Journal of Arid Agriculture

J. Arid Agric. 2025, Vol. 25 (2): 125 - 132
Available Online at www.jaaunimaid.ng

0189-7551

QUALITY EVALUATION OF *ACHA* AND PINEAPPLE PULP FLOUR BLEND BISCUITS

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ABSTRACT: The quality of biscuits produced from blends of *acha* flour and pineapple pulp flour (PPF) were investigated. The PPF was substituted into *acha* flour at 2.5, 5 and 10 %. The 100% *acha* served as the control. The chemical, phytochemical and sensory properties of the biscuits were determined using standard methods AOAC, 2015. The moisture, protein, ash, fats and carbohydrates contents of the *acha*-pineapple flour 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 fiber content increased from 2.87 to 5.10 % with an increase in added pineapple flour (0-10%). The tannin, *saponin, phytate* and oxalate content of the *acha*-pineapple pulp flour composite biscuits increased from 0.90 to 1.75, 2.98 to 9.84, 1.07 to 1.20 and 0.89 to 1.11 mg/g, respectively, with an increase in the added pineapple fiber (0-10%). Generally, all the flour blended biscuits produced from acha and pineapple flour blend were all acceptable, but the most preferred was that containing 5% pineapple pulp flour. The acceptability of *acha* flour in food baking process will greatly reduce the dependence on imported wheat flour with subsequent decrease in cost of production and sales of baked products with great open door for commercial production of *acha* grain and pineapple fruits in the agricultural sectors.

Key Words: Quality, *Acha*, Pineapple Pulp, Biscuits

INTRODUCTION

Biscuits are snacks of high demand by all age groups. They are easy to carry, tasty, low in cholesterol and reasonably low cost. 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 (Ayo *et al* 14). In Nigeria, about 25 percent of the wheat is used in the preparation of baked goods (Ayo et al., 2007; Ayo *et al* 2023). Nigeria is a country fully depending on importation of wheat which had caused increase in the cost of baked products. The federal government has through intensive collaboration with research institutes, encouraged the use of composite flours in the production of bread and related food products such as biscuits (Okaka and Isieh, 2010). This initiative has enhanced the uses of flours from underutilized cereals such as *acha*, sorghum and millet in baking industries. The adoption of these locally produced flours in the bakery industry will increase the utilization of indigenous crops cultivated in Nigeria and also lower the cost of bakery products (Ayo *et al* 2023).

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, Ayo *et al* 2024, Jideani 2012). 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*

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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, Rachie 2004; Ayo and Nkama 2006). Proximate analysis of *acha* revealed the following; 7.7% protein, 1.8% fat, 71% carbohydrate, and 6.8% fibre (Jideani and Jideani 2011). The protein of the grain is rich in methionine and cysteine which are vital for human health but lacking in most cereals (Sarwar, 2013).

Recent study has shown *acha* grain to have high water absorption capacity, a property that could be linked to appreciable amount of pentosan (Jideani and Jideani, 2011). The high-water absorption capacity of *acha* could be utilized in baked food. Pentosan has been found to be a very important regulator of water absorption in dough (Ayo and Kajo, 2016).

Pineapple (*Ananas comosus*) is a tropical fruit. 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}. 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 fiber is a group of food components that is resistant to hydrolysis by human digestive enzymes and necessary for promoting good health (Prakongpan *et al.,* 2006). Dietary fiber has also been reported as one of the components that assist in preventing and managing prediabetes and type 2-diabetes (Jideani and Jideani, 2011). In recent times, it has been reported that there are several diseases relating to inadequate consumption of high fiber diets (Sylvia *et al.,* 2014). Upgrading the fiber content of these snacks involves the utilization of inexpensive fiber sources.

In Nigeria, reliance on wheat flour in the pastry and bakery industries has over the years restricted the use of other cereals and tuber crops available for domestic use (Gernah, *et al.* 2012). The high demand and soaring price of wheat and the inability of the developing countries like Nigeria to meet this demand calls for research into alternative local sources of flour for baking, example *acha*, cassava, millet, sorghum, etc. The broad objective of the research is to evaluate the quality of biscuits produced from *acha* and pineapple pulp flour.

