IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402, p- ISSN: 2319-2399.Volume 19, Issue 5 Ser. 1 (May 2025), PP 53-60
www.iosrjournals.org

Nutritional And Sensory Quality Of Acha And Pineapple Pulp Fibre Based Biscuits

Idyu, R.M.
Department Of Home Economics, Akperan Orshi Polytechnic, Yandev, Nigeria;

Abstract
The quality of biscuits produced from blends of acha flour and pineapple pulp fibre (PPF) were investigated. The PPF was substituted into acha flour at 2.5, 5 and 10 %. The 100% acha served as the control. The nutritional and sensory qualities of the biscuits were determined using standard methods of AOAC, 2012. The moisture, protein, ash, fats and carbohydrates contents of the acha-pineapple fibre composites biscuits decreased from 14.25 to 11.01, 8.26 to 6.28, 3.12 to 2.00, 7.50 to 6.19 and 67.70 to 65.40% respectively. The fibre content increased from 2.87 to 5.10 % with an increase in added pineapple fibre powder (0-10%). The biscuits containing 95% acha and 5% PPDF (sample C) came out to be the most preferred biscuit in terms of sensory attributes. The most preferred biscuits sample had moisture content of 12.04%, protein, fibre, ash, fats and carbohydrate contents of 6.93%, 4.42%, 2.99%, 6.44% and 67.58%, respectively. The biscuit contained 17.21 mg/g vitamin C and 1.44mg/g vitamin A. The most preferred sample (sample C) also contained a low amount of antinutrients of 1.53 mg/g tannins, 7.89 mg/g saponins, 1.16 mg/g phytate, 0.01 mg/g cyanide and 1.06 mg/g oxalate. In terms of sensory quality, sample C which was the most preferred biscuit scored 7.15 in appearance, 8.00 in flavor, 8.90 in mouthfeel, 7.90 in crispiness, and an overall acceptability score of 8.01. Conclusively, 95% acha flour and 5% PPDF can be used as composite flour to produce biscuits of good nutritional and sensory quality.
Keywords: *Biscuit, quality, assessment*

Date of Submission: 27-04-2025 Date of Acceptance: 07-05-2025

I. Introduction

Biscuits are snacks of high demand by all age groups. They are easy to carry, tasty, low in cholesterol and reasonably low cost. In Nigeria, about 25% of the wheat is used in the preparation of baked goods (Kahlon, 2009).

Biscuits are prepared by baking at high temperatures followed by drying at lower temperatures (Opaluwa *et al.* 2015). The simplest form of biscuit is a mixture of flour and water but may contain fat, sugar, and other ingredients mixed into a dough which is rested for a period, passed between rollers to make a sheet; which is then stamped out, baked, cooled and packaged (Opaluwa *et al.* 2015). The nutritional value of biscuits varies with the type of cereal used. Biscuits generally contain fat (18.5%), carbohydrate (78.23%), ash (1.0%), protein (7.1%) and 0.85% salt (Yada *et al.*, 2011).

Pineapple (*Ananas comosus*) is a tropical fruit that may be enjoyed whole and fresh, juiced or canned. The fruit is now of high economic importance. Pineapple juice is also popular and consumed all over the world. One of the by-products in the production of pineapple juice is the pineapple pomace. About 76% of pineapple pomace is fibre, from which 99.2% is the insoluble fraction and 0.8% is the soluble fraction (Martinez *et al.*, 2012) which is regarded as waste. Nutritionally, pineapple is rich in vitamins and minerals and especially vitamin C and manganese.

Pineapple is also a good source of carotene (vitamin A) and is fairly rich in vitamin B and B_{12}. It also contains carbohydrates, protein, fat, fibre, calcium, and iron. World production of pineapple reached 21.8 million tons in 2011 (FAO, 2013) the increase in production of pineapple has resulted in higher byproduct such as pomace regarded as waste which needs to be utilized. The major by-product from pineapple processing is the peel and core which consists about 76 % of pineapple. About 99.2 % of the peel core is the insoluble fraction and 0.8 % is the soluble fraction. Dietary fibre plays an important role in human health by promoting several physiological and metabolic beneficial effects (Raninen *et al.*, 2011). FDA (2013) stated that for a product to claim a „„high source of fibre‟‟ or "good source of fibre‟‟, it must contain, 20 % and 10–19 % respectively of fibre of the recommended daily value for dietary fibre in a serving size.

Acha (*Digitaria exilis* and *Digitaria iburua*) is a small annual herbaceous plant (forest seed/grain) commonly found in Nigeria, Sierra Leon, Ghana, Guinea Bissau, Togo, Mali, Benin republic, and Ivory Coast (Jideani and Jideani, 2011). Glew *et al., (*2013) reported that the crude protein content of the acha grain is comparable to that of maize and has as much methionine and cysteine contents as legumes. Acha grain belongs to the group of lost crops of Africa and has been neglected due to insufficient knowledge of its nutritional value by nutritionists and other researchers (Chivenge *et al.*, 2015).

