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Phytochemical, Physicochemical and Sensory quality of Acha-orange Peel Flour Blend Biscuits

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Abstract
This study investigated the phytochemical, physicochemical, functional, proximate composition and sensory properties of biscuit supplemented with orange peel powder. The orange peel powder was substituted into the acha flour at 5, 10, 15, 20 and 25%, to produce acha-orange peel blend flour with 100% acha flour as the control. The blend with other ingredients (baking fat, sweet potato flour, salt, and baking powder) was baked at 160^{0}C to produce acha-orange peel powder blend biscuit. The biscuit was analysed for proximate, physical, phytochemical and sensory properties. The moisture, ash, crude fiber, and fat increased from 5.57-6.25, 1.77-2.35, 0.77-1.05, and 15.51-17.05% with increase in the added orange peel flour (5-25%). The loose density, packed, water absorption capacity, swelling capacity increased from 0.53-0.75, 0.40-1.05 and 7.05-7.95mg/100g respectively while the carotenoid, saponin, flavonoid and anthocyanine increased from 4.77-9.44, 1.02-0.08, 0.03-0.12 and 0.05-0.75mg/100g, respectively with increased in added orange peel flour. The acha-orange peel flour blend was generally accepted up to 15%, but most preferred at 5% added orange peel flour.
Key words: Phytochemical, Sensory, Quality, Acha flour, Orange peel powder

INTRODUCTION

Biscuits are ready-to-eat convenient and inexpensive food products of digestive and dietary importance consumed by all ages (Hussein *et al.,* 2006). Biscuit is known to generally contain fat (18.5%), carbohydrate (78.23%), ash (1.0%) and protein (7.1%) also the major ingredients in biscuit are wheat flour, fat, sugar and water while other ingredients such as milk, salt and aerating agent can be included (Javaid *et al*., 1995).
However, Nigeria has climatic conditions that are not so favorable for wheat cultivation but suitable for other cereal crops such as sorghum, millet, maize and acha. Therefore, any effort made to substitute wheat flour by any of locally available cereal flours will contribute a lot to lowering the cost of baking products in Nigeria.

The main problem facing the baking industry in Nigeria is the total dependence on the importation of wheat to sustain it (NRC, 1996). The high cost of importation of wheat has challenged researchers to look into the possible use of local cereals such as millet, rice and acha to substitute wheat (Ayo *et al*., 2014).

Acha (*Digitaria exilis*) also known as hungry rice is one of the indigenous and underutilized African cereals (Jideani and Akingbala, 1993). Lasekan (1994) reported that acha contains high pentosans, which gives it the properties of absorbing water to produce very viscous solution, baking operation. Recent research has shown that acha could reduce diabetes due to its relative low glycemic index (Jideani *et al.,* 1999).The a need to utilize gluten-free flour from under utilized cereals (acha, millet, rice among others) which could be complemented with legumes and tuber to formulate nutrient-dense,gluten-free diet such as biscuits (Abayomi *et al.,* 2013).

Like most cereals, acha is deficient in essential amino acid such as lysine and tryptophan, therefore enrichment of cereals based foods with other protein source such as legumes has received considerable attention (Mensah and Tunkins, 2003). The urgent need for improving acha based food has left no stone on turned, particularly for carrying some important. Under utilized and waste bye products such as legume husk, rice bran, orange peel and pulp could be source of important nutrients (Ayo *et al*., 2007). It is believed that orange waste such as peels, and pulp and improve the quality of acha based food product. (Rouseff and Nagy, 1994).

Global production of citrus fruit has significantly increased during the past few years and has reached 82 million tons in the years 2009–2010, of which oranges commercially the most important citrus fruit accounts for about 50 million tons and 34% of which was used for juice production, yielding about 44% peel as by-product (Li *et al.,* 2006).

