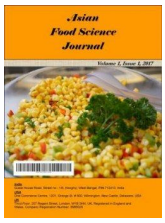

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Proximate, Phytochemical Composition and Sensory Quality of Acha –Turmeric Flour Blend and Biscuits

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Authors' contributions

This work was carried out in collaboration between all authors. Author JAA designed the study, wrote the protocol and wrote the first draft of the manuscript. Author MOO managed the literature searches, Author CAO performed the statistical analysis. Author MKN managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Turmeric tuber and acha grain were dried, milled, sieved to produce respective flours. The turmeric flour was substituted (1, 2, 3, 4, and 5%) into acha flour to produced acha-turmeric flour blend and other ingredients (baking fat, baking powder, salt, sugar and water) was used to produce biscuits. Wheat flour (100% whole) was also used to produce biscuit as a control. The flour blends were analysed for functional property and proximate composition while the biscuits were analysed for physical and sensory properties. The moisture, ash, fat, protein and fibre increased from 16.66-17.06, 1,79 – 2.11, 15.13 – 1523, 5.29- 5.43, 1.22-1.39%, while the carbohydrate decreased from 61.13 to 60.17% with an increase in the added turmeric flour (0 - 5%). The tannin, HCN, alkaloid and saponin content increased from 243.67 to 256.78, 2.69 to 2.83, 28.73 to 37.33 and 0.54 to 0.57 mg/100 g. The spread ratio decreased from 5.86 to 5.75, while the break strength increased from 2.59 to 2.37 kg. The average mean score for colour, crispiness, flavour, taste, texture, and general acceptability increased from 7.80 to 8.80, 7.35 to 7.36, 7.60 to 8.70, 7.20 to 7.96, 8.20 to

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8.22, 8.05 to 8.57. The flour blend biscuits containing 4% turmeric flour was most preferred and accepted with the corresponding increament of 9.48, 11.17 and 22.29% of protein, ash and fibre content respectively.

Keywords: Phytochemical; acha-turmeric; blend flour; biscuits.

1. INTRODUCTION

The word biscuit, a Latin word, meaning twice cooked:- baking at high temperature followed by drying at lower temperature [1]. Biscuits are baked, edible and commonly flour based products. Biscuits may be regarded as a form of confectionery dried to very low moisture content. The simplest form of biscuit is a mixture of flour and water but may contain fat, sugar and other ingredients mixed together into a dough which is rested for a period, passed between rollers to make a sheet; the sheet is then stamped out, baked cooled and packaged [1]. The nutritional value of biscuits varies with the type of cereal used. Biscuit is known to generally contain fat (18.5%), carbohydrate (78.23%), ash (1.0%), and protein (7.1%) and salt (0.85%) [2].

The consumption of cereal foods such as biscuits and bread has become very popular in Nigeria, especially among children. Biscuits have been classified into four different categories according to their sugar levels. Soft-dough biscuits containing 25% sugar; digestive with 32% sugar; shortcake or flow-type biscuits containing 59% sugar (Schellford) and ginger-nuts with 79% sugar [3]. Biscuits could also be classified based on their degree of enrichment and processing or by the method adopted in shaping them [1].

The dependence on wheat as the basic ingredient for baked products in developing country like Nigeria that do not grow wheat has greatly affected the economy of the nation as the cost of importation is on the increase. This problem has drawn most researchers in search of alternative raw material particularly the underutilise cereals such as millet, acha, sorghum etc. [4].

Acha (*Digitaria exillis*) is a cereal grain in the family of gramineae and commonly referred to as fonio or hungry rice [5]. The grain is grown in areas with at least 800mm of rain fall such as the mountain Fouta Dyllon region of Guinea and dry Savanna zone of Mali and Upper Volta [6,7]. Acha can be used for porridge (kunu) in the morning as gwete and tuwo in the afternoon and evening with different kinds of stew and vegetables the filtrates are used as potash for cooking indigenous delicacies [8]. Acha grain can also be grounded into flour to produce biscuit [9]. Acha contain high water absorption capacity to be utilised in baked foods. It also contain pentosans [6] which give it the ability to form gel in the presence of oxidising agents at room temperature with high residual protein coupled with high levels of sulphur and hydrophobic amino acid residues which makes it useful in baking [10]. In a recent study, acha grain has shown to have high water absorption capacity, a property that could be linked to the appreciable amount of pentosan. The high water absorption capacity of acha could be utilised in baked food. Pentosan has been found to be a very important regulator of water absorption and distribution in dough [2].

