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Full Length Research Paper

Quality Attributes of Biscuit from Acha (*Digitaria exilis*) Flour Supplemented with Cowpea (*Vigna unguiculata*) Flour

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Biscuits were produced from blends of acha and cowpea flours. The blends were 100%, 90%, 80%, 70% and 60% acha with cowpea flour to make 100% in each. Proximate composition, trypsin inhibition activity, functional properties including water absorption index, fat absorption index, gelation capacity, bulk density and emulsifying capacity of the blends were determined. Biscuits were produced from the blends. Trypsin inhibition activity, physical properties of the biscuit including break strength, spread ratio, comparative colour analysis and sensory properties of the biscuits were investigated. The results indicated that both protein and trypsin inhibition activity of the blends increased with increase in the amount of cowpea flour substitution. However, significant (p<0.05) reduction in trypsin inhibition activity was noted in the biscuits. Samples with 10% and 20% cowpea substitutions compared favourably with all wheat biscuit in all sensory attributes.

Keywords: Acha, Cowpea, Biscuit, Proximate composition, Antinutritional factor

INTRODUCTION

There are many cereal based foods consumed in Nigeria and they include biscuit, cookies, bread, dough-nut among others. Most of these foods are poor sources of dietary protein and subsequently have poor nutritional quality (Akpapunam and Derbe, 1994). Several research efforts have been made into the enrichment of cereal based foods with legume protein sources such as oil seeds and pulse (McWatters *et al*. 2004), because legume proteins are high in lysine, an essential amino acid limited in most cereals (Alain *et al*., 2007). Nigeria produces very large quantities of cowpea and Bambara-nut. The world production of cowpea in 2000 was about 3.3 million tons with Nigeria as the leading producer (IITA, 2003). The legume contributes significantly toward protein, minerals and B-complex vitamins necessary to people in developing countries. The use of raw material in food manufacture is surely dependent on its availability and the cost. The main problem facing the baking industry in Nigeria is the total dependence on the importation of wheat to sustain it. Nigeria has climatic conditions that are not so favourable for wheat cultivation but very suitable for other cereal crops such as sorghum, millet, maize and acha. Therefore, any effort made to substitute wheat flour by any of locally available cereal flours will contribute a lot to lowering the cost of baking products in Nigeria. Acha is one of the oldest African cereals and is classified as an underutilized crop (NRC, 1996). Acha is noted for its high pentosan, an attribute recognized for good baking operation (Lasekan, 1994). The grain is uniquely rich in methionine and cystine, and evokes low sugar on consumption (Ayo *et al*., 2003). The objective of this study was to produce acceptable biscuit from acha flour supplement with cowpea flour in order to

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Practical Application

The preliminary investigation has revealed that it is possible to produce an acceptable biscuit from blend of acha and cowpea flour with improved protein content. The significance of this study is that protein intake of people of developing countries such as Nigeria can be enhanced since significant quantity of biscuit is consumed by the population.

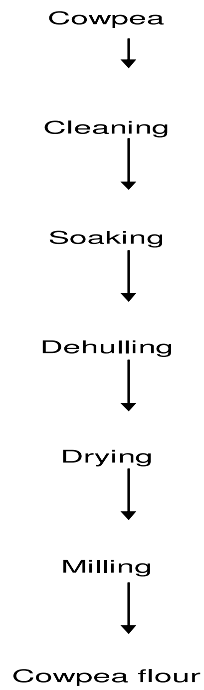

Figure 1. Flow diagram of cowpea flour preparation

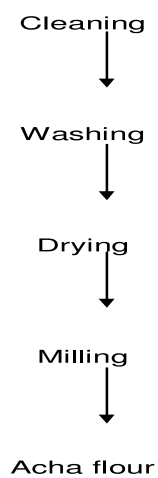

Figure 2. Flow diagram of acha flour preparation

improve its aminoacid profile.

MATERIALS AND METHODS

Procurement of Materials

Creamy coloured cowpea cultivar was obtained from International Institute of Tropical Agriculture, Ibadan. Also, creamy coloured acha was procured from Jos central market, Jos. Other ingredients for biscuit preparation like table sugar and salt, butter, powdered milk and eggs were obtained from Bodija market in Ibadan.

