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Nutrient and Sensory Evaluation of Cowpea -Acha Flour Blend in Pudding Production

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Research Article

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Abstract

Cowpea is an important food crop that is widely consumed as a protein and energy source despite its limitation and high cost when compared to other grains, with the use of acha gaining popularity. The present study was conducted to highlight the diverse potential and domestic applications of acha as well as its nutritional value. The nutritive properties of the cowpea-acha composite flour blends were investigated as well as the proximate and sensory properties of pudding (moin-moin) developed from the blends. Cowpea (100%) was used as the control and substituted with acha at different ratio from 10-50%. The flour blends were analyzed for, functional, chemical composition and pasting properties, while proximate composition and sensory evaluation was done on the products. The functional properties showed that bulk density, oil and water absorption, solubility and swelling power increased with substitution of acha and ranged from 0.74-0.80g/mL, 1.20-1.29%, 1.13-1.45%, 20.92-30.14% and 7.03-9.89% respectively, while dispersibility decreased from 76.00-74.50%. Chemical analysis of cowpea-acha composite flour blends showed that there were no significant ($p>0.05$) differences in moisture, fat, fiber and carbohydrate contents, while ash, protein, starch, sugar, amylose and amylopectin showed significant ($p<0.05$) difference. The pasting characteristics of cowpea-acha blends showed that peak and breakdown viscosities reduced as the level of acha substitution increased, while trough, final and setback viscosities increased with an increase in the level of acha substitution with all pasting parameters showing no significant ($p>0.05$) difference. The sensory evaluation result indicated an organoleptically acceptable pudding from different blends of cowpea and acha with the 100% cowpea (control) as the most preferred.

Keywords: Cowpea; Acha; Blends; Nutrient; Pudding; Sensory

Introduction

Cowpea (*Vigna unguiculata*) is one of the most ancient food sources known to man and has probably been used as a crop plant since neolithic times [1]. It is cultivated primarily for grain, but also as vegetable (leafy green, green pods, shelled dried peas, and fresh shelled green peas) and a cover crop. Cowpea is a drought tolerant and warm weather crop that is well adapted to drier regions of the tropics [2]. In Nigeria and in many African countries, cowpea is an important, nutritious leguminous crop, rich in vitamins, protein, minerals, soluble and insoluble dietary fiber, providing an alternative source to animal protein.

Cowpea has found utility in various ways in traditional and modern food processing in the world. The harvested dry seeds of cowpea can be ground into paste and used to make bean pudding (moin-moin), made by steaming cowpea paste, flavored with onion, salt, pepper, fish, egg and vegetable or palm oil or the seeds boiled, mixed with sauce or stew and consumed directly. Traditionally, cowpea paste is prepared by the combined processes of soaking, dehulling and wet milling of cowpea seeds.

Flours have been processed from different types of legumes due to changing trends in consumer demands for more convenient products. Cowpea flour has added to household convenience Ashaye, et al. [3], Fasoyiro, et al. [4], as the flour is ready for use. Composite flours have also been developed from cereals and tuber crops mixed with legume flours. Cowpea flour is usually rehydrated and utilized in formulations as desired [5].

However, the growth in the dietary share of cowpea has been constrained by high preparation time, labour requirements and undesirable product characteristics including beany flavor, low protein digestibility, anti-nutritional factors, poor mineral bioavailability and flatulence in both man and other monogastric animals as well as post-harvest grain losses to insect pests Dolvo, et al. [6], McWatters [7], Henshaw & Lawal [8]. Therefore it is of interest to complement these deficiencies and associated challenges with acha which is relatively richer in protein and attracts less labour. Although flatulence is not a health problem, it however limits the use of legumes [9]. The removal of these anti-nutrients like phytate is essential to improve the nutritional quality of the legumes by different processing methods like cooking, soaking, sprouting, fermentation [10].

Achinewhu [11] reported that the nutritive value of food protein does not depend only on the quantity of the protein but also on the quality of the protein. Thus, supplementing cereal-based diets with legumes improves overall nutritional status and is one of the best solutions to protein calorie malnutrition in the developing countries [12].