Proximate analysis of acha revealed the following; 7.7% protein, 1.8% fat, 71% carbohydrate, and 6.8% fibre (Oburuoga and Anyika, 2012). The protein of the grain is rich in methionine and cysteine which are vital for human health but lacking in most cereals (Sarwar, 2013). In recent study, acha grain has shown to have high water absorption capacity, a property that could be linked to appreciable amount of pentosan. The high water absorption capacity of acha could be utilized in baked food.

This work sets out to formulate and develop biscuit from Acha and pineapple pulp fibre and also determine the most suitable blend by evaluating nutritional and sensory their quality attributes.

II. Materials And Methods

Source of Materials and Sample Preparation

Creamy coloured Acha grain (*Digitaria exilis*), ripe pineapple fruits (*Ananas comosus*), baking powder (omega), bakery fats (Simas), sugar (Golden penny) and salt (Uncle palm) were purchased from Gboko Main Market, Benue State, Nigeria.

Acha flour was prepared using the method of Olapade (2002). The acha grain was winnowed to remove the chaff, stones and other extraneous materials were picked manually .The acha grains was then washed and oven dried at 45^{o} c for 12h.The dried acha then was milled using attrition milling machine (model R 175A) to fine powder then packaged in polyethylene bags and stored under room temperature. The method of Tarhemba and Asemave (2019) was used in the preparation of pineapple fibre flour. The pineapple fruits were washed with (water) and peeled manually (stainless steel knife) and the peels. The peeled fruits were sliced into small cubes and passed through a rotary wedge Kraus-Maffei with a 3 mm hole sieve plate through which shredded pineapple pulp was forced out. The resulting pineapple pomace was poured into a cloth filter and the juice pressed out and the residue (pulp) dried at 55 ^{o}C using a hot air oven.

Blend formulation

The composite flour was formulated by substituting proportions of pineapple fibre flour into acha flour as shown in Table 1.

Table 1: Formulation of acha-pineapple fibre composite flour for biscuit production

Sample	PDF (g)	Acha Flour (g	Sugar (g)	Salt (g)	Baking Powder (g)	Fat (g)	Water(ml)
A	0	100	5	0.5	1	5	60
B	2.5	97.5	5	0.5	1	5	60
C	5.0	95.0	5	0.5	1	5	60
D	10.0	90.0	5	0.5	1	5	60

PPF = Pineapple fibre flour

Production of the biscuit samples

Acha - Pineapple pulp fibre flour biscuit was produced from the various samples using the method described by Ayo and Nkama (2003). The various blends were thoroughly mixed (using Kenwood mixer model) into a consistent dough, the dough was filled and pressed out into predetermined sizes and shapes using biscuits cutters arranged in pre-oiled trays and baked in a pre-heated mechanical convection oven at 180^{o} C. The baked biscuits were allowed to cool down to room temperature and were packaged in polyethylene bags. The flow chart for the biscuit production is as shown in Figure 1.

Ingredients weighing
↓
Mixing
↓
Kneading
↓
Moulding
↓
Baking (180^{o}C for 20 min)
↓
Cooling
↓
Packaging
↓

Storage
↓
Biscuits

Figure 1: Production of acha –pineapple fibre biscuit (Ayo and Nkama, 2003)

Proximate composition Analysis

The proximate composition analysis was carried out to determine nutrient composition of the formulated biscuit samples. The samples were analysed in triplicates for crude protein, crude fibre, crude fat, moisture, and ash content using the analytical method described by AOAC (2010)

Mineral and vitamin Analysis

The methods of AOAC (2010) were also employed for mineral and vitamin composition analysis of the biscuit samples. The samples were also analysed in triplicates for Potassium, Magnessium, vitamin A and vitamin C content. The average values of the three measurements were extrapolated.

Sensory Evaluation

Thirty-five (35) panelists who are familiar with biscuit quality parameters were randomly selected from the students of the University of Mkar. The sensory evaluation room was well lit and air-conditioned to ensure the comfort of panelists as well as to prevent exterior distractions. The sensory panelists were asked to evaluate the randomly coded using on a 9 – point hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor a dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) for color, taste, flavor and overall acceptability as described by Ihekoronye and Ngoddy (2005). The biscuit samples were served in 3-digit coded polytene bags. The panelists were presented with clean tap water to rinse their mouths in between evaluations

Statistical Analysis

The data were analyzed using one-way analysis of variance (ANOVA) using statistical package for social sciences (SPSS) software version 22. Duncan's multiple range test (DMRT) was used for mean separation at $p<0.05$.

