



Proximate Composition, Physical and Sensory Quality of Acha-moringa Seed Flour Blend Biscuits

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Authors' contributions

This work was carried out in collaboration between both authors. Author AJA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author AVA managed the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2018/43505

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- Complete Peer review History: <http://prh.sdiarticle3.com/review-history/27008>

Original Research Article

**Received 24 July 2018
Accepted 22 October 2018
Published 03 November 2018**

ABSTRACT

Moringa (*M. oleifera*) seed flour was substituted into acha (*Digitaria exilis*) at 5, 10, 15, 20 and 25 %, thoroughly mixed to produce acha-moringa seed flour blends. Principal ingredients (baking fats, salt, yeast, water) were added to the blends, mixed, rolled, cut and baked at 180°C to produce biscuits. The proximate composition, physical (spread ratio and break strength) and sensory quality of the biscuits were determined. The values of moisture, ash, fats, protein, fibre and carbohydrate content of the acha-moringa seed flour blend biscuits range from;- 8.79 - 8.60, 4.85 - 5.96, 18.46 - 20.31, 12.25 -14.19, 2.56 - 4.15 and 52.86 - 46.80%, respectively. The spread ratio and break strength of the acha moringa flour blend biscuits decreased from 4.81 to 3.46 and 1572.50 to 1125.00g, respectively, with an increase in the added moringa seed flour. The average means

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scores for colour, aroma, texture, taste, mouthfeel and general acceptability ranges from 6.52-5.48, 6.52- 5.44, 5.8- 5.18, 5.44-4.52, 5.24- 4.44, 6- 5.24, respectively, with added moringa seed flour. The flour blend biscuits were most acceptable at 10% and below of added moringa seed flour.

Keywords: *Acha-moringa seed flour; proximate; physical; sensory; quality.*

1. INTRODUCTION

Acha (*Digitaria exilis*), commonly known as fonio or hungry rice is a cereal grain in the family *gramineae* [1,2]. It is grown in Guinea and dry Savanna zone of Mali and Upper Volta with at least 800mm rainfall [3,2].

Some varieties of traditional foods prepared from *acha* include thick porridge (*Tuwo*), thin Porridge (*kunu*), steamed product (*brabusco* or couscous), *gowete* and alcoholic beverages [4,5,6]. The grains of *acha* may be also boiled like rice and eaten with stew. Flour can be prepared from *acha* which may be fortified with other cereals flour for the production of porridge or pudding [7]. In some part of Nigerian states such as plateau, Bauchi and Kaduna, *acha* grain is not only consumed as food, but the straws are burnt to produce ash of which its filtrate is used for cooking indigenous delicacies [8]. Nutritionally, the seed of *acha* is rich in amino acids (methionine, and cysteine) which are deficient in some major cereals like wheat, rice, maize, sorghum, barley, rye, etc [4,8]. Generally, cereals contain little or lack lysine an essential amino acid which necessitates their enrichment with protein sources such as legumes (soya bean, bambara nut, tiger nut, etc.) [9,10,11]. *Acha* grains is said to have high water absorption capacity due to its appreciable amount of pentosan content. Studies conducted by Lasekan [3] and NRC [12] revealed that *acha* contains about 33 g/Kg pentosan. The appreciable water absorption capacity of *acha* is a good quality that could be employed in baked food [13,10]. The distinctive *acha* protein could make it a good potential for cookies production [14]. Among traditional cereals, *acha* (*Digitaria exilis* stapf) and *iburu* (*D. iburu* stapf), also called *fonio* [15], *fudy*, *findi*, hungry rice or Asian millet [12] had received an increasing attention in research and development in the recent times [16,17,5,18] [19,20,21,22].

The consumption of cereals based foods like biscuit has initiated the development of sufficient substitutes for wheat [6]. The protein content of *acha*, though similar other grains but contains *methionine* and *cysteine* (essential amino acids) which are deficient in major cereals.