MATERIAL AND METHODS

Materials

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 preparation: *Acha* flour was prepared as described by 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 45ºC for 12h. The dried *acha* then was milled using attrition milling machine (Mill Powder crusher Model F-237Sill Code 11014) to fine powder then packaged in polyethylene bags and stored under room temperature.

Preparation of pineapple pulp: The method of Tarhemba and Asemave (2019) was used in the preparation of pineapple pulp flour. The pineapple fruits were washed with (water) and peeled manually (with a stainless-steel knife) and the peels discarded. The peeled fruits were sliced into small cubes and passed through a rotary wedge Kraus-Maffei (Blender Grinder Mill model BLG-452 Binatone CE Made in China) 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 ºC using a hot air oven (Dry oven Model NL - 9023A New Life Scientific Equipment).

Formulation of acha and pineapple pulp composite flour: The composite flour was formulated by substituting pineapple pulp flour at 2.5, 5.0, 10.0, and 12.5% into acha flour and mixed with salt (0.5%) and baking powder (1.0%). The fats (5%) was blended with the sugar (5%) to form a homogeneous and mixed with the flour blends. The 100% acha flour biscuit was served as the control (Ayo et al 2022 and Ayo et al 2023).

Production of *acha* - pineapple pulp flour biscuit: Acha - Pineapple pulp fibre flour biscuit was produced from the various samples using the method described by Ayo and Nkama (2003). These blends that contained (2.5,5.0 and 10% pulp) were thoroughly mixed (using Kenwood mixer model Model NL -9023A New Life Scientific

Equipment) 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.

METHODS

Proximate analysis

The moisture, ash, crude protein, crude fat, fiber content were determined using AOAC (2015) method while the total carbohydrate content was determined by difference as described by Ayo *et al* (2023). This was done by subtracting the percentage of moisture, ash, protein, fibre, and fat obtained from 100 %. Thus, % Carbohydrate = 100 - (%Moisture + %Ash + %Protein + %Crude fibre + % Fat).

Minerals and vitamins Determination: The potassium, manganese element, vitamin A and C were determined using AOAC (2015) method.

Phytochemicals analysis: Tannins, phytate, oxalate content: were determined by AOAC (2015) method while saponin was determined as described by Obadoni and Ochuko (2001). Twenty (20 g) gram of each milled sample was put into different conical flasks and 100 ml of 20% aqueous ethanol was added. The sample was heated over a hot water bath for 4 h with continuous stirring at about 55 ^{o}C. The mixture was then filtered and the residue again extracted with another 200 ml of 20% ethanol. The combined extract was reduced to 40 ml over a water bath at about 90 ^{o}C. The concentrate was transferred to a 250 ml separation funnel and 20 ml diethyl ether was added with vigorous shaking. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated and 60 ml of n-butanol was added. The combined n-butanol extract was washed twice with 10 ml of 5% aqueous sodium chloride and the remaining solution was heated in a water bath to a temperature of 42 ^{o}C. After evaporation, the sample was dried in the oven to a constant weight, and saponin content calculated as a percentage.

Sensory Evaluation

Thirty-five (35) panelists who are familiar with biscuit quality parameters were randomly selected from the students of the University of Mkar, Benue State, Nigeria. 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 biscuit using on a 9 - point hedonic scale (1 = dislike extremely and 9 = like extremely) for color, taste, aroma and overall acceptability as described by Ayo et al (2022). The biscuit samples were served in 3-digit coded polytene bags. The panelists were presented with portable clean tap water to rinse their mouths in between evaluations.

Statistical Analysis

The data obtained 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 $p<0.05$.

RESULTS AND DISCUSSION

Proximate composition of the composite *Acha* and Pineapple pulp flour blend Biscuits

The proximate composition of biscuit produced from *acha* flour supplemented with pineapple pulp flour blends is presented in Table 1. The moisture, protein, ash, fats, and carbohydrate contents of the *acha* and pineapple pulp blend 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 fiber content increased from 2.87 to 5.10% with an increase in added pineapple fibre flour (0-10%). The effects were significant, $p<0.05$.

