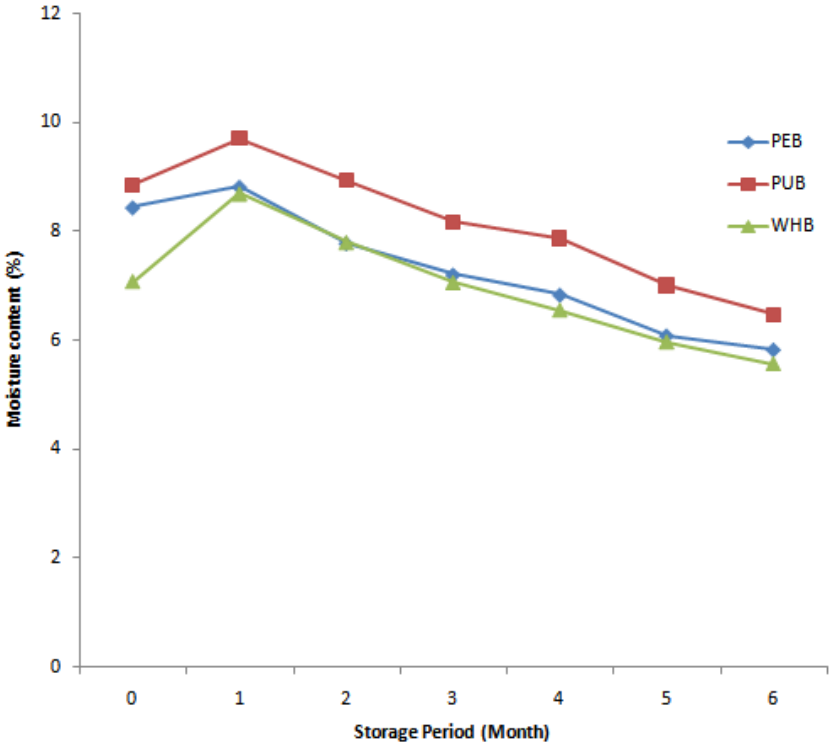

Figure no 3: Effect of storage on moisture content of biscuits during storage

PEB = Biscuit containing 10 % orange peel and 90 % wheat flour.
PUB = Biscuit containing 10 % orange pulp and 90 % wheat flour.
WHB = Biscuit containing 100 % wheat flour.

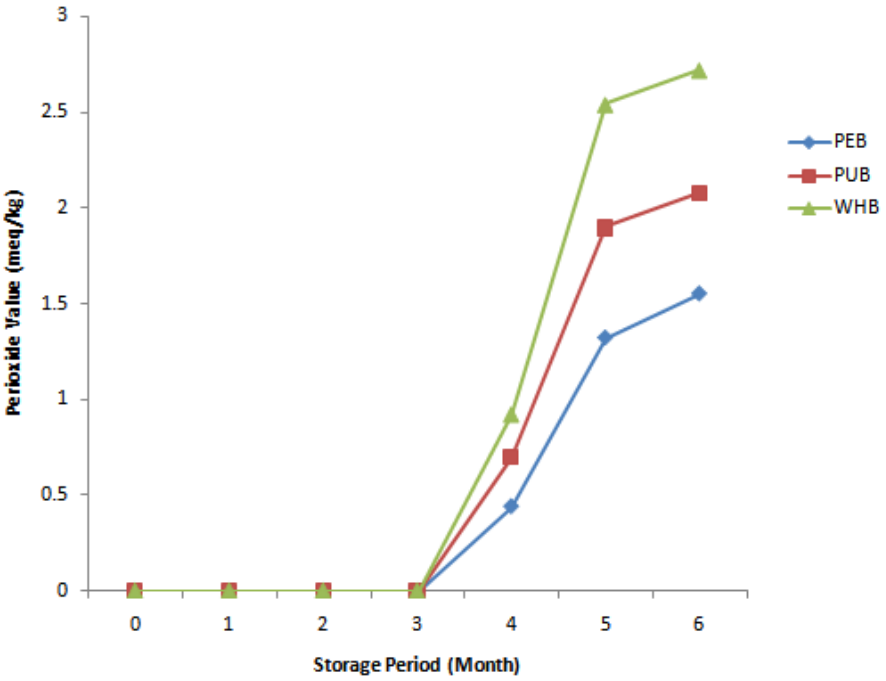

Figure no 4: Changes in peroxide value of biscuits supplemented with orange peel and pulp flours during storage

PEB = Biscuit containing 10 % orange peel and 90 % wheat flour.
PUB = Biscuit containing 10 % orange pulp and 90 % wheat flour.
WHB = Biscuit containing 100 % wheat flour.

IV. Discussion

The results showed that all the samples had very good sensory ratings for colour, texture, flavour, taste and overall acceptability.

After production, the control sample made from 100% wheat flour was significantly different ($p<0.05$) form other samples. It recorded the highest level of acceptability. This is because people are not conversant with biscuits made from orange peel and pulp. The biscuit made from the peel was also appreciated more than the pulp because of the content of essential oils in the peel. The bitter taste of the peel was still masked as it developed with storage.

After two months of storage, the control sample still had higher ratings in all the parameters accessed except for colour. Sample containing 10 % orange peel flour was better appreciated in colour. There was no significant difference ($p>0.05$) in texture and flavour between biscuits containing 10 % peel and 100 % wheat flour. The flavour of sample containing 10 % peel was appreciated probably because of the contributions of the orange peel, which is known and used as a flavouring agent due to its content of essential oils. Orange peel can be grated and used to flavour tea, salads, soups e.t.c. During the middle ages, cooks preferably used dried orange peels as flavouring [14]. As regards taste sample containing 10 % orange peel was the least acceptable. This may be attributed to the bitter taste caused by the tannins present. This bitter taste increased as storage progressed.