Acha (*Digitaria exilis*) is an underutilized crop Philip, et al. [13] that is gaining popularity. Like other millet, acha is widely reported to be rich in amino acids but particularly in methionine and cystine Belton & Nuttall [14]. Studies have shown that the methionine level in acha is twice that found in egg protein leading to suggestions that acha could be used to complement diets Belton & John [15] that are low in the essential amino acids. Okeme, et al. [16] in support of this statement described acha as an excellent nutritional complement to legumes as most legumes are deficient in methionine and cystine. It is also a good source of vitamins, minerals, fibre, carbohydrate, lipids, proteins and ash [17].

Furthermore, acha is reported to be important in the management of chronic diabetes because of its low glycemic index. Therefore the study is aimed at evaluating the physico-chemical and sensory properties of cowpea-acha flour blend in pudding (moin-moin) production.

Materials and Methods

Material

Cowpea used for this study was obtained from mile one market, while acha was obtained from Bori Camp Market, both in Port Harcourt, Rivers State.

Chemicals

Chemicals used for analysis were obtained from the Biochemistry Laboratory, Department of Food Science and Technology, Rivers State University and were all of analytical grade.

Methods

Processing of Acha Flour

Acha was manually cleaned by washing in clean tap water using local calabash to wash and de-stoned by sedimentation. Draining and drying in cabinet drier at 50°C for 6 hrs. The resultant dried acha was milled into flour using hammer mill (2014, hot model PC 180) (Figure 1).

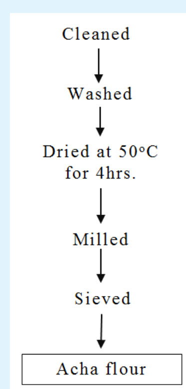

Figure 1: Process flow diagram of acha flour preparation.

Processing of Cowpea Flour

The cowpea was sorted, washed, dehulled and dried at 50°C for 12hour in a hot air oven. The dried seeds where milled using hammer mill and the resultant flour sieved to obtain flour of particle size 50 -70um. This was stored in an air tight container (Figure 2 & Table 1).

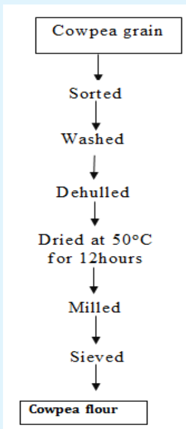

Figure 2: Process flow diagram of cowpea flour preparation.

Source: Barber, et al. [18].

Composite Materials Samples (G)	Samples (G)					
	A (control)	B	C	D	E	F
Cowpea flour	100	90	80	70	60	50
Acha flour	0	10	20	30	40	50
Tatashe pepper	30	30	30	30	30	30
Onions	30	30	30	30	30	30
Salt	4	4	4	4	4	4
Maggi cube	5	5	5	5	5	5
Water distilled (ml)	250	250	250	250	250	250
Vegetable oil (ml)	30	30	30	30	30	30

Table 1: Formulation of Cowpea- acha Flour Blend

Production of Pudding from Cowpea-acha Flour Blends

The method of Akusu and Kiin-Kabari (2012) modified was used for the pudding production. One hundred fifty (150g) gram of cowpea-acha flour for each blend was mixed with ingredients as stated in table 1.

Sensory Characteristics

Coded pudding samples were subjected to sensory analysis test within 2hrs of production. This was done using a 20-untrained but experienced panelist comprising of students of the Department of Food Science and Technology, Rivers State University (RSU), who were familiar with cowpea based pudding (moin-moin) and were neither sick nor allergic to any raw material used for the development of the product. A 9-point hedonic scale was used where 1 and 9 represented dislike extremely and like extremely Ihekoronye & Ngoddy [19] respectively. The attributes that were evaluated include color, taste, flavor, texture, sogginess, structure and general acceptability. The data obtained was analyzed using analysis of variance while the means were compared using Duncan's multiple range test.

Chemical Analysis

Proximate analysis: Moisture content, protein, fat, ash and crude fiber was determined by AOAC method [20]. Carbohydrate content was determined by difference. While energy in kcal was calculated using At-water factor as described by Obiegbuna & Baba [21].

Functional properties: Bulk density of the flour samples was determined as described by Appiah, et al. [22]. Water and oil absorption capacities were determined by the method of Elkhalifa, et al. [23], while solubility and swelling power were determined based on the method of Leach, et al. [24].