Major constraints reported in acha cultivation and harvesting are related to the small size of the grain, showing tiny kernels of 700 um size [11]. This leads to tedious time- consuming post-harvest and cooking processes [12].

Turmeric is an Indian perennial herb (*Curcuma longa*) of the ginger family with a large aromatic yellow rhizome. Turmeric contains 8.92% moisture, 2.85% ash, 4.60% crude fibre and 6.85% fat. It also contains 9.40% crude protein and 67.38% carbohydrate. It is rich in phytochemical components.

Importantly, turmeric has been used in treating serious medical conditions such as arthritis, asthma, allergy, liver disorders, diabetic wounds and sinusitis in addition to treating minor illnesses such as cough, cold and runny nose.

The research work is aimed at investigating into effects of turmeric on the phytochemical proximate composition of acha-turmeric flour blends and the physical and sensory property of its biscuit.

2. MATERIALS AND METHODS

2.1 Materials

Acha grain (*Digitaria exilis*), the creamy coloured type, locally grown was purchased from Kaduna, baking powder, baking fats, salt, and turmeric

used in the production of the biscuit were purchased from Gboko main market, Benue state Nigeria.

Acha flour: The acha was manually cleaned by handpicking of the chaff and the dust and stones were removed by washing in clean water (sedimentation) using plastic containers. The washed and de-stoned grains were sun dried and then milled using attrition milling machine (model R175A). The flour was sieved (0.4 mm aperture size), packaged (polyethylene) put in tight air transparent plastic containers and stored under room temperature. The turmeric flour was substituted (1, 2, 3, 4, and 5%) into acha flour to produced acha-tumeric flour blend that was used to produce biscuits. Wheat flour (100% whole) was also used o produce biscuit as a control.

Production of acha-tumeric flour blend biscuits: Biscuits where prepared from the blends of 100% acha flour according to the formulation shown in Table 1. The Oyewole et al. [13] and Ayo and Nkama [9] method of biscuit production was adopted. The turmeric and fat were mixed, mixture of salt and baking powder which were mixed at the same time with acha flour. The mixture was thoroughly mixed into consistent dough. The dough was filled and pressed out into predetermined size and shape. The dough was arranged in pre-oiled trays and baked in a pre-heated laboratory oven operating at 180°C for 20-30 min. After baking, the hot biscuits were removed from the pan and placed on a clean tray to cool down. The biscuits were then packed after cooling in polyethylene sachets of appropriate thickness and permeability using an impulse sealing machine prior to further analysis.

2.2 Methods

Spread ratio and break strength of the flour blend biscuits were determined as described by Gomez et al. [14] and Okaka and Isieh [3], respectively.

Proximate: The protein, fat, ash, crude fibre and moisture content of the samples were determined as described by AOAC [15]. The carbohydrate content was determined by simple difference: CHO = 100 – (% moisture + % fat + % ash).

Determination of phytochemical: Alkaloids, sterol, saponin, hydrogen cyanide, flavonoid, phenol and tannin were determined as described by AOAC [15], Haborne [16], Onwuka [17], and Person [18] methods, respectively.

Determination of Functional properties: Bulk density, water absorption capacity, oil absorption, foaming cabacity, gellation, swelling of the flour blends were determined as described by Onwuka [17].

Sensory evaluation: The sensory evaluation of the sample was carried out for consumer acceptance and preference using randomly selected 20 untrained judges (students and staff of the Department of Food Science and Technology, University of Mkar, Benue state Nigeria), using a nine point hedonic scale (1 and 9 representing ‘extremely dislike’’ and ‘extremely like’’, respectively) [19]. Qualities assessed include: colour, crispiness, aroma, mouth feel, flavour, taste, texture and general acceptability. Coded samples of the same size and temperature were served to judges. The results obtained were subjected to analysis of variance (ANOVA) and Duncan multiple range test was used to separate means where significant differences existed. The software used for the statistical analysis was statistical package for social sciences (SPSS) ver. 16.

Statistical analysis: The results obtained from the various analyses were subjected to analysis of variance (ANOVA) using statistical package for social sciences (SPSS) version 16.0. Means were separated with Duncan. Multiple Range test (DMRT) at 95% confidence level ($p \leq 0.05$).

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Acha-Turmeric Flour Blends

The effect of turmeric flour on the proximate composition of acha-turmeric flours biscuit is shown in Table 1. The moisture, ash, fat, protein and fibre content increased from 16.66 to17.06, 1,79 to 2.11, 15.13 to 15.23, 5.29 to 5.43, 1.22 to 1.39%, while the carbohydrate decreased from 61.13 to 60.17% with an increase in the added turmeric flour (0 - 5%) as shown in Table 1.