III. Results And Discussion

Proximate Composition of Biscuits produced from Acha – Pineapple pulp fibre Blends

The proximate composition of biscuits produced from acha supplemented in the pineapple pulp dietary fibre is presented in Table 2. The moisture content of the biscuits decreased significantly ($p<0.05$) when more pineapple pulp dietary fibre was supplemented into the formulation. This was an indication that acha flour contained more moisture than pineapple pulp dietary fibre. The differences in moisture contents of the biscuit samples may be attributed to the hygroscopic nature of acha flour. Acha flour is described as being hygroscopic implying it absorbs moisture when exposed to atmospheric humidity (Jideani, 2010). It may, therefore, have allowed the absorption of moisture in high acha flour-containing samples which eventually reduced as the level of acha flour in the formulations also reduced.

Moisture content has a relationship with the shelf stability of a food product in that the higher the moisture content, the lower the shelf stability, and vice versa (Atume *et al.,* 2018). Sample A (composed of 100% Acha flour) had a moisture content of 14.25% but the incorporation of 2.5%, 5%, and 10% pineapple pulp dietary fibre into the formulations significantly ($P<0.05$) decreased the moisture content of biscuit samples B, C and D to 12.26%, 12.04%, and 11.61%, respectively. Biscuit above 12% moisture is liable to mold infestation and hydrolytic rancidity (Ayo and Ayo, 2018). The biscuit samples (B, C, and D) can be safely stored as they were all within the 12% maximum moisture content recommended for the safe storage of baked products.

The ash content of a food is an indicator of its mineral content (Lasekan, 2014). The formulated biscuit samples were low in ash content. Sample A contained 3.12% ash which significantly ($P<0.05$) decreased to 2.99%, 2.53%, and 2.00% in samples B, C, and D at the incorporation of 2.5%, 5%, and 10% pineapple pulp dietary fibre in the formulations respectively. This implied that pineapple pulp dietary fibre contained more ash. Thus, its incorporation in the biscuit increased ash content to levels that were significantly ($P<0.05$) different. In separate research works, Jideani and Akingbala (2013) and Ayo and Ayo (2018) reported ash content 4.78% and 4.85% in acha flour while Tarhemba and Asemave (2019) reported pineapple pulp to have contained 1.04%ash. Ayo (2018) explained that a correlation exists between the ash content of food and its mineral content. High ash contents of food indicate high mineral content. The recommended dietary allowance (RDA) for ash ranges between 7.0 – 9.2 %/day (FAO, 2015) Based on this standard, all the acha- pineapple fibre biscuit samples ash was less than FAO recommended daily intake.

The crude fibre contents of the acha –pineapple pulp biscuit increased significantly (P<0.05). This result was expected as the pineapple pulp fibre to the acha. Acha had higher fibre content. This result also showed that acha flour has low fibre content. The low fibre content of acha flour was explained by Ayo and Ayo 2018) who reported that acha flour has low cellulose content that is easily broken down, giving it a low fibre content of 2.01%. Different values of crude fibre have been reported in both acha seeds and pineapple pulp with many attributing the differences to the chemical composition of the soil upon which the crops were planted.

Sample A (100% acha biscuits) was highest in protein. The acha –pineapple pulp fibre but its protein content significantly (P<0.05) reduced as the acha flour in the formulation was substituted with pineapple pulp dietary fibre. This result was a confirmation of the findings of Ayo *et al.,* (2018) who reported acha seeds to contain 9.36% protein and rated acha seeds as one of the most proteinous cereals. The protein content of the biscuit samples decreased with an increase in the amount of pineapple pulp dietary fibre in the formulation. This result is an indication that the pineapple pulp dietary fibre supplemented into the formulations was lower in protein.

Significant (P<0.05) differences were observed in the crude fat contents of all the samples. This result showed that the difference in the crude fat contents of acha flour and pineapple pulp is pronounced. These findings were in agreement with the findings of the Ogbonnaya and Abdul-kadir (2008). The decrease in the protein and carbohydrate content of the blends biscuits with an increase in added pineapple fibre could be due to the relatively lower content of the same pineapple fibre than acha.

Table 2: Proximate Composition of rats fed with Biscuits produced from Acha – Pineapple pulp fibre Blends (%)

Samples	Moisture	Protein	Fibre	Ash	Fats	CHO
A	$14.25^{a}\pm0.05$	$8.28^{a}\pm0.01$	$2.87^{d}\pm0.75$	$3.12^{d}\pm0.01$	$7.50^{a}\pm0.01$	$67.70^{d}\pm0.68$
B	$12.26^{b}\pm0.03$	$7.16^{b}\pm0.01$	$3.83^{c}\pm0.03$	$2.99^{c}\pm0.01$	$6.83^{b}\pm0.29$	$67.58^{c}\pm0.05$
C	$12.04^{c}\pm0.03$	$6.93^{c}\pm0.01$	$4.42^{b}\pm0.55$	$2.53^{b}\pm0.01$	$6.44^{c}\pm0.01$	$67.39^{b}\pm0.56$
D	$11.61^{d}\pm0.03$	$6.28^{d}\pm0.01$	$5.10^{a}\pm0.01$	$2.00^{a}\pm0.01$	$6.19^{d}\pm0.33$	$66.40^{a}\pm0.06$

Values are means ± standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly different (p<0.05).