Citrus peel, the primary waste, is a good source of molasses, pectin and limonene and is usually dried, mixed with dried pulps and sold as cattle feed and also used for the production of fruit juice (Bocco *et al*., 1998). *C. sinensis* is consumed all over the world as an excellent source of vitamin C, which is a powerful natural antioxidant that builds the body's immune system (Etebu and Nwauzoma, 2014). It has been used traditionally to treat ailments like constipation, cramps, colic, diarrhea, bronchitis, tuberculosis, cough, cold, obesity (Milind and Chaturvede, 2012). Generally, juice from orange contain moisture (86%), protein (1.0%), fat (0.2%), carbohydrate (12%), vitamin C and mineral are shown in Table 2.1 and 2.2 (Cho *et al.,* 2014). The phytochemicals present in sweet orange peel include: alkaloid (0.60%), phenol (0.07%), tannin (7.40%), flavonoid (0.16%) and saponin (1.70%) (Madziga *et al.,* 2014)

Development of acha-orange peel blend may improve the nutrient of acha based food products, encourage production of acha grains and reduce orange peel waste with consequent improved environmental standard. Little research effort had been directed to the possibility of using these wastes as food for humans. It was hoped that at the end of this research, a balanced, and nutritious content of acha based biscuit food would be formulated with orange peels.
The study therefore was conducted to determine phytochemical, physicochemical and sensory quality of acha and orange peel biscuit.

MATERIALS AND METHODS

Materials

Acha (D. *exilis*) was purchased from Wukari new market, Wukari, Nigeria. Sweet aronge fruit was purchased from, Gboko market. Benue State. Other ingredients such as sweet potatoes (*Impomea batata*), powder milk, baking fat, baking powder eggs, and salt were purchased from Gboko central market Gboko Nigeria.

Methods

Preparation of Acha and orange peel flour

Acha grains were manually cleaned, sorted (hand picking of the chaff and foreign materials. Dust and sands were removed by washing repeatedly using tap water and plastic bowls for stone separation), sun dried milled (attrition mill), sieved (150 µm apertue sieve) to produce acha flour packed tight (polyethylene bags) and stored at ambient temperature (25 to 30°C). The sweet orange fruits were sorted, washed and peeled. The peels were sun dried (38^{o}C), milled (attrition mill), sieved (1µm sieve) and packaged (polyethylene bag) and stored at room temperature 27^{o}C .

Production of sweet potatoes flour

Sweet potato tubers were sorted, wash (in water) peeled (with knife) chopped or shreded, sun dried (for 5 days), milled (attrition mill) sieve (1µm sieve), packed in (polyethene bag) and stored at ambient temperature 25^{o}C

Production of acha-orange peel blend biscuit
The orange peel flour was substituted into the acha flour (5, 10, 15, 20 and 25%) and then mixed with sweet potato as seetener, baking fat, powder and salt using Agu *et al.,* (2014) method for production of acha orange peel blend biscuits

Analytical method

Determination of proximate composition
Moisture, protein, crude fibers and ash contents were determined according to the method described in the AOAC (2000). Fat content was determined as the ether extract and the total carbohydrates were calculated by difference according to AOAC (2000).

Determination of physical properties of acha-orange peel blend

Spread ratio: The spread ratio was taken putting two column of five well-formed biscuits were made and the height of the biscuit was determined using Gomez *et al.,* (1997) method. They were also arranged horizontally edge to edge and the sum of the diameters measured, and the spread ratio was calculated as diameter divided by height.

Break strength: The break strength of the biscuit sample of 0.4cm thickness was placed centrally between two parallel metal bars 2cm apart and weights were applied until the biscuit snapped. The least weight that caused the breaking of the biscuit was regarded as the break strength of the biscuit using Gomez *et al.* (1997) method.

Determination of functional properties of acha-orange peel flour biscuit
Wettability, water absorption capacity, oil absorption capacity, bulk density, foaming capacity and stability, emulsion capacity, swelling capacity as well as protein solubility were determined by the methods described by Onwuka *et al,.* (2004).