The relatively high moisture and protein content observed could be attributed to higher water binding capacity of the turmeric flour. There is a relatively higher fat content in the acha turmeric flour blend compared to that of 100% acha and wheat flour could be attributed to the fat content of turmeric flour which could improve the sensory quality products [20]. However, excessive amounts of fat might be of health hazard to the consumer and keeping quality of product as it

could aid oxidation, though it is envisaged that rancidity problems can be minimised by the relative high level of Vitamin E (natural antioxidant) of turmeric flour.

3.2 Phytochemical Composition of Acha-Turmeric Flour Blends

The phytochemical composition of acha-turmeric flour blends is presented in Table 2. The tannin, hydrogen cyanide (HCN), alkaloid and saponin content increased from 243.67 to 256.78, 2.69 to 2.83, 28.73 to 37.33 and 0.54 to 0.57 mg/100 g. The relative increase in the alkaloid and saponin with addition of turmeric flour could be an advantage as it has been proved to aid curing headache associated with hypertension, management of cold, chronic catarrh and migraine [21,22]. Research has shown that tannin could exert antimicrobial activities by iron deprivation, hydrogen bonding or specific interactions with vital proteins such as enzymes in microbial cells [23]. However, the relative increase in the hydrogen cyanide (HCN) calls for pre treatment of the turmeric flour before use.

3.3 Physical Property of Acha-Turmeric Flour Biscuit

The spread ratio and break strength of the acha-Turmeric flour blends biscuits decreased from 5.86 to 5.75 and 2.59 to 2.37 kg, respectively (Table 3). The decrease could be as result of low fibre content of acha which could increase viscosity of the paste prior to baking. The break strength decrease from 2.58 to 2.37 kg with added turmeric flour (1-5%) could be as a result of the increase in the fibre content of the turmeric, which could weakens the bonds between the carbohydrate – carbohydrate and carbohydrate- protein molecules.

3.4 Sensory Properties of Acha-Turmeric Flour Biscuit

The sensory properties of acha-turmeric flour bled biscuits is shown in Table 4. The average mean score of the sensory quality:- colour, crispiness, flavour, taste, texture, and general acceptability increased from 7.80 to 8.80, 7.35 to 7.36, 7.60 to 8.70, 7.20 to 7.96, 8.20 to 8.22,

Table 1. Proximate composition of Acha-turmeric flour blends

Acha (%)	Turmeric (%)	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)	Carbohydrate (%)
100	0	16.66^{b}±0.01	1.79^{c}±0.11	15.13^{b}±0.00	5.29^{b}±0.00	1.35^{c}±0.00	61.73^{a}±0.00
Wheat	0	13.95^{c}±0.00	2.91^{a}±0.00	16.23^{a}±0.00	5.91^{a}±0.00	1.39^{c}±0.00	61.00^{a}±0.00
99	1	15.76^{b}±0.00	1.80^{c}±0.00	15.15^{b}±0.00	5.26^{b}±0.01	1.49^{b}±0.00	62.03^{a}±0.00
98	2	17.72^{a}±0.01	1.92^{b}±0.00	15.19^{b}±0.00	5.30^{b}±0.01	1.56^{a}±0.00	59.27^{a}±0.00
97	3	17.65^{a}±0.00	1.95^{b}±0.00	15.26^{b}±0.00	5.66^{b}±0.01	1.59^{a}±0.01	59.88^{a}±0.00
96	4	17.35^{a}±0.00	1.99^{b}±0.00	15.28^{b}±0.00	5.79^{a}±0.00	1.58^{a}±0.00	59.59^{a}±0.00
95	5	17.06^{b}±0.01	2.11^{b}±0.00	15.23^{b}±0.01	5.83^{a}±0.00	1.59^{a}±0.00	60.17^{a}±0.00

Average means with the same alphabet along the same column are not significantly different at p≤0.05

Table 2. Phytochemical composition of Acha-Tumeric flour blends (mg / 100 g)