Acha is easily digestible. Traditionally it is recommended as food for children, aged, diabetic, abdominal disorder and weight reduction [14,2]. *Acha* lacks *glutenin* or *gliadin* proteins thus, making it appropriate for consumption to gluten intolerance people [23,2,10].

Edible wild indigenous plants could be an alternative source of food with appreciable vitamins, minerals and other interesting elements especially at off-season when food is scarce (February to May) [24]. Wild fruits also have nutritional and medicinal features ascribed to the presence of an antioxidant in them; hence, could be used for food fortification for malnourished children [23].

Moringa olifera seeds could serve as encouraging resource for food and non-food applications because they contain high mono-unsaturated fatty acid contents with high mono-unsaturated saturated fatty acids (MUFA/SFA) ratio, sterol and tocopherols, and proteins rich in sulfate and amino acids [25].

Moringa trees grow rapidly (4-8 months) in sub-tropical and tropical areas, even in prolonged drought season; thus, become a suitable raw material to improve the nutritional status of local people. Although, there are somewhat spread in use of *moringa* seeds and their oil in traditional medicine; however, no pharmacological activity study has been conducted on humans. Some new efforts are coming up as evidence to acquire vivid and definite information on the benefits of its seed consumption to human health.

Series of studies had indicated the potential use of different parts of *Moringa olifera* in food applications like soup making [25], weaning foods [26]. Amala, a stiff dough made from or plantain flour [27] herbal biscuits [28], cake [27]. The plant is gaining more attention in its use for food fortification. The research work is aimed at assessing the effect of adding *moringa* seeds flour on the proximate composition, physical and sensory properties of the *acha* based biscuits.

2. MATERIALS AND METHODS

2.1 Preparation of *acha*, *Moringa oleifera* Flour and *acha-moringa* Seed Flour Blends

The *acha* seed (cream coloured cultivar) obtained from Jos, Nigeria was cleaned, washed, de-stoned (using sedimentation method), dried (oven dried at 50°C for 5hr), milled (Attrition mill), sieved (0.4 mm aperture) and packaged in a poly-ethene bag. *Moringa oleifera* seeds were purchased from the Newmarket, Wukari, Nigeria, was cleaned, hull removed (manually), oven dried (50°C for 5 hr), milled (Attrition Mill), sieved (0.4 mm aperture) and packaged in a poly-ethene bag. Flour blends were prepared by substituting *moringa* seed flour into *acha* flour at 5,10,15,20 and 25%, and thoroughly mixed (using Kenwood blender for 5mins) to produce *acha-moringa* flour blends.

2.2 Preparation of Biscuits

Baking fat was mixed with potato flour (substituting sugar as a sweetener) to produce a fluffy mixture, added to the blends flour and mixed with other ingredients (0.9% salt, 45%baking fats, 55% sweet potato, 1% baking powder, 11% water) to produce batter. The batter was rolled (on a stainless table), cut into shape (using a biscuit cutter), placed on greased trays and baked at 180°C for 20 minutes [29].

2.3 Proximate Composition

The proximate composition (moisture, protein, fats, ash, fibre and carbohydrate) were determined as described by AOAC [30] method.

2.4 Physical Property

The spread ratio and break strength of the *acha-moringa* flour blend biscuits were determined as described by Gormez et al. [31] method.

2.5 Sensory evaluation

Sensory qualities of the *acha-moringa* seed flour blend biscuits were analysed for consumer acceptance and preference using 20 untrained judges (randomly selected among students and staff of the Department of Food Science and Technology, Federal University Wukari, Nigeria).

Nine (9) point Hedonic scales (1 to 9 representing "extremely dislike" and "extremely like", respectively) was used for evaluation.