Wettability: Wettability was estimated by measuring the wetting time in seconds, of 1g of acha-orange peel composite flour sample dropped from a height of 15mm on the surface of 200cm^3 distilled water contained in 250cm^3 beaker at room temperature of 30 ± 2^{o}c. The wetting time was expressed as the time required for all the powder to be wetted and penetrate the surface of the distill water.

Water absorption capacity: Ten milliliters (10 ml) of distilled water was added to 1g of acha-orange peel composite flour sample in a weighed centrifuge tube. The tube was agitated on a vertex mixer for 2min and then centrifuged at 4000rpm for 20min. The clear supernatant was decanted and discarded. The adhering drops of water was removed and then weighed. Water absorption capacity was expressed as the weight of water bound by 100g of dried flour.

Oil absorption capacity: One gram (1g) of acha-orange peel composite flour sample was mixed with 10ml of refined vegetable oil and allowed to stand at ambient temperature for 30min. it was then centrifuged for 30min at 2000rpm. The oil and adhering drops of oil was decanted and discarded. Oil absorption capacity was expressed as percent oil bound per gram flour.

Bulk density: Fifty grams (50g) of ach-orange peel composite flour sample was weighed into a 100ml measuring cylinder. The cylinder was tapped several times (50 times) on a laboratory bench to constant volume. The volume of sample was recorded.

Bulk density (g/cm^3) = $\frac{weight\ of\ sample}{volume\ of\ sample\ after\ tapping}$

Foaming capacity: Two grams (2g) of acha-orange composite flour sample was added to 50ml of distilled water at 30 ± 2^{o}C in a 100ml graduated cylinder. The suspension was mixed and shaken for 5min to foam. The volume of foam at 0 second after whipping was expressed as foaming capacity using the formula;

Foaming capacity = $\frac{volvme\ foam\ after\ whipping}{volume\ of\ mixture} \times 100$

The volume of foam was recorded at different time intervals after whipping to determine the foam stability as percent of the initial foam volume.

Emulsion capacity: The emulsion, 1g of acha-orange peel composite flour sample, 10ml distilled water and 10ml refined vegetable oil was prepared in a calibrated tube. The emulsion was centrifuged at 2000rpm for 5min. The ratio of the height of the emulsion layer to the total height of the mixture was calculated as the emulsion activity expressed in percentage. The emulsion stability was estimated after heating the emulsion contained in a calibrated centrifuge tube at 80^{o}c for 30min in a water bath, cooling for 15min under running tap water and centrifuging at 2000rpm for 15min. The emulsion stability, expressed as a percentage was calculated as the ratio of the height of the emulsified layer to the total height of the mixture.

Swelling capacity: One gram (1g) of acha-orange peel composite flour sample was mixed with 10ml of water in a weighed centrifuge tube. The tube was heating in water bath at 85^{o}c for 15min and then centrifuged at 2000rpm for 30min. The clear supernatant was decanted and discarded. The adhering drops of water was removed and then weighed. Swelling capacity was expressed as percent swelled per gram flour.

Phytochemical analysis

Determination of carotenoids contents: A measured weight of acha-orange peel composite biscuit sample was homogenized in methanol using a laboratory blender. A 1:10 (1%) mixture was used. The homogenate was filtered to obtain the initial crude extract, 20 ml of other was added to the filtrate and mixed well and then treated with 20 ml of distilled water in a separating funnel. The ether layer was recovered and evaporated to dryness at low temperature (35-50^{o}C) in a vacuum dessicator.

The dry extract was then saponified with 20 ml of ethanoic potassium hydroxide and left over in a dark cupboard. The carotenoid was taken up in 20 ml of ether and then washed with two portions of 20 ml distilled water. The carotenoid extract (ether layer) was dried in a dessicator and then treated with light petroleum (petroleum spirit) and allowed to stand overnight in a freezer (-10^{o}c). The precipitated steroid was removed by centrifugation the next day and the carotenoid extract was evaporated to dryness in a weighed evaporation dish, cooled in a dessicator and weighed. The weight of carotenoid was determined and expressed as a percentage of the sample weight (Onwuka *et al,.* 2004).