After four months of storage, the samples were still rated high, although there was a slight decrease in the sensory scores. There was no significant difference ($p>0.05$) among samples as regards colour. Sample containing 10 % orange peel was rated higher than sample containing 10 % orange pulp in texture and flavour. The higher rating for flavour was due to the flavour contribution of the orange peel. Sample containing 10 % orange pulp seemed to absorb moisture due to its content of fibre (the pulp was more fibrous than the peel) which affected its texture. In taste and overall acceptability, the control sample containing 100 % wheat flour was preferred while sample containing 10 % orange peel was the least accepted.

By the end of the storage period, there was still no significant difference ($p>0.05$) in the colour of the samples. The flavour of sample containing 10 % orange peel and sample containing 100 % wheat flour where still preferred. While in taste sample containing 10 % orange peel was rated very low. This may probably indicate that the bitter taste of the sample increased as storage progressed. In overall acceptability, the control sample was the most appreciated followed by sample containing 10 % orange pulp, while sample containing 10 % orange peels was the least accepted.

Changes in pH of biscuits during storage: Figure 2, shows the changes in pH of biscuit samples during storage. The initial pH of the biscuits containing orange peel, pulp and wheat flour were 7.08, 7.23 and 7.61 respectively. As storage progressed, the pH of all the samples decreased steadily. The decreases in pH were higher in the biscuits containing orange peel and pulp than in that containing 100 % wheat flour. At the end of storage, the pH was 5.86, 5.97 and 6.31 for the biscuits containing orange peel, pulp and wheat flours, respectively.

Effect of Storage on Moisture Content of Biscuits: Figure 3, shows the effect of storage on the moisture contents of the biscuits. The storage temperature of the biscuit samples was between 28 °C and 33 °C while the relative humidity of the storage environment ranged between 80 % and 90 %.The biscuit samples differed in the initial moisture contents. The control sample (WHB) had the least moisture content (8.70 %). After one month of storage, the moisture contents of all the samples increased because this period was the peak of the rainy season (July) in Nigeria. The high density polyethylene bags could not provide the biscuit total protection against moisture intake. As the intensity of the rain decreased, there were slight decreases in moisture contents of the biscuits. This period coincided with the onset of the dry season which continued to the end of the storage period.

Nigeria, like the rest of West Africa and other tropical lands, has only two seasons. These are the dry season and the rainy season. The dry season is accompanied by dust laden air-mass from the Sahara Desert, locally known as Harmattan, while the rainy season is heavily influenced by air-mass originating from the South Atlantic Ocean, locally known as the south west wind. The southern region of Nigeria experiences a double rainfall maxima characterized by two high rainfall peaks, with a short dry season and a longer dry season falling between and after each peaks.

The first rainy season begins around March and last to the end of July with peak in June. This rainy season is followed by a short dry break in August known as the August break, which is a short dry season lasting for two or three weeks in August. This break is broken by a short rainy season starting around early September and lasting to mid-October with a peak at the end of September. The ending of the short rainy season in October is followed by long dry season. This period starts from late October and lasts till early March with peak dry conditions between early December and late February [15].

The rate at which the gain or loss of moisture occurs depends on the makeup of the product, its hygroscopicity, the temperature and the atmospheric pressure. In packaged products, the changes in moisture content are relatively slow [16]. Moisture loss or uptake is one of the most important factors that control the shelf life of foods. Control of moisture exchange is necessary to prevent microbiological or enzymic spoilage, drying out or softening of the food, condensation on the inside of packages and resulting mould growth [17]. Foods that have low equilibrium relative humidity, such as dehydrated foods, biscuits and snack foods, require packaging that has a low permeability to moisture or they will gain moisture from the atmosphere and lose their crispness [17].

Changes In Peroxide Value Of Biscuits During Storage: Figure 4, shows the changes in the peroxide value of the biscuits during storage. For the first three months of storage, no peroxides were formed in the biscuits. Peroxides accumulated in the biscuits from the fourth month of storage. The peel (0.44 meq/kg) and pulp (0.70 meq/kg) had lower peroxide values when compared to the 100 % wheat biscuit which had 0.92meq/kg peroxide value. The differences in the peroxide value of the biscuits was probably due to the incorporation of the orange peel and pulp flours which have high total phenols contents and antioxidant activity [18]. The addition of orange peel and pulp flours to biscuit reduced the extent of oxidative rancidity which is attributed to the antioxidant effect of the orange peel and pulp. The antioxidant property observed may be due to the presence of phenols, including numerous flavonones in the peel and pulp [19].

Peroxide value is used as an indicator of rancidity development during storage. The delay in the formation of peroxides during the early months of storage was due to the low environmental temperature as it was at the peak of rainy season. High temperatures are known to accelerate the rate of oxidative rancidity and peroxide formation [20]. [20]also reported that oils stored at 40 ^{O}C showed higher peroxide values than those stored at 25 ^{O}C. [21,22] reported that there was no rancidity development observed in formulated biscuits up to 60 days of storage. The odour and flavour associated with typical oxidative rancidity are mostly due to carbonyl type compounds. Peroxide values of fresh oils are less than 10 milliequivalent/kg[23]. When the peroxide value is between 30 and 40 millequivalent/kg, a rancid taste is noticeable [23].

V. Conclusion

In conclusion, acceptable biscuits that are shelf stable could be produced from blends of wheat and orange peel and pulp flours.

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