This result was an indication that *acha* flour contained more moisture than pineapple pulp flour. The differences in moisture contents of the biscuit samples may be attributed to the hygroscopic nature of *acha* flour (Jideani, 2011). This observation corroborates the decrease in the moisture content with increase in the acha flour as observed in this work. Moisture content has a relationship with the shelf stability of a food product. The higher the moisture content, the lower the shelf stability, and vice versa (Atume *et al.*, 2018). Biscuit above 12% moisture is liable to mold infestation and hydrolytic rancidity (Ayo and Ayo, 2018). Biscuits produced from *acha* – pineapple pulp flour blends can be safely stored for longer period.

Table 1: Proximate Composition of Biscuits produced from *Acha* and Pineapple pulp flour Blends (%)

	Parameters (%)					
Samples Dm	**Moisture**	**Protein**	**Fibre**	**Ash**	**Fats**	**Carbohydrate**
A 85.7±7.1	14.25^{a}±0.05	8.28^{a}±0.01	2.87^{d}±0.75	3.12^{d}±0.01	7.50^{a}±0.01	67.70^{d}±0.68
B 87.7±8.4	12.26^{b}±0.03	7.16^{b}±0.01	3.83^{c}±0.03	2.99^{c}±0.01	6.83^{b}±0.29	67.58^{c}±0.05
C 88.0±9.2	12.04^{c}±0.03	6.93^{c}±0.01	4.42^{b}±0.55	2.53^{b}±0.01	6.44^{c}±0.01	67.39^{b}±0.56
D 88.4±8.6	11.61^{d}±0.03	6.28^{d}±0.01	5.10^{a}±0.01	2.00^{a}±0.01	6.19^{d}±0.33	66.40^{a}±0.06

Values are means ± standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly (p<0.05) different. : A = Biscuit prepared from 100% Acha (control sample); B = Biscuit prepared from 97.5% Acha and 2.5% pineapple pulp flour; C = Biscuit prepared from 95% Acha and 5% pineapple pulp flour; D = Biscuit prepared from 90% Acha and 10% pineapple pulp flour; ***Dm= Dry matter***

The blend biscuits were generally low in ash content. Sample A contained 3.12% ash which significantly (p<0.05) decreased to 2.99, 2.53, and 2.00% with increase in the added pineapple pulp flour (2.5%, 5%, and 10% pineapple pulp flour in the blends, respectively). In separate research works, Jideani and Akingbala (2013) and Ayo and Ayo (2018) reported ash content of 4.78% and 4.85% in *acha* flour. High ash contents of food indicate high mineral content (Lasekan, 2014). However the flour blends biscuits of this work fall below the recommended dietary allowance (RDA) of 7.0-9.2% (FAO, 2015).

The crude fibre contents of the *acha* –pineapple pulp biscuit increased significantly (p<0.05) from 2.87 to 5.10% with increase in the added pineapple pulp. The increase could be due to inherent high fiber content of pineapple pulp. Dietary fiber could improve the nutrient status since they could aid in nutrient absorption during digestion process (Ubboret et al., 2022)

The protein and fat content of *acha*-pineapple pulp flour blend biscuit decrease from 8.28 to 6.28, 7.50 to 6.19%, respectively with increase in added pineapple pulp. 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 flour could be due to the relatively lower content of the same in pineapple flour than acha flour,.

Mineral and Vitamin Contents of Biscuits from *Acha* and pineapple Pulp flour Blends

The mineral and vitamin content of the biscuits from the flour blends are shown in Table 2. The potassium and manganese content of the blend's biscuits increased significantly (p >0.05) from 215.20 - 266.98 and 43.11 to 48.80mg/g while the vitamin A and vitamin C decreased from 2.53 to 1.15mg/g and 29.36 to 15.00, respectively, with an increase in the added pineapple pulp flour.