Determination of Saponins contents: Twenty grams of acha-orange peel composite biscuit sample was dispersed into 200 ml of 20% ethanol. The suspension is heated over hot water bath for 4hours with continuous stirring at about 55^{0}C. The mixture is filtered and the residue re-extracted with another 200 ml of diethyl either is added and shaken vigorously. The aqueous layer is recovered while the either layer is discarded. The purification process is repeated. 60 ml of n-butanol is added. The combined n-butanol extracts are washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution is heated in a water bath. After evaporation, the samples are dried in the oven to a constant weight. The saponin content is calculated in percentage (Harbon, 1997).

Determination of flavonoids contents: Five grams of acha-orange peel composite biscuit sample was boiled for 30 min under reflux. It was allowed to cool and then filtered through a

Whatman No. 42 grade filter paper. A measured volume of the extract was treated with equal volume of ethyl acetate starting with drop. The flavonoid precipitate was recovered by filtration using a weighed filter paper. The resulting weight difference was recorded as the weight of flavonoid in the sample (Edeoga *et al.* (2005).

Determination of Anthocyanins: Five grams of acha-orange peel composite biscuit sample was hydrolysed by boiling in 100 ml of 2MHcl solution for 30 minutes. The filtrate is transferred into a separation funnel and equal volume of ethyl acetate is added to it, mixed well and allowed to separate into two layers. The ethyl acetate layer {extract} is recorded while the aqueous layer is discarded. The extract is separated to dryness in the crucible over a steam bath. The dried extract is then treated with concentrated amyl alcohol to extract the anthocynins. After filtration, the alcohol extract and the filtrate are transferred to a weighed evaporating dish and evaporated to dryness. It is then dried in the oven at 30^0C for 30 minutes and cooled in desiccators. The weight of anthocyanins is determined and expressed as percentage of the original sample (Harbone, 1997).

Sensory quality evaluation

The biscuits were subjected to sensory evaluation using twenty (20) panelists, randomly selected from Federal University Wukari, Taraba state, Nigeria based on their familiarity with the product. The products, appropriately coded and of the same size and temperature (33 ± 3 ^{o}c) were placed in white plastic plates and served to the panelists. The panelists rinsed their mouths with bottled water after tasting each sample and were not allowed to make comment during evaluation to prevent influencing other panelist. (Akijayelu, 2009). A nine-point Hedonic scale with one (1) representing "extremely dislike" and nine (9) "extremely like" was used. The qualities assessed were color, texture, taste, flavor, crispness and general acceptability.

Statistical analysis

All the experiments were conducted in duplicates in completely randomized design. The data were subjected to analysis of variance using Statistical Package for Social Science (SPSS) software version 15, 2007. Means where significantly different were separated by the Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Proximate composition of biscuit

The proximate composition of acha-orange peels flour blends biscuits were shown in Table 1. The moisture content of the biscuit ranged from 5.57 to 6.25 at low level of moisture content of 5.57 would increased the shelf life of the biscuit at ambient temperature, the moisture at 6.25 which indicate high moisture will favour microbial growth or spoilage. Salgado (2011) reported similar work produced bread from wheat and cupuassu peel flour and observed that bread samples produced had moisture content ranging from 25.28 to 28.78%. These values were close to values obtained in this work. Increase in the level of orange peel flour had a significant reducing effect ($p<0.05$) in the protein and fat contents of the bread samples. This could be due to the low protein (1%) and fat (0.2%) contents of the orange peel as observed by Cho *et al.* (2014).