2.6 Statistical Analysis

The data obtained were analysed statistically using SPSS version 23.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of *Acha-moringa* Flour Blend Biscuits

The proximate composition of the *acha-moringa* flour blend biscuits is shown in Table 1. The ash, fats, protein and fibre content increased from 4.85 to 5.96, 18.46 to 20.31, 12.25 to 14.18 and 2.56 to 4.15% while the moisture and carbohydrate decreased from 8.79 to 8.60 and 52.86 to 46.80%, respectively, with an increase in the added *moringa* flour (0-25%). The increase observed in the respective parameters could be due to the inherent nutrient composition of *moringa* seed flour which agreed with other relevant researches involving fortification with *Moringa oleifera* seeds/ leaf [26,28,32,33,34,35]. The seed of *moringa* has a relatively high protein content, on average 31.4%, with carbohydrate, fibre and ash contents of 18.4, 7.3 and 6.2%, respectively [36,37]. The increase in the protein content could improve the nutrient intake, particularly the essential amino acids of the consumers as *moringa* seeds are available and could be cheaper [38]. Many of the reported studies concerning *M. oleifera* have shown an exceptionally high protein content when compared to other plant foods, and could therefore of great importance in human nutrition [38].

The fibre content of *moringa* seed-acha flour blend biscuits studied increased from 2.56 to 4.14% with an increase in the added *moringa* flour which could improve the fibre intake of the consumer. Dietary fibre, the indigestible cell wall component of plant materials according to Anderson [39] could play an important role in human health. A previous study linked Low dietary fibre intake in developed countries have been linked to several Western diseases [40]. Epidemiological studies by Anderson and Gustafson [41] and Anderson [39] have shown that high dietary fibre intake helps to prevent or treat hyperlipidemia. Also linked with high dietary fibre is the prevention of cardiovascular disease, hypertension, obesity

[42], gastrointestinal disorders [43] and diabetes [44].

3.2 Physical Properties of Acha-moringa Flour Blend Biscuits

The addition of moringa flour to acha flour has decreased the spread ratio ($4.81 \pm .01$ to $3.46 \pm .13$) and break strength (1572.50 ± 3.54 to 1125.00 ± 35.36 g) of the acha moringa flour blend biscuits, with an increase in the *moringa* flour (Table 2). The decrease could be due to the relatively high oil content of the added *Moringa oleifera*, which agreed with the findings of Mazahib et al. [45]. However, Ayo et al. [29] in their related studies, reported increasing break strength of *acha* based biscuit with an increasing level of *bambara* substitution which was attributed to low oil content. The decrease in the spread factor of the flour blends biscuits with an increase in the level of added *moringa* seed flour could be due to the high protein content of the *moringa* flour. Increase in a number of hydrophilic sites available due to increased protein content competes for the limited free water in the biscuits dough/ pastes could result to decrease in the spread factor [46,47,29,48,49]. Ayo and Gidado [50] reported a decrease in spread factor with increased protein in the cookies. The decrease in the break strength of

the acha-moringa seed flour blend biscuits with added moringa seed flour could be due to increase in the fibre and decrease in carbohydrate content of the flour blends. The relative decrease in the break strength could improve the digestively and the release of more nutrient from the product. However, a low break strength of products particularly could decrease the ability to withstand breakage during packaging, transportation and bulk storage.

3.3 Sensory Quality of Acha-moringa Flour Blend Biscuits

The average mean score for colour, aroma, texture, taste, mouthfeel and general acceptability of the acha-moringa flour blend biscuits ranged from 6.52 to 5.48, 6.52 to 5.44, 5.8 to 5.18, 5.44 to 4.52, 5.24 to 4.44, 6.0 to 5.24, respectively, with increase in the percentage of added moringa flour (Fig. 1).

The relative decrease in the mean scores of aroma (6.52-5.44) and taste (5.44-4.52) of the acha-moringa seed flour blend biscuits could be due to slight bitter taste inherent to *moringa* seed flour [33,27]. The addition of moringa flour had a significant negative effect generally on the assessed parameters at above 10%.