Table 2 Mineral and vitamin contents of Biscuits produced from *Acha* and Pineapple pulp flour Blends

	Minerals (mg/g)		Vitamins (mg/g)	
Samples	**Potassium**	**Manganese**	**Pro-A**	**C**
A	215.20^{d}± 0.02	43.11^{a}± 0.06	2.53^{a}± 0.02	29.36^{a}± 0.06
B	232.18^{c} ± 0.01	45.28^{b}± 0.07	1.68^{b} ± 0.01	20.00^{b}± 0.07
C	251.11^{b} ±0.03	47.25^{c}± 0.01	1.44^{c} ±0.03	17.21^{c}± 0.01
D	266.98^{a} ±0.01	48.80^{c}± 0.01	1.15^{d} ±0.01	15.00^{d}± 0.01

Values are means ± standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly(p<0.05) different. A = Biscuit prepared from 100% Acha (control sample); B = Biscuit prepared from 97.5% Acha and 2.5% pineapple pulp flour; C = Biscuit prepared from 95% Acha and 5% pineapple pulp flour; D = Biscuit prepared from 90% Acha and 10% pineapple pulp flour

This increase in the potassium content could be due to inherent high content of the potassium in pineapple which agreed with findings of Tarhemba and Asemave (2019) who reported potassium content of 251 mg/g in pineapple pulp. Though far less than 3500 mg/day recommended as the body's daily need (FAO, 2015) but acceptable as pointed out by Bonire *et al* (2012) who reported that 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.

The relative increase in the manganese content (43.11 - 48.80mg/g) falls within the RDA (35-50 mg/day) (FAO, 2015) and also agreed with the work of Tarhemba and Asemave (2019) who reported 57 mg/g of manganese in pineapple pulp. Manganese could contributes to 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 produced biscuits had low vitamin C content as compared to 30.06 mg/g and 31.00 mg/g reported by Ogunsina, *et al.,* (2010) for *acha* biscuits. 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 (218^{o}C) 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. Vitamin C plays an important role in several body functions including the production of collagen, L-carnitine, 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).

Phytochemical contents of biscuits from *acha* and pineapple pulp flour blends

The phytochemical and anti-nutrient contents of the composite biscuit formulations is presented in Table 3. The tannin, saponin, phytate, and oxalate content of the *acha* –pineapple flour blends biscuits increased from 0.90 to 1.75, 2.98 to 9.84, 1.07 to 1.20, and 0.89 to 1.11 mg/g, respectively, with increase in the added pineapple flour (0-10%). The effects of added pineapple flour blends are significant p<0.05.

Table 3: Phytochemical content of biscuits produced from *acha* and pineapple pulp flour blends

	Phytochemicals (mg/g)				
Samples	**Tannin**	**Saponin**	**Phytate**	**Cyanide**	**Oxalate**
A	$0.90^{c} \pm 0.02$	$2.98^{a} \pm 0.06$	$1.07^{b} \pm 0.12$	$0.01^{b} \pm 0.00$	$0.89^{a} \pm 0.03$
B	$1.26^{b} \pm 0.01$	$4.91^{b} \pm 0.07$	$1.10^{b} \pm 0.02$	$0.01^{b} \pm 0.00$	$0.97^{a} \pm 0.05$
C	$1.53^{a} \pm 0.03$	$7.89^{c} \pm 0.01$	$1.16^{a} \pm 0.03$	$0.01^{b} \pm 0.00$	$1.06^{a} \pm 0.12$
D	$1.75^{a} \pm 0.01$	$9.84^{c} \pm 0.01$	$1.20^{a} \pm 0.01$	$0.02^{a} \pm 0.00$	$1.11^{a} \pm 0.08$

Values are means ± standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly different (p<0.05). A = Biscuit prepared from 100% Acha (control sample); B = Biscuit prepared from 97.5% Acha and 2.5% pineapple pulp flour; C = Biscuit prepared from 95% Acha and 5% pineapple pulp pulp flour, D = Biscuit prepared from 90% Acha and 10% pineapple pulp pulp flou

The findings of this research with relatively low phytochemical content agreed with the findings of Tarhemba and Asemave, (2019) that the anti-nutrient factors in pineapple pulp are low.