Conversely, increase in orange peel flour (5-25%) increased levels of fibre (0.77- 1.05%) and ash (1.77 - 2.15%) which were significant at ($p<0.05$). The increase in agreed with that (2.3%) reported by Forbes *et al.*, (2013). Okaka (2006) also reported similar work on bread with increase in fibre content with increase in OPF level. Increase in fibre content may have resulted in its reducing the moisture content of the biscuit samples due to its inherent functional property as observed by Forbes et al., (2013). Increased levels of ash/minerals with increase in orange peel flour levels could be due to high levels of minerals in orange peels as earlier observed by Li *et al.,* (2006). This suggests that orange peels could help in boosting the mineral content of acha biscuit. Fibre has been reported to have many health benefits including prevention of certain cancers and lowering the risk of developing hemorrhoids. Carbohydrate content decreased(69.04 – 65.45%) with an increased in orange peel flour(5-25%) which could be due to the dilution of the blend with addition of the peel flour..

Table 1: Proximate composition of acha based biscuit incorporated with orange peels

Acha/orange Peel flour ratio (g)	**Moisture Content (%)**	**Ash content (%)**	Crude fiber (%)	Fat content (%)	Crude protein (%)	Carbohydrate (%)
100:0	5.75±0.02^{b}	1.77±0.04^{a}	0.77±0.02^{b}	15.51±0.01^{a}	7.34±0.01^{b}	69.04±1.08^{a}
95:5	5.76±0.02^{b}	1.78±0.02^{a}	0.81±0.04^{b}	15.93±0.02^{a}	7.44±0.08^{b}	68.28±0.24^{a}
90;10	5.78±0.28^{b}	1.840.03^{a}	0.85±0.01^{b}	16.20±0.04^{a}	7.56±0.06^{b}	67.77±0.01^{a}
85:15	5.90±0.52^{b}	1.94±0.03^{a}	0.89±0.04^{b}	16.45±0.01^{a}	7.70±0.08^{b}	67.12±0.53^{a}
80;20	6.10±0.02^{a}	1.99±0.02^{a}	0.93±0.03^{b}	16.90±0.01^{a}	7.95±0.06^{b}	66.13±0.02^{a}
75:25	6.25±0.02^{a}	2.15±0.04^{b}	1.05±0.02^{a}	17.05±0.02^{a}	8.15±0.05^{a}	65.45±0.02^{a}

Mean values in the same column with the same superscript are not (p>0.05) significantly different.

Functional properties of acha-orange peel flour blends

The functional properties of acha incorporated with orange peel flour are shown in table 2. The loose density, water absorption capacity and swelling capacity increased from 0.53 to 78 this may be due to increase in fibre content. The results are within the reported values (0.69-0.76%) for starch foodstuff (Onuh and Abdulsalam, 2009). The packed density, oil absorption and foaming capacity decreased from 0.63 to 0.50, 3.30 to 2.75 and 7.52 to 5.45mg/100g, respectively with increase in the added orange peel flour (5-25%) and with a none significant effect (p>0.05) The observation of this work agreed with that of Adeleke and Odedeji (2010) that the addition of sweet potato had general decrease on the functional property of wheat flour .

The oil absorption capacity values decreased (3.30-2.75g/g) with increasing levels of orange peel flour. The major chemical affecting oil absorption index is protein, which composed hydrophilic and hydrophobic parts (Tharise *et al.,* 2014) and are relatively low in orange peel flour.

The swelling capacity value of the flour blend increased from 7.15 to 7.95g/g with increased orange peel flour blend(5-25%) and that of water absorption capacity increased from 0.40 to 1.05g/g within increase in orange peel flour. These may be due to the presence of fiber content in the orange peel flour. Niba *et al.,* (2001) reported similar existing study that composite flours exhibited higher water absorption capacity and swelling capacity than the control sample (100% whole meal wheat flour).

The foaming capacity decreased with an increase in the level of the sun dried orange fruit peel range from 7.52 to 6.45 with the control sample (100% acha flour) having the highest value. Akubor and Eze (2012) reported similar trend and attributed it to variation in food composition such protein, solubility and other factors.