Table 1. Effect of added moringa on the proximate composition of acha-moringa biscuits

Acha	Moringa	Moisture	Ash	Fats	Protein	Fibre	Carbohydrate
100	0	8.79± .01e	4.85± .01f	18.46± .41d	12.25 ±.42c	2.56 ± .05d	52.86± .16a
95	5	8.74± .01de	5.02± .09e	19.04± .22cd	12.91± .01b	2.69 ± .08cd	50.96 ± .44b
90	10	8.67± .01d	5.34 ± .01d	19.36± .08c	13.16± .08b	2.93 ± .07c	50.59± .55b
85	15	8.64± .01c	5.56 ± .01c	19.63± .29bc	13.15 ± .01b	3.34 ± .19b	49.28 ± .39c
80	20	8.62 ± .01b	5.82± .02b	20.03± .29ab	13.75 ± .27a	3.65 ± .08b	47.65± .05d
75	25	8.60 ± .00a	5.96 ± .05a	20.31 ± .29a	14.19± .05a	4.15± .22a	46.80± .23d

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

Table 2. Effect of added moringa on the physical properties of acha-moringa composite biscuits

Acha flour(%)	Moringa paste (%)	Spread Ratio	Break Strength
100	0	$4.81 \pm .01a$	$1572.50 \pm 3.54a$
95	5	$4.73 \pm .04a$	$1405.00 \pm 7.07b$
90	10	$4.45 \pm .06b$	$1355.00 \pm 7.07c$
85	15	$4.23 \pm .03c$	$1305.00 \pm 7.07d$
80	20	$4.11 \pm .01c$	$1212.50 \pm 17.68e$
75	25	$3.46 \pm .13d$	$1125.00 \pm 35.36f$

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

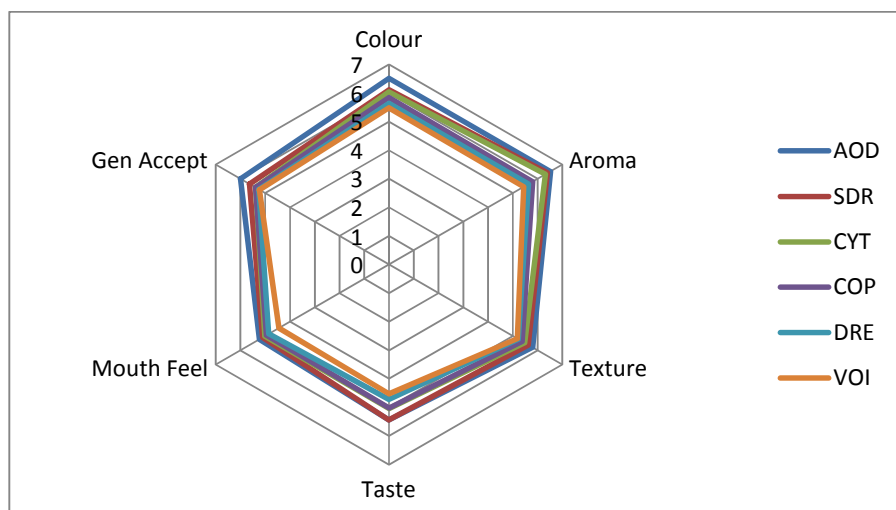


Fig. 1. Spider Web graph showing the effect of added moringa paste on the sensory quality of acha based biscuits

AOD=100% acha composite biscuits, SDR=5% moringa and 95% acha composite biscuits, CYT=10% moringa paste and 90% acha composite biscuits, COP=15% moringa paste and 85% acha composite biscuits, DRE=20% moringa paste and 80% acha composite biscuits, VOI=25% moringa and 75% acha composite biscuits

4. CONCLUSION

The addition of moringa seed flour to acha based biscuits have shown to improve the nutrient content, particularly the protein, fats and fibre content and the spread factor of the acha based biscuits. However, the acceptance of product was poorly accepted at above 10% added moringa seed flour and could be linked to the bitter taste attributed to the inherent component in the seed. It is essential that further studies be aimed at debittering the natural compounds to improve the use of moringa seed.

ACKNOWLEDGEMENTS

Authors acknowledged the Tertiary Education Fund Nigeria and The Federal University Wukari, Nigeria for sponsoring this research and the Department of Food Science and Technology, Federal University Wukari, Nigeria for their generosity in allowing the use of their Food processing laboratory facilities.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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