Phytate is a strong anti-nutrient as its high content in food has a strong binding affinity for minerals like calcium, magnesium, iron, copper, and zinc, preventing their bioavailability and absorption. Tannins are one of the major groups of antioxidant polyphenols found in food and beverages. Tannin have been reported to provide health benefits like accelerated blood clotting, reduce blood pressure, reduce serum lipid level and modulate immune responses.. The relative high saponins content observed in biscuits produced flour blend could be of benefit in producing emulsification of fat-soluble molecules that promotes absorption into intestinal walls (Okwu and Josiah, 2006), saponins bind to bile acids and help eliminate them from the body, preventing cholesterol from being reabsorbed and be immune system boosters through their antioxidant activities and scavenging for cancerous cells (Nneoma *et al.,*2016)

The biscuit produced from the flour blends are very low in oxalates which confirm its safety as the compound bind to dietary calcium to form calcium oxalate crystals preventing the absorption and utilization of this important mineral by the body, thereby causing health defects like osteo malacia and rickets (Nneoma *et al.,* 2016). The very

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low cyanide content observed agreed with that reported by Tarhemba and Asemave (2019) who concluded the amount of cyanide in pineapple pulp to be was negligible. The maximum permissible limit of cyanide in foods is 10 mgEq/g (FAO, 2015) and all the biscuit samples produced in the present study were within safe limits.

Sensory properties of the biscuits produced from *acha* and pineapple pulp flour blends

Sensory properties of *acha* biscuits supplemented with pineapple pulp flour is presented in Table 4. The average means scores of the flavor, mouthfeel, crispness, and general acceptability of the blends increased from 7.2 to 8.0, 6.5 to 8.9, 6.90 to 7.90 and 7.00 to 8.01, respectively with the increase in the added pineapple pulp flour up to 5% and thereafter decreased. However, the average means scores of the appearances decreased from 7.40 to 7.00 with an increase (0 to 10%) of added pineapple pulp flour. the effect was significantly ($p<0.005$) different. The blend with 5% pineapple flour was the most preferred and accepted product.

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 flour in the formulations. 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). Generally, all biscuits were acceptable but that with 5% pineapple pulp flour is the most preferred.

Table 4: Sensory properties of rats fed biscuits produced from *Acha* – Pineapple pulp flour 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 ($p<0.05$).. A = Biscuit prepared from 100% Acha (control sample); B = Biscuit prepared from 97.5% Acha and 2.5% pineapple pulp flour; C = Biscuit prepared from 95% Acha and 5% pineapple pulp flour; D = Biscuit prepared from 90% Acha and 10% pineapple pulp flour

CONCLUSION

The research has shown that acceptable biscuits can be produced from *acha* and pineapple pulp. The nutrient content, particularly the fiber, potassium and manganese content of the biscuits were significantly improved by the addition of the pineapple pulp. Generally the biscuits produced from the flour blends are acceptable but the most preferred and acceptable blend biscuit is that with 5% pineapple pulp flour. The acceptability of biscuits from *acha* and pineapple will greatly reduce dependence on imported wheat flour for baked products and subsequent decrease in production and sales price of dietary fiber rich products. Consequently, commercial production of acha and pineapple will be encouraged with the acceptability of the flour blend confectionaries.

REFERENCES

AOAC,(2015). Official methods of analysis.Association of Official analytical Chemists.18th edn. Washington D.C., USA.

Atume, G.T, Alakali J.S. and Ismaila R.I. (2018).Effect of local processing techniques on the nutrient and anti-nutrient content of bitter cassava (Manihot esculenta Crantz).*American Journal of Food Science and Technology*. 10(6):,13-17.