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Table 2: Functional properties of acha incorporated with orange peel flour

Acha/orange Peel flour (g/cm^3)	Loose density (g/cn^3)	Packed density (g/cm^3)	Water absorption capacity ($cm^3/100g$)	Oil absorption capacity ($cm^3/100g$)	Swelling capacity ($cm^3/100g$)	Foaming capacity ($cm^3/100g$)
100:0	0.53±0.42[a]	0.63±0.07[a]	0.40±0.14[b]	3.30±0.14[a]	7.15±0.64[a]	7.52±0.64[a]
95:5	0.56±0.41[a]	0.62±0.01[a]	0.70±0.14[b]	3.90±0.92[a]	7.15±0.07[a]	7.45±0.13[a]
90:10	0.58±0.21[a]	0.58±0.07[a]	0.90±0.14[b]	2.85±0.35[b]	7.18±0.28[a]	6.38±1.32[b]
85:15	0.61±0.01[a]	0.57±0.07[a]	0.95±0.21[b]	2.80±0.57[b]	7.20±0.07[a]	6.35±1.12[b]
80:20	0.68±0.07[a]	0.52±0.08[a]	1.00±0.21[a]	2.80±0.57[b]	7.25±0.09[a]	6.35±0.05[b]
75:25	0.78±0.07[a]	0.50±0.07[a]	1.05±0.28[a]	2.75±0.63[b]	7.95±0.06[a]	6.45±0.11[b]

Mean values in the same column with the same superscript are not ($p>0.05$) significantly different.

Physical properties of biscuit

The physical analysis of acha based biscuit blends with orange peel flour are shown in Table 3. The spread ratio of the blend biscuit increased from 4.65-7.06 with increase in the added orange peel flour (5-25%). The break strength of the blend biscuit increased from 1.00-1.88kg with increase in the added orange peel flour. The increased was an indication of the binding properties of the flour, as well as the presence of orange peel flour and fibre The result of the break strength agree with the work of Okaka and Isieh (1990).

Acha flour biscuit exhibited spread ratio of 0.65 to 7.06 while biscuits containing orange peel flour exhibited increase in their spread ratio (5.03-0.26%) as the amount of orange peel in the blend increased with the control (100% acha flour biscuits) having the highest values. Okaka and Isieh (1990) reported similar trend in biscuits from wheat and cowpea flours. The increase in the break strength could be an advantage in reducing the rate of breakage of the biscuits during transportation from industry to the consumers. However, too high break strength could reduce the efficiency of digestion and possible absorption of the inherent nutrient. The increase in the spread ration could be due to dilution of the acha flour by the orange flour with consequence reduction of the intra molecular forces.

Table 3 Physical properties of acha based biscuit blends with orange peels flour

Acha/orange peel Flour blends (g)	Spread ratio (cm)	Break Strength (kg)
100:0	4.65±3.01[c]	1.00±0.00[a]
95:5	5.03±0.00[b]	1.10±0.01[a]
90:10	5.49±0.00[b]	1.25±1.01[a]
85:15	6.11±0.07[a]	1.68±1.07[a]
80:20	6.69±0.00[a]	1.78±2.02[a]
75:25	7.06±0.07[a]	1.88±3.01[a]

Mean values in the same column with the same superscript are not significantly different, ($p>0.05$) OPF =Orange peel flour.

Phytochemical composition of acha-orange peel biscuit

The result of the phytochemical composition of the acha-orange peel blend biscuits are shown in Table 4. The carotenoids, saponins, flavonoids and anthocyanines increased from 4.77- 9.44, 0.02 - 0.08, 0.03 - 0.12 and 0.05 - 0.75mg/100g, respectively with increase in the added orange peel flour (5-25%). Inuwa *et al.*, (2011) reported similar increased in saponins content of bread produced from orange peel flour. The increase in these values could be due to inherent content of the added orange peel flour as observed by Madziga *et al.,* (2014) and these compounds have been proven to be advantageous to the growth of the body.. Saponins had been reported to have antioxidant and anti-mutagenic properties. The biological activities of flavonoids as have been identified include anti free radicals, free mediated cellar signaling, allergies, platelet aggregation, microbes, ulcers, viruses and tumors and hepatoxins (Hertog, 1993). Flavoinoids in regularly consumed foods have been proven to reduce the risk of death from coronary heart diseases for elderly men (Hertog, 1993). Anthocyanines are anti-cancer, anti-inflammatory (Mepba *et al.,* 2007). Carotenoids are known for their high antioxidant properties and protective effects against certain cancers, like prostate. Alpha-carotene, beta-carotene, lutein, lycopene, and zeaxathin are the most common dietary carotenoids (Hertog, 1993).