Key:
A = Biscuit prepared from 100% Acha (control sample)
B = Biscuit prepared from 97.5% Acha and 2.5% pineapple pulp fibre
C = Biscuit prepared from 95% Acha and 5% pineapple pulp fibre
D = Biscuit prepared from 90% Acha and 10% pineapple pulp fibre

Mineral and vitamin content biscuits produced from Acha – Pineapple pulp fibre blends

Table 3 presents the result of mineral and vitamin content of biscuits from Acha supplemented with pineapple pulp fibre (PPF).

The potassium content of the biscuit samples increased from 215.20 mg/g in sample A to 232.18 mg/g in sample B, 251.11 mg/g in sample C, and 266.98 mg/g in sample D. this increase in potassium content was significant (p<0.05) across all the biscuit samples. This increase in the potassium content of the samples as the formulations were varied to include more pineapple pulp dietary fibre is an indication that pineapple pulp dietary fibre contains more potassium than acha flour. This result is in agreement with the findings of Tarhemba and Asemave (2019) who reported high potassium content (251 mg/g) in pineapple pulp and Ayo *et al.,* (2017) who in a separate study on the effect of pretreatments on the quality of Acha flow and acha flour-based biscuits reported a comparatively lower value of potassium (216 mg/g) in acha flour.

Potassium is one of the most important minerals in the body. It helps to regulate fluid balance, muscle contractions, and nerve signals. 3500 mg/day has been recommended as the body"s daily need for potassium (FAO, 2015). Potassium content above the recommended daily allowance (RDA) has been reported to be the prime cause of hyperkalemia, a condition that affects the human kidney (Pilch, 2017). Although the potassium content of the biscuits produced from acha flour supplemented with pineapple pulp dietary fibre was lower than the RDA (3500 mg/g) it was high enough to provide health benefits to the body. Bonire *et al* (2012) reported 150 mg/g of potassium to have provided optimal nerve impulse and muscle contractions in rats fed with a specially formulated diet that contained 150 mg/g of potassium. This result implied that the potassium content of all the processed biscuit samples was high enough to provide consumers of the biscuit with all the nutritional and health benefits associated with the consumption of potassium-rich foods and at the same time, low enough to prevent the occurrence of hyperkalemia.

The manganese content of the biscuit samples also increased with an increase in the amount of pineapple pulp dietary fibre supplemented into the formulations indicating that pineapple pulp dietary fibre contains more manganese than acha flour. Tarhemba and Asemave (2019) reported 57 mg/g of manganese in pineapple pulp whereas 43 mg/g of manganese was reported in Acha flour by Ojimelukwe (2009). Thus, the findings of the present study are in line with that of other researchers. An increase in the manganese content of the biscuits was significant (P<0.05) between samples A and B but insignificant (p>0.05) in samples C and D.

Manganese is a trace mineral that is very important for the human body. It contributes to many bodily functions including the metabolism of amino acids, cholesterols, and carbohydrates. It also plays a role in bone formation, blood clotting, and reducing inflammation (Pascual, 2001) The human body cannot produce manganese, the manganese from the diet is stored in the liver, pancreas, bones, brain, and kidney (Purves, 2003). The RDA for manganese is between 35-50 mg/day (FAO, 2015). This implied that the manganese content of all the biscuit samples (43.11 mg/g for sample A, 45.28 mg/g for sample B, 47.25 mg/g for sample C, and 48.80 mg/g for sample D) were within the recommended range and were all capable of providing the health benefits associated with the consumption of manganese-rich diets.

The values of potassium (215.20 mg/g) and manganese (43.11 mg/g) reported for 100% acha biscuit in the present study were slightly lower than those reported by other researchers in the literature. Ayo *et al.,* (2015) reported 247.08 mg/g of potassium and 44.93 mg/g of manganese in acha biscuits. The lower potassium and manganese content reported in the present study may be due to variations in the mineral composition of the soil upon which the acha used in the present study was cultivated. Atume *et al.,* (2018) reported the mineral composition of soil varies from one geopolitical region to another and it influences the mineral composition of crops grown on them. The lower potassium and manganese content of acha recorded in this study may also be attributed to the presence of ant nutrient factors like trypsin, phytate, and tannins in the cereal which are capable of limiting the bioavailability of minerals in crops (Rachie, 2004).

Vitamins are essential compounds that help the body grow and function optimally. The biscuit samples were analyzed for vitamins A and C. These vitamins were selected based on the recommendations of other researchers (Ayo and Ayo, (2018) and Ogbonnaya and Abdul-kadi (2008)) that they are the prominent vitamins in acha flour and they exert the highest antioxidant activity amongst other vitamins contained in acha.