Acha (%)	Turmeric (%)	Tannin (mg/100 g)	HCN (mg/100 g)	Alkaloid (mg/100 g)	Saponin (mg/100 g)
100	0	243.67^{a}±0.01	2.69^{ab}±0.01	28.73^{ab}±0.01	0.54^{a}±0.01
Wheat	0	233.71^{b}±0.01	2.28^{c}±0.00	24.44^{c}±0.01	0.49^{c}±0.00
99	1	245.48^{a}±0.00	2.68^{ab}±0.00	28.23^{ab}±0.00	0.53^{ab}±0.01
98	2	247.82^{a}±0.00	2.74^{ab}±0.00	29.32^{ab}±0.01	0.54^{ab}±0.00
97	3	250.96^{a}±0.00	2.76^{a}±0.00	31.79^{b}±0.00	0.55^{a}±0.00
96	4	255.31^{a}±0.00	2.76^{a}±0.01	32.05^{b}±0.01	0.56^{a}±0.00
95	5	256.78^{a}±0.00	2.83^{a}±0.01	37.33^{a}±0.00	0.57^{a}±0.00

Average means with the same alphabet along the same column are not significantly different at p≤0.05

Table 3. Physical properties of Acha-turmeric flour blends biscuits

Acha (%)	Turmeric (%)	Spread ratio (g/cm)	Break strength (kg)	Weight (g)
100	0	5.86^{a}±0.00	2.58^{a}±0.00	12.47^{b}±0.00
Wheat	0	5.21^{c}±0.00	2.40^{c}±0.00	14.47^{a}±0.00
99	1	5.85^{a}±0.00	2.58^{a}±0.00	12.50^{b}±0.00
98	2	5.84^{a}±0.00	2.57^{a}±0.00	12.51^{b}±0.00
97	3	5.84^{a}±0.00	2.57^{a}±0.00	12.53^{b}±0.00
96	4	5.80^{ab}±0.00	2.50^{ab}±0.00	12.60^{bc}±0.06
95	5	5.75^{b}±0.00	2.37^{b}±0.00	11.63^{c}±0.00

Average means with the same alphabet along the same column are not significantly different at p≤0.05

Table 4. Sensory properties of Acha-turmeric flour blend biscuit

Acha (%)	Turmeric (%)	Colour	Crispiness	Flavour	Taste	Texture	General accept
100	0	7.80^{d}±1.24	7.35^{a}±1.39	7.60^{c}±1.27	7.20^{c}±1.12	8.20^{a}±0.89	8.05^{c}±1.05
Wheat	0	7.20^{e}±1.19	7.20^{ab}±1.47	7.30^{d}±1.38	7.60^{ab}±1.31	7.90^{b}±0.97	7.60^{d}±1.05
99	1	7.85^{d}±1.44	7.35^{a}±1.90	7.71^{c}±1.55	7.60^{ab}±2.10	8.15^{ab}±2.04	7.96^{a}±1.23
98	2	8.46^{c}±1.76	7.36^{a}±1.27	7.80^{c}±1.49	7.87^{a}±1.87	8.17^{a}±2.00	8.30^{b}±1.76
97	3	8.64^{b}±1.36	7.35^{a}±1.47	8.25^{b}±1.39	7.91^{a}±1.62	8.20^{a}±1.60	8.50^{ab}±1.18
96	4	8.79^{a}±1.76	7.36^{a}±1.81	8.65^{a}±1.85	7.82^{a}±1.41	8.22^{a}±1.79	8.60^{a}±1.61
95	5	8.80^{a}±1.99	7.36^{a}±2.01	8.70^{a}±1.67	7.78^{a}±1.69	8.22^{a}±1.85	8.57^{a}±1.46

Average means with the same alphabet along the same column are not significantly different at p≤0.05

8.05 to 8.51. The relative increase in the mean score of the colour with increase in the added turmeric flour could be attributed to the high content of the carotinoid (yellow pigment) which is colour in the turmeric.

The relative decrease in the mean score of the taste at above 4% could be due to the none acceptability of the inherent tannin and alkaloid taste present in turmeric flour. The quantity of turmeric added is relatively small to have caused any noticeable change in the crispiness and texture of the biscuit product as indicated by the mean scores (7.35- 7.36 and 8.15- 8.22 for crispiness and texture, respectively).

4. CONCLUSIONS

The research has shown a relative improvement in the nutrient composition and the sensory acha based flour and biscuits on the addition of turmeric flour. However, there could be needed to reduce the hydrogen cyanide level. Acha-turmeric biscuit could serve as a means of increasing the quantity of protein, fat and fibre intake of the consumers. A study on the shelf-life extension of biscuit containing turmeric flour needs to be investigated to evaluate the stability of the product during extended storage conditions.

CONSENT AND ETHICAL APPROVAL

As per university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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