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.*

Ayo, A. J., Ibrahim, A. N., and Luka, J. K. (2022). Effect of Feeding Albino Rats with Acha-Orange Fleshed Sweet Potato Blends on the Blood Glucose Level and Hematological Parameters. *Asian Food Science Journal*, *21*(9), 42–53.

Ayo J. A, Ibrahim A. N, Orafa, P. N, Omolagu A. C, Gbuusu, B. and Vongfa A. C.(2024). Production and Quality Evaluation of Acha (*D.exilis*)-Cowpea (*Phaseleous vulgaris*)-Carrot *(Daucus carota)* Based Couscous. ***Asian Food Science Journal*** *Volume 23, Issue 1, Page 49-65, 2024; Article no.AFSJ.111919 ISSN: 2581-7752*

Ayo J. A., Awogbenja M. D, Gbuusu B, Akaahan S. P. and Gani I. A.(2023). Quality Evaluation of Biscuits Made from Amaranthus Seed (*Amaranthus spp*) and Tiger Nut (*Cyperus esculentus lativum*) Flour Blend. Asian Journal of Food Research and Nutrition Vol. 2(4):681-694, Article no.AJFRN.108614

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.

Ayo, J.A and Kajo, N (2016). Effect of soybean hulls supplementation on the quality of acha based biscuits. **American Journal of Food Nutrition, 6(2): 49-56.**

Ayo, J.A and Gafa.T (2002). Innovations in the Traditional *Kunnu Zaki* Production. Pakistan Journal of Nutrition Vol.1 (5): 202-20.

Ayo, J.A; Ayo, V.A; Nkama. I and Adewori. R (2007).Physio-chemical, in-vitro digestibility and organoleptic evaluation of acha wheat biscuit supplemented with soybean flour. **Nigerian Food Journal, 25(1):77-89**

Ayo, J.A and Nkama, I (2006). Physical quality of *acha* grains composite flour. **African Development Review, Vol.1 (2):85-88**

Bonire, J.J., Jalil, NS..and Lori, J.A. (2012). Sodium and potassium content of two cultivars of white yam *(Dioscorea rotundata*) and their source soils. *Journal of Food Science and Agriculture* 53, 271-274.

Chivenge . P; Saito, K ;Bunquin,M.A(2015).Co-benefits of nutrient management tailored to smallholder agriculture Global Food Security 30:100570

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.

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 (Sesamunindicum L.) Flour. *African Journal of Food Agriculture Nutrition and Development* 12(6): 6614-6631.

Glew RH, Ayaz FA, Sanz C, VanderJagt DJ, Huang HS, Chuang LT (2013). Changes in sugars, organic acids and amino acids in medlar (*Mespilus germanica* L) during fruit development. *Food Chemistry*. 83:363-369.

Gills, L.S. (2012).Ethno medical uses of plants in Nigeria.*African press, Benin City*. 9(2):276.

Hernandez, M.M., Heraso, C., Villarreal, M.L., Vargas-Arispuro, I. and Aranda, E. (2013). Biological activities of crude plant extracts from *Vitex trifolia* L. (Verbenaceae). *Journal of Ethnopharmacology.*67(1):37–44

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.

,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.

Jideani, A.I., (2011). Acha-*Digitaria exilis*-the neglected cereal, *Agriculture International Journal*., 42 (5): 132-134.

Jideani,I.A.(2012).*Digitaria exilis*(acha,fonio),*Digitaria iburrua(*iburu,fonio)*Eleusine corocana* (fingermillet,tanba)–non-conventional grains with potentials. Scientific Res.Essays7(45):3834-3843.

Jideani, I.A. and Jideani, V.A. (2011). Developments on the cereal grains *Digitaria exilis* (acha) and *Digitaria iburua* (iburu). *Journal of Food Science andTtechnology* 48(3):,251-259.

Jones, E. and Hughes, R. E. (2003).Foliar ascorbic acid in some angiosperms. *Journal of Phytochemistry* 22(11): ,2493-2499.

Lasekan, O.O. (2014). Chemical composition of acha (*Digitaria exilis*) flour. *Journal of Food Science and Agriculture* 14:177–179.