The amounts of vitamin A in all the biscuit samples were low and failed to meet the RDA of 15 mg/day (FAO, 2015). This result implication is that the processed acha biscuit supplemented with pineapple pulp dietary fibre does not contain enough amounts of vitamin A to provide health benefits like the protection and maintenance of sight and should not be depended on as the sole source of vitamin A to the body.

Vitamin C plays an important role in several body functions including the production of collagen, Lcarnitine, and some neurotransmitters. It helps metabolize proteins and reduce the risk of some cancers through its antioxidant activity and free radical scavenging (Indian Food and Nutrition Board, Institute of Medicine, 2000). It is, however, not synthesized by the human body and is difficult to store since it is water-soluble. Therefore, a continuous supply of vitamin C to the body through diet is to be ensured. The formulated biscuit samples had low vitamin content as compared to 30.06 mg/g and 31.00 mg/g reported in the literature for acha biscuits (Ogunsina, *et al.,* (2010) and Hooda and Jood, (2005)). The lower values of vitamin C recorded in this study may be attributed to some processing unit operations that were used during the processing of the flour blends into biscuits particularly the baking unit operation. Vitamin C is heat-labile and the baking temperature (218ºC) was high enough to have a reducing and lowering effect on the vitamin C content of the baked biscuits. Gernah *et al.,* (2012) reported vitamin C to be readily lost in a product if thermal processing methods were employed in its production.

Sample A contained 29.36 mg/g vitamin C which reduced to 20.00 mg/g in sample B, 17.21 mg/g in sample C, and 15.00 mg/g in sample D. The decrease in vitamin C content of the samples as the percentage composition of Acha flour decreased and pineapple pulp dietary fibre increased indicated more vitamin C were contained in acha flour than pineapple pulp dietary fibre. Differences in the vitamin C content of the biscuit samples were significant across all the samples. All the biscuit samples contained an amount of vitamin C that was lower than the 60 mg/g recommended for daily intake of vitamin C.

Table 3: Mineral and vitamin contents of Biscuits produced from Acha – Pineapple pulp fibre Blends

A	$215.20^{d}\pm 0.02$	$43.11^{a}\pm 0.06$	$2.53^{a}\pm 0.02$	$29.36^{a}\pm 0.06$
B	$232.18^{c} \pm 0.01$	$45.28^{b}\pm 0.07$	$1.68^{b} \pm 0.01$	$20.00^{b}\pm 0.07$
C	$251.11^{b} \pm 0.03$	$47.25^{c}\pm 0.01$	$1.44^{c} \pm 0.03$	$17.21^{c}\pm 0.01$
D	$266.98^{a} \pm 0.01$	$48.80^{c}\pm 0.01$	$1.15^{d} \pm 0.01$	$15.00^{d}\pm 0.01$

Values are means ± standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly different (p<0.05).

Key:
A = Biscuit prepared from 100% Acha (control sample)
B = Biscuit prepared from 97.5% Acha and 2.5% pineapple pulp fibre
C = Biscuit prepared from 95% Acha and 5% pineapple pulp fibre
D = Biscuit prepared from 90% Acha and 10% pineapple pulp fibre

Sensory Evaluation of Biscuits produced from Acha – Pineapple pulp fibre Blends Consumer‟s appetite for food is stimulated or dampened by physical attributes such as its Appearance. Biscuit sample A had the most preferred means scores for sensory appearance (7.40) followed by sample B (7.25), C (7.15), and D (7.00) in that order as shown in Table 4. The three most preferred products (A, B, and C) contained high proportions of Acha (100%, 97.5%, and 95%). Conversely, the least preferred product (sample D) contained the least amount of Acha (90%).

The consumer‟s preference of the biscuits appearance decreased significantly ($p<0.05$) from a mean score of 7.40 in sample A to 7.25 in sample B, 7.15 in sample C, and 7.00 in sample D when formulations were altered in the respective samples to contain increased amounts of pineapple pulp dietary fibre. This trend may be attributed to the earlier reports that consumer‟s preference for food in terms of appearance (Ogazi *et al.*, 2010). Research by Jideani and Akingbala, (2013) showed Acha is a rich source of carotenoids that impact colorful appearance on the cereal. Pineapple, on the other hand, has also been reported to be a good source of carotenoids but the bulk of the carotenoid is contained in the pulp itself leaving a great possibility of carotenoid deficiency in pulp extracts like dietary fibre (Tarhemba and Asemave, 2019). It is therefore understandable that the consumer‟s preference for the biscuit samples decreased as the amount of acha flour in the formulations also decreased.