Preparation of Acha and Cowpea Flours

Cowpea and acha flours were prepared as described in figures 1 and 2 respectively. Cowpea was manually cleaned, then soaked in water at room temperature (28±2 ^{o}C) and manually dehulled. The dehulled beans were

Table 1. Formulations utilized in the preparation of biscuits

Ingredient	Amount (g)
Flour	200
Sugar	100
Baking fat	100
Eggs	1 (Large)
Milk	30
Salt	1
Baking powder	1

Table 2. Proximate chemical composition of acha, cowpea and blended flours

Sample	Dry Matter %	Crude Protein %	Crude Fat %	Crude Fibre %	Ash Content %	Carbohydrate* %	TIA TIU
Cowpea flour	88.7±4.2	25.4±2.1	1.48±0.02	1.76±0.4	2.67±0.51	68.7±1.5	14.5±2.34
Acha flour	85.3±2.7	7.41±1.2	1.21±0.01	2.34±0.1	2.94±0.35	86.1±1.8	2.67±0.35
90% acha/10% cowpea	88.3±2.3	10.3±1.3	1.23±0.02	1.89±0.2	3.02±0.22	83.6±0.8	3.43±1.10
80% acha/ 20% cowpea	87.6±3.6	12.7±0.6	1.41±0.02	1.86±0.2	2.78±0.30	81.3±1.5	4.01±1.21
70% acha/30% cowpea	88.2±1.7	16.3±0.3	1.38±0.02	1.67±0.2	2.80±0.32	77.9±1.8	6.70±1.65
60% acha/40% cowpea	88.2±4.5	18.2±0.6	1.12±0.1	1.89±0.2	2.68±0.31	76.1±0.9	8.12±2.1

Means of triplicate trials

dried in a Mermmet cabinet dryer at 60 ^{o}C for 8 h and then milled using an Apex hammer mill to pass through 0.2 mm screen size. Acha was also manually cleaned, washed and dried using the dryer at 50 ^{o}C for 4 h. The treated acha was milled using a plate mill. The flour was sieved to pass through 0.2 mm mesh. Blends of acha and cowpea flours in ratios 100:0, 90:10, 80:20, 70:30 and 60:40 respectively were thoroughly mixed using Hobart mixer.

Analysis of the Flours

Proximate chemical composition of the blends including moisture, protein, fat, ash and crude fibre was determined according to the official methods of AOAC (1990), while carbohydrate was determined by difference. Trypsin inhibition activity of both flours and biscuits were determined according to the method of Kakade *et al.* (1974). Bulk density, water absorption and fat absorption indexes, and gelation capacity were determined for all the blends according to methods described earlier (Olapade *et al*., 2004). Emulsion capacity was determined according to the method described by Yatsumatsu *et al*. (1972).

Preparation and Evaluation of Biscuits

Biscuits were prepared from the blends and 100% wheat flour according to the formulation shown in Table 1. The sugar and baking fat were creamed together until light and fluffy. Egg and flour were added to the mixture followed by milk, salt and baking powder. The mixture was thoroughly mixed into a consistent dough. The dough was rolled on flat wooden surface and cut into predetermined size and shape using a biscuit cutter. The dough was arranged in pre-oiled trays and baked in a preheated laboratory oven operating at 180 ^{o}C for 12 min. The biscuits were allowed to cool down to the room temperature before packaged in polythene bags and stored for evaluation. Colour of the biscuits was determined using a Lovibond tintometer (Lovibond Model F). Comparative colour analysis of the sample was done according to Goose and Binstead (1973). Spread ratio of the biscuits was determined using the method of Gomez

Table 3. Functional properties of acha and cowpea blends

Sample	Bulk density g/ml	Least gelation concentration %	Water absorption index %	Fat absorption index %	Emulsifying capacity
Cowpea flour	0.69±0.03	14±2	108±11	104±2	ND
Acha flour	0.80±0.05	20±2	80±5	98±6	5.49±1.21
90% acha/10% cowpea	0.77±0.02	20±1	78±3	108±8	7.84±1.20
80% acha/ 20% cowpea	0.77±0.08	18±2	79±5	107±9	9.81±0.89
70% acha/30% cowpea	0.78±0.04	18±2	89±4	104±4	10.5±0.21
60% acha/40% cowpea	0.76±0.05	18±2	95±5	116±5	13.9±0.91

Means of triplicate trials
ND- Not determined

et al (1997). Break strength of the biscuits was determined using the methods described by Okaka and Isieh (1990). Coded samples of the biscuits were presented to a twenty-five untrained but experienced panel for sensory evaluation. The attributes evaluated include colour, taste, flavour, mouth-feel, crispness, after-taste and overall acceptability using 9-point Hedonic scale. Data obtained were statistically analyzed using analysis of variance, while the means were compared using Duncans' multiple range test.

RESULTS AND DISCUSSION

Proximate Chemical Composition

The results of proximate analysis of the samples are shown in Table 2. The results obtained for both acha and cowpea were within the ranges earlier reported for acha (McWatters *et al*., 2004 and Jideani and Akingbala, 1997) and cowpea (Bressani, 1985, Olapade *et al*., 2004 and McWatters *et al*., 2004). The major differences between acha and cowpea were protein and Trypsin inhibition activity with cowpea showing higher activity than acha. The dry matter values were 85.3±2.7% and 88.7±4.2% for acha and cowpea flours respectively. There were no significant differences among the blends for crude fat, fibre and ash contents. Both crude protein content and Trypsin inhibition activity were increased with increasing amounts of cowpea flour in the blends. Previous workers have reported similar trend in protein and Trypsin inhibition activity for potato flour supplemented with soybean flour (Iwe, 2000 and Iwe and Ngoddy, 1998) and wheat flour supplemented with cowpea flour (Okaka and Isieh, 1990). The higher level of protein in the blends is nutritionally significant since biscuit consumption is very high among Nigerians.