Martínez,R; Torres P; M.A. Meneses, M.A;Figueroa,J.G; Pérez-Álvarez,J.A Viuda-Martos,M(2012). Chemical, technological and in vitro antioxidant properties of mango, guava, pineapple and passion fruit dietary fibre concentrate. *Food Chemistry, 135 (2012), pp. 1520-152*

Moors, E.H. (2012). Functional foods: regulation and innovations in the EU. *Innovation: The European Journal of Social Science Research. 25.4:424-440.*Morton, J. (2007). Pineapple. In: Fruits of warm climates. Julia F. Morton, Miami, FL. p. 18-28.

Nneoma, E.A., Chibuike, S.U., Nkoyo, I.N., Alexander, A.N., Uchechukwu, U.N. and Anthony, I.O. (2016). Evaluation of Saponin Extract from Vitex doniana and Pentaclethra macrophylla for potential health benefits in rats. *Journal of Applied Science* 6(11):180.

Obadoni, B.O. and Ochuko, P.O. (2001).Phytochemical studies and comparative efficacy of the crude extracts of some homeostatic plants in Edo and Delta States of Nigeria.*Global journal of pure and applied science.* 8(6):,203-208.

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.

Okaka, J.C. and Isieh, M.I. (2010).Development and quality evaluation of cowpea-wheat biscuits.*Nigeria Food Journal*. 8(1):56-62

Okwu, D.E. and Josiah, C. (2006).Evaluation of the chemical composition of two Nigeria medicinal plants.*African Journal of Biotechnology*. 12(7):27-30

Olapade, A. A., Aworh, O. C. andOluwole, O. B. (2011). Quality attributes of biscuit from acha

(Digitaria exilis) flour supplemented with cowpea (Vigna unguiculata) flour. *African Journal of Food Science and Technology*, 2(9): 198-203

Opaluwa, 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 Sci*ence, 4(3): 030-041

Pascual, E., Slowing, K., Carretero, E., Sanchez-Mata, D. and Villar, A. (2001).*Lippia*: traditional uses, chemistry and pharmacology: a review.*Journal of Ethnopharmacology. 76:201-214.*

Prakongpan, T., Nitihamyong, A. and Luangpituksa, P. (2006).Extraction and application of dietary fibre and cellulose from pineapple cores.*Journal of Food Science*.267(4): 1308-1313.

Rachie, K.O. (2004). The millet and minor cereals: A bibliography of the world literature in millets processing 1930 and 1964-69 and all literature on other minor cereals. *The Scarecrew Pres Inc. Metuchen, NJ.pp 564.*

Ubbor, S. C., Ezeocha, V. C., Okoli, J. N., Agwo, O. E., Olaoye, O. A., & Agbai, I. E. (2022). Evaluation of biscuits produced from wheat (Triticum aestivum), tiger nut (Cyperus esculentus) and orange fleshed sweet potato (Ipomea batatas) flours. *FUDMA JOURNAL OF SCIENCES*, *6*(4), 254-261.

Sarwar,G(2013). Available from: Evaluation of Crude Ethanolic Extract of Qurcus incana Fruit for Analgesic and Gastrointestinal Motility Profile Middle-East. *Journal of Scientific Research* 13 (4): 455-458

Siddhuraju, P. and Becker, K. (2013). Antioxidant properties of various solvent extracts of total phenolic constituents from three different agro-climatic origins of drumstick tree (*Moringa oleifera* Lam.) leaves. *Journal of Agriculture and Food Chemistry. 51:2144-2155.*

Sylvia, L.G; Bernstein, E.E; Hubbard, J; Anderson, E (2013). A Practical Guide to Measuring Physical Activity. *Journal of the Academy of Nutrition and Dietetics 114(2) 10. 1016/j.jand.2013.09.018*

Tarhemba, P.T. and Asema, K.. (2019). Nutritional profile of some pineapple varieties. *Journal of Food Science and Nutrition*. 11(9):14-19.