Differences in mouth feel scores amongst all the biscuit samples were significantly different ($P<0.05$). Sample A (6.50) had the least mouth feel score than all other biscuit samples. This low mouthfeel score may be attributed to perceived high oxalate content of the biscuit (0.89mg/100g). Oxalates have been reported to impart a bitter taste to foods and beverages and this must have affected the consumer‟s preference of the sample in terms of mouthfeel (Igbabul *et al.*, 2014). Sample B scored 6.85 while sample C had a mouth feel score of 8.90and was the most preferred product by the panelists in terms of mouthfeel. The mouthfeel score dropped to 6.55±1.93 in sample D as the level of pineapple pulp dietary fibre was increased in the formulations. It is reported that pineapple contains high phenolics and phenolic compounds are known to improve the taste, flavor, and mouth feel of foods (Siddhuraju and Becker, 2013). This explains why the consumer‟s preference of the biscuit samples in terms of mouthfeel increased with an increased amount of pineapple pulp dietary fibre in the formulations. The decrease in consumer preference observed in sample D where the amount of pineapple pulp dietary fibre was increased to 10% may be due to an overemphasize pineapple aroma in the biscuit sample D which consumers feel was too pronounced to be desirable.

The flavor of foods including biscuits describes the lasting impression of the food after consumption and it seems to mask acceptable attributes such as taste and aroma since it is often perceived last. As the taste of new products such as biscuits is a crucial determinant of acceptance, flavor plays a similar role (Moors, 2012).

Dietary fibres are known to have a slightly bitter after taste which, however, does not linger for long and this could be the reason for the low flavor score of sample D which contained high amounts of the dietary fibres. As the concentration of pineapple pulp dietary fibre was increased in the formulations, a threshold was met at sample C where incorporation of more dietary fibre into the formulations tends to decrease the panelist's preference since the biscuits developed had a slippery mouthfeel.

Sample C had the highest mean score in overall acceptability (8.01±0.12) of the formulated biscuits. This was expected as it was the most preferred biscuit in flavor (8.00), mouth feel (8.90), and crispness (7.90). Conversely, sample D was the least preferred product in overall acceptability (6.80). This too was not strange as it was least preferred in all the sensory parameters that were evaluated. The mean score for overall acceptability of sample C was significantly ($P<0.05$) different from all the other biscuit samples ($P<0.05$). The mean overall acceptability score of sample D was also significantly ($P<0.05$) different from that of the other samples. However, the mean overall acceptability scores for samples A (7.00) and B (7.08) were not significantly ($P<0.05$) different.

Sample C had an overall acceptability score of 8.01which means it is "liked very much", samples A and B had 7.00and 7.08meaning they were "liked moderately" while sample D scored 6.8 meaning it was "liked slightly". This implied that none of the formulated biscuit samples was disliked. Sample C made from 95% Acha and 5% pineapple pulp dietary fibre can be produced on a commercial scale with assured confidence of consumers‟ acceptance.

Table 4: Sensory properties of rats fed with biscuits produced from Acha – Pineapple pulp fibre blends

Attributes					
Samples	**Appearance**	**Flavour**	**Mouthfeel**	**Crispness**	**Acceptability**
A	$7.40^a \pm 1.14$	$7.20^b \pm 1.94$	$6.50^c \pm 2.28$	$6.90^c \pm 0.00$	$7.00^b \pm 0.03$

B	$7.25^{b} \pm 1.28$	$7.15^{b} \pm 1.69$	$6.85^{b} \pm 1.81$	$7.25^{b} \pm 0.00$	$7.08^{b} \pm 0.05$
C	$7.15^{c} \pm 1.50$	$8.00^{a} \pm 2.43$	$8.90^{a} \pm 1.85$	$7.90^{a} \pm 0.00$	$8.01^{a} \pm 0.12$
D	$7.00^{d} \pm 1.12$	$6.75^{c} \pm 1.94$	$6.55^{c} \pm 1.93$	$6.90^{c} \pm 0.00$	$6.80^{c} \pm 0.08$

Values are means ± standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly different ($p<0.05$).

Key:
A = Biscuit prepared from 100% Acha (control sample)
B = Biscuit prepared from 97.5% Acha and 2.5% pineapple pulp
C = Biscuit prepared from 95% Acha and 5% pineapple pulp
D = Biscuit prepared from 90% Acha and 10% pineapple pulp

IV. Conclusion

The research has shown that pineapple pulp fibre can be added to acha flour to improve the nutrients content. The fibre content of acha pineapple fibre blends was significantly improved by the addition of the pineapple pulp fibre. The most preferred and acceptable blend biscuits are that with 5% pineapple pulp fibre flour.

Consequently, 95% Acha flour and 5% pineapple pulp dietary fibre can be used as composite flour to produce biscuits of good quality that will promote snack consumption that will serve as a measure towards achieving food security. This will encourage the consumption of indigenous products, create employment opportunities too many Nigerians and culminate in economic development as biscuit imports will also reduce.