Functional Properties

The results of functional properties of cowpea, acha and blends of the flours are shown in Table 3. Bulk density ranged from 0.69 g/ml for cowpea flour to 0.80 g/ml for acha flour. The results are within the reported values for starch foodstuff (Onuh and Abdulsalam, 2009). Bulk density is significant in package design, storage and transport of foodstuff. The least gelation concentrations of the blends were significantly higher than that of cowpea flour alone but lower than that of acha flour. Water absorption index ranged from 78 to 108% pointing out that cowpea flour presented the highest value. The values for the blends were significantly lower than that of cowpea flour alone but higher than that of acha alone. Fat absorption index values for the blends were significantly higher than the values for both cowpea and acha flours. Emulsion capacity ranged from 5.49 to 13.9%. Emulsifying increased with increasing amounts of cowpea flour in the blends.

Physico-chemical properties of Biscuits

Results of physico-chemical properties of biscuits from blends of acha and cowpea flours are shown in table 4. Acha flour biscuit exhibited spread ratio of 5.35 while biscuits containing cowpea flour exhibited increase in their spread ratio (5.40-6.28%) as the amount of cowpea in the blend increased. The highest spread ratio was obtained for 40% cowpea in the blends. Okaka and Isieh (1990) reported similar trend in biscuits from wheat and cowpea flours. A value of 70.5% was reported for all wheat flour biscuit, which is higher than the value obtained for all acha flour biscuits in this study. The difference may be attributed to absence of gluten, protein

Table 4. Physico-chemical properties of biscuits

Sample	Spread Ratio	Break strength (kg)	Comparative Colour Neutral (LU)	Orange (LU)	Yellow tint (LU)	Trypsin Inhibition Activity (TIU)
Acha flour	5.35	2.75	0.71	2.48	2.01	ND
90% acha/10% cowpea	5.40	2.75	1.24	2.51	1.82	0.10
80% acha/ 20% cowpea	5.67	2.53	1.94	3.13	0.95	0.09
70% acha/30% cowpea	6.12	2.48	2.41	2.10	0.67	0.12
60% acha/40% cowpea	6.28	2.43	3.48	2.40	0.92	0.13

ND= Not detected, LU= Lovibond unit, TIU= Trypsin inhibition unit
Yellow+Blue=Green, Yellow+Red=Orange Neutral tint= the lowest value of either red, blue or yellow combined with equal measured values of the other two colours (Goose and Binstead, 1973).

Table 5. Sensory properties of biscuits from blends of acha and cowpea flours

Sample	**Colour**	**Taste**	**Flavour**	**Aftertaste**	**Crispness**	**Overall acceptance**
Wheat flour	7.9a	7.8a	7.4a	7.0a	7.0a	7.7a
Acha flour	6.9b	6.3b	6.4b	6.7ab	6.5ab	6.8b
90% acha/10% cowpea	6.4bc	6.5b	6.2b	6.2b	6.4b	6.7b
80% acha/ 20% cowpea	6.8b	6.6b	6.7b	6.8b	6.5ab	6.4b
70% acha/30% cowpea	6.2cd	6.1b	5.6c	5.4c	6.0b	5.7c
60% acha/40% cowpea	5.7d	5.1c	4.9d	4.6d	4.8c	5.6c

Means with the same letters along the column are not significant different ($p<0.05$)

responsible for visco-elastic behavior of wheat flour. The weight to break the biscuits are as presented in Table 4. Addition of cowpea flour weakened the break strength of the biscuits as the 40% cowpea blend had the least break strength. The neutral tint colour is an indication of lightness or dullness of the sample. The higher the value the dullest the sample and vice versa. Acha flour alone produced biscuit with light colour while increasing amounts of cowpea led to an increase in dullness of the biscuits. The observed increase in dullness may be attributed to Maillard reaction between cowpea protein and acha sugar, which led to non-enzymatic browning of the products. Trypsin inhibition activity of the biscuits was drastically reduced compared to that of raw blends. Inactivation of the enzyme may be due to high temperature employed in the baking.

Sensory attributes of Biscuits

The results of sensory evaluation of the biscuits are presented in Table 5. Biscuits from 10% and 20% cowpea in the blends were favourably scored compared to the control sample, which was scored highest in all sensory attributes. Samples containing more than 20% cowpea flour were poorly scored compared to the control.

CONCLUSION

The preliminary investigation so far has indicated the possibility of preparing an acceptable biscuit from blend of acha and cowpea flours with an increase in protein content. Biscuit prepared from 10% substitution of cowpea flour in acha flour compared favourably with all wheat biscuit in all sensory attributes.

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