Table 4 Phytochemical composition of acha based biscuit incorporated with orange peel flour

Acha:Orange peel flour(%)	Carotenoid mg/100g)	Saponin mg/100g)	Flavonoid mg/100g)	Anthocyanine mg/100g)
100:0	4.77±0.41[d]	0.02±0.03[a]	0.03±0.01[a]	0.05±001[a]
95:5	5.88±0.02[c]	0.04±0.02[a]	0.07±0.01[a]	0.07±0.00[a]
90:10	7.44±0.02[b]	0.08±0.01[a]	0.08±0.01[a]	0.06±0.02[a]
85:15	8.58±0.03[a]	0.08±0.02[a]	0.08±0,02[a]	0.07±0,01[a]
80:20	8.83±0.10[a]	0.08±0.04[a]	0.08±0.02[a]	0.08±0.00[a]
75:25	9.44±0.02[a]	0.08±0.03[a]	0.12±0.02[a]	0.72±0.03[a]

Mean values in the same column with the same superscript are not significantly different, (p>0.05) .

Sensory Evaluation

Sensory evaluation results of acha based biscuit incorporated with orange peel flour is shown in Table 5. The mean average scores of colour, texture, taste and flavour decreased from 8.70 - 5.91, 8.05 - 5.45, 8.30 - 3.80 and 7.70 - 4.10, respectively. The decrease were generally significant ($p<0.05$). The relatively low average means score in the taste above 10% added orange peel could be due to the inherent bitter compound abedo in the peel. The blend biscuit was generally accepted up to 15% level of added orange peel flour, but most preferred of 5% level.

The scores for general acceptability decreased significantly ($p < 0.05$) from 8.0 in the biscuit produced from 100% acha flour to the ranged of 3.95 to 7.05 for the biscuit containing sweet orange peel flour. Akpata and Akubor *et al.,* (2000) reported similar work in bread production, that increase in orange peel decreased the taste from 8.2-4.4 and texture from 8.6-6.8 respectively.

Table 5: Sensory evaluation of acha based biscuit incorporated with orange peels blends

Acha:Orange peel flour(%)	Colour	Texturee	Taste	Flavour	Gen. Acceptability
100:0	8.70±0.47[a]	8.05±0.60[a]	8.30±0.57[a]	7.70±0.66[a]	8.00±0.65[a]
95:5	7.55±0.69[b]	7.65±0.88[b]	7.30±0.66[b]	7.30±1.08[a]	7.05±0.60[b]
90:10	7.05±0.98[b]	7.15±0.99[b]	7.15±0.81[b]	6.00±0.86[b]	6.20±0.62[c]
85:15	6.95±1.28[c]	6.15±0.81[c]	4.30±1.49[c]	5.50±1.51[c]	5.40±0.82[d]
80:20	6.20±1.36[c]	5.80±1.37[d]	3.95±1.36[d]	4.51±1.47[d]	4.45±1.39[e]
75:25	5.91±1.19[d]	5.45±1.47[d]	3.80±1.47[d]	4.10±1.68[d]	3.95±1.76[f]

Mean values in the same column with the same superscript are not significantly different, p>0.05.

CONCLUSION AND RECOMMENDATION

The study has shown that acceptable baked biscuit product could be produced from acha-orange peel flour blends. These composite flour and their products could be good sources of fibre and phytochemical compounds. The sample containing 5% orange peel was most acceptable.

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