Acknowledgment

The author acknowledges Tertiary Education Trust Fung (Tetfund) for funding this research

References

[1] Ackom, N. B And Tano D.K. (2012). Processing Pineapple Pulp Into Dietary Fibre Supplement.African Journal Of Food, Agriculture, Nutrition And Development, 12, 6823- 6834.
[2] Adeniji, T.A., Barimalaa, I.S And Achinewhu S.C. (2006). Evaluation Of Bunch Characteristics And Flour Yield Potential In Black Sigatoka Resistant Plantain And Banana Hybrids. Global Journal Of Pure And Applied Science 12(1): 41-43.
[3] Ahmed, S., Guptan, D And Srivastava, A.K. (2013). Studies On Development, Quality Evaluation And Storage Stability Of Weaning Food Prepared From Multipurpose Flour Papaya Powder And Milk Powder. Journal Of Food Process Technology 4(2): 201.
[4] AOAC, (2012). Official Methods Of Analysis. Association Of Official Analytical Chemists.18th Edn. Washington D.C., USA.
[5] Ayo, J.A And Ayo, V.A (2018). Proximate Composition, Physical And Sensory Quality Of Acha-Moringa Seed Flour Blend Biscuits. Asian Food Science Journal 5(2): 1-7; 43505.
[6] Ayo, J.A And Nkama, I. (2003).Effect Of Acha (Digitaria Exilis) Grain Flours On The Physical And Sensory Quality Of Biscuit. Journal Of Nutrition And Food Science. 33(3): 125-130. Https://Doi.Org/10.1108/00346650310476122
[7] Ayo, J.A., Ayo, V.A., Popoola, C., Omosebi M. And Joseph, M. (2014).Production And Evaluation Of Malted Soybean-Acha Composite Flour Bread And Biscuits. African Journal Food Science And Technology. 5(1):2128.
[8] Ayo, J.A., Nkama, I, Haruna, U.S., Bitrus, Y And Onajaife, F. (2018). Effect Of Dough Improvers On The Physical And Sensory Quality Of Acha (Digitaria Exilis) Flour Bread.Nigeria Food Journal. 26:102–110.
[9] Ayo, J.A., Ojo, M.O., Popoola, C And Chieshe, E. (2017). Effects Of Pretreatments On The Quality Of Acha Flour And Acha Flour Based Biscuit. Journal Of Agriculture And Life Sciences, Fed. University Wukari. 1(1): 56-59.
[10] Baskaran, V., Malleshi, M., Jayaprakashan, S.G And Lokesh, R. (2011). Biological Evaluation For Protein Quality Of Supplementary Foods Based On Popped Cereals And Legumes Suitable For Feeding Rural Mothers And Children In Indian Journal Of Plant Foods Human Nutrition 56(1): 37-49.
[11] DAFF (2012) Department Of Agriculture, Forestry And Fisheries. A Profile Of The South African Pineapple Market Value Chain.Http://Www.Nda.Agric.Za/Docs/AMCP/Pmcp2012.Pdf. (Accessed 27 November 2013).
[12] De Lumen, O., Thompson, S And Odegard, J.W. (2003). Sulphur Amino Acid Rich Proteins In Acha (Digitaria Exilis), A Promising Underutilized African Cereal. Journal Of Agriculture And Food Chemistry 11(41): 1045-1047.
[13] Dhingra, S And Jood, S. (2002). Organoleptic And Nutritional Evaluation Of Wheat Bread Supplemented With Soybean And Barley Flour. Journal Of Food Chemistry. 77:479-488.
[14] Duncan, D.B. (1955). New Multiple Range And Multiple F Tests.Biometrics 11:1-11.
[15] FAO. (2015). Amino Acid Content Of Foods And Biological Data On Proteins. FAO Nutritional. Studies, Food And Agriculture Organization Of The United Nations, Rome, Pp: 285.
[16] Fibiz, T.M. (2011). Fibiz Dietary Fibre.Product Specification Sheets. Http://Www.Summerpride.Co.Za/. (Accessed 13 July 2013).
[17] Gernah D.I., Ariahu, C.C., Ingbian, E.K. (2012). Nutritional And Sensory Evaluation Of Food Formulations From Malted And Fermented Maize (Zea Mays L.) Fortified With Defatted Sesame
[18] (Sesamunindicum L.)Flour.African Journal Of Food Agriculture Nutrition And Development 12(6): 6614-6631.
[19] Hamner, K.C. (2012), Ascorbic Acid Content Of Pineapples As Correlated With Environmental Factors And Plant Composition. Journal Of Food Science. 11(6):17.24
[20] Hooda, S. And Jood, S. (2005). Organoleptic And Nutritional Evaluation Acha Biscuits Supplemented With Untreated And Treated Fnugreela Flour. Journal Of Food Chemistry. 90:427-435.
[21] Huang, Y., Chow, C And Fang, Y. (2011). Preparation And Physicochemical Properties Of Fibre-Rich Fraction From Pineapple Peels As A Potential Ingredient. Journal Of Food And Drug Analysis, 19, 318-323.
[22] Ihekoronye A.I. And Ngoddy P.O. (2005).Integrated Food Science And Technology For The Tropics. Macmillian Publishers Limited, London, P 236-253
[23] Indian Food And Nutrition Board, Institute Of Medicine (2000). Dietary Reference Intakes For Vitamin C, Vitamin E, Selenium, And Carotenoids. Washington DC: National Academies Press.

[24] Indian Food And Nutrition Board, Institute Of Medicine (2012). Dietary Reference Intakes For Vitamin C, Vitamin E, Selenium, And Carotenoids. Washington DC: National Academies Press,

[25] Jideani, A.I And Akingbala, J.O. (2013).Some Physicochemical Properties Of Acha (Digitaria Exilis Stapf And Digetaria Iburua Stapf) Grains. Journal Of Food Science And Agriculture 63: 369-374.

[26] Jideani, I.A., Owusu, R.K And Muller, H.G. (2004). Proteins Of Acha (Digitaria Exilis Stapf): Solubility Fractionation, Gel Filtration And Electrophoresisof Protein Fractions. Journal Of Food Chemistry 51:51–59.

[27] Kahlon, T.S. (2009). Evaluating Healthful Properties Of Cereals And Cereal Fractions By Their Bile-Acidbinding Potential.Cereal Foods World. (5)4:118–121.

[28] Larmond, E. (2007). Laboratory Methods For Sensory Evaluation Of Foods.Publication No.1637. Canada Department Of Agriculture, Ottawa

[29] Lasekan, D.O. (2004). Chemical Composition Of Acha (Digitaria Exilis) Flour. J. Food Sci. Agric. 14:177179.

[30] Lasekan, O.O. (2014). Chemical Composition Of Acha (Digitaria Exilis) Flour.Journal Of Food Science And Agriculture 14:177–179.

[31] Nawirska, A And Uklanska, C. (2008).Waste Products From Fruit And Vegetable Processing As Potential Sources For Food Enrichment In Dietary Fibre. Acta Science. Pol., Technol. Aliment. 7, 35-42.

[32] Ogbonnaya, C And Abdul-Kadir, A.J. (2008).Proximate Chemical Composition Of Acha (Digitaria Exilis And Digitaria Iburua) Grains. Journal Of Food Technology, 6 (5): 214-216.

[33] Ogunsina, B., Radha, C And Indrani, D. (2010). Quality Characteristics Of Bread And Biscuits From Acha Flour Enriched With Debittered Moringa Oleifera Seed Flour. International Journal Of Food Science And Nutrition. 62:185-194.

[34] Olapade, A.A And Aworh, A.A. (2002). Evaluation Of Extruded Snacks From Blends Of Acha (Digitaria Exilis) And Cowpea (Vigna Unguiculata) Flours. International Food Research Journal. 14 (3), 210-217

[35] Onwuka G.I. (2005). Food Analysis And Instrumentation.Theory And Practice. Naphtali Prints. A Division Of HG Support Nigeria Limited, Surulere, Lagos, Nigeria, Pp133-137.

[36] Opeoluwa, O. O. Ijarotimi, O. S And Fagbemi, T. N. (2015). Evaluation Of Nutritional Properties Of High Protein-Fibre Based Snacks Formulated From Wheat, Soybeans Concentrate And Cassava Fibre. Sky Journal Of Food Science, 4(3): 030-041

[37] Paul, N. G. (1980). Some Methods For The Utilisation Of Waste From Fibre Crops And Fibre Waste From Other Crops. Journal Of Agricultural Wastes, 2, 313-318.

[38] Rosell, C. M., Santos, E And Collar, C. (2009). Physico-Chemical Properties Of Commercial Fibres From Different Sources: A Comparative Approach. Journal Of Food Research International, 42, 176-184.

[39] Tarhemba, P.T And Asema, K. (2019).Nutritional Profile Of Some Pineapple Varieties. Journal Of Food Science And Nutrition. 11(9):14-19

[40] Temple, V.J And Bassa, J.D. (2001).Proximate Chemical Composition Of Acha (D. Exilis) Grain.Journal Of Acience And Food Agriculture 56:561-563.

[41] Uckiah, A., Goburdhun, D And Ruggoo, A. (2009). Vitamin C Content During Processing And Storage Of Pineapple.Journal Of Nutrition And Food Science. 39(4):398-412.

[42] Yada, S. Huang. L, K And Hung. G.W. (2011). A Review Of Composition Studies Of Biscuits: Macronutrients And Micronutrients. Journal Of Food Composition Analysis; 24. 464-480.