Pasting properties: The pasting properties (RVU) of the cowpea-acha samples where determined using the Rapid Visco Analyser (RVA) Tecmaster, Pertern Instrument as reported by Eke [25].

Statistical analysis: Data obtained from all the experimental analysis carried out were subjected to statistical analysis using the analysis of variance (ANOVA) using a linear model Wahua [26] and the significant difference between the means was analyzed using Duncan Multiple Range Test. All statistical tests were performed at 5% significant level.

Results and Discussion

Functional Properties of Cowpea and Acha Flour Blends

(Table 2) shows the result of functional properties of the cowpea-acha flour blends.

Functional properties are those physico-chemical properties of food proteins that determine their behavior in food system during processing, storage and consumption Berchie, et al. [27]. These properties had been defined as the intrinsic physico-chemical characteristics which affect the behavior of protein in food system during processing, storage and preparation Jones & Tung [28].

The result of bulk density ranged from 0.74g/ml to 0.80g/ml with the highest value found in the sample with 50%cowpea: 50%acha (sample F) blend and the lowest value in sample A 100%cowpea. There was a gradual increase in bulk density as the level of acha substitution increased in the blend. Sample B, E and F showed no significant (p>0.05) difference as well sample A, C and D. However, bulk density is significant in package design, storage and transport of foodstuff. The results are within the findings of Olapade & Adeyemo [29].

Oil absorption capacity of the flour ranged from 1.04-1.45g/ml with sample C (80% cowpea, 20% acha) recording the highest and sample D (70% cowpea, 30% acha) as the lowest. The hydrophobicity of proteins is known to play a major role in fat absorption. This acts to resist physical entrapment of oil by the capillary of non-polar side chains of the amino acids of the protein molecules [30]. The present study showed no significant different (p>0.05) between the blends.

The result of the water absorption capacity ranged from 1.20-1.36g/ml with sample D (70%cowpea, 30% acha) recording highest and sample E the lowest value. The water absorption behavior can be linked to the nature of starch of the acha and cowpea blends. The nature of starch has been found to have effect on water absorption capacity [31]. High water absorption capacity is attributed to lose structure of starch polymers while low values indicate compactness of the structure Adebowale, et al. [32], Oladipo & Nwokocha [33]. Osundahunsi, et al. [34] reported that higher water absorption capacity is desirable in food system to improve yield and consistency of such food product.

The solubility of the flour samples ranged from 20.92 - 30.14% with samples F (50%cowpea: 50%acha) as highest and A (100%cowpea) as lowest (20.92%). Solubility increased with an increase in the level of acha inclusion. There was no significant different (p>0.05) between sample A, B and C, although they differed significantly (p<0.05) from D and F which had no significant difference (p>0.05).

The result of the swelling power of the flour blends ranged from 7.03 - 9.89% with samples F (50%cowpea: 50%acha) as highest and A (100%cowpea) as lowest (7.03%). Result showed an increase in swelling power of the blends as substitution increased. This is expected as the starch component of acha has positively affected the ability of the blend to take up water. Finney [31] reported that swelling capacity affects the temperature at which product forms gel. The swelling capacity of flour depends on the particle size, source of raw material and type of processing method or unit operation used. There was a significant different (p<0.05) between the samples across each blend.

Dispersibility values ranged from 74.50-76.00%, showing a decrease in value as the level of substitution increased. Dispersibilty is a measure of reconstitution of flour or starch in water. The higher the value the better the sample reconstitutes in water and gives a fine constitutes during mixing

Sample	Bulk Density	OAC	WAC	Solubility	Swelling Power	Dispersibility
A	0.74±0.00^{ab}	1.25±0.01^{a}	1.13±0.03^{a}	20.92±0.06^{d}	7.03±0.00^{e}	76.00±3.00^{a}
B	0.75±0.01^{b}	1.24±0.02^{a}	1.07±006^{a}	23.00 ±0.31^{c}	7.25±0.00^{de}	75.00±3.00^{a}
C	0.77±0.02^{ab}	1.30±0.06^{a}	1.45±0.29^{a}	25.43±0.56^{b}	7.88±0.08^{cd}	76.00±4.00^{a}
D	0.78±0.00^{ab}	1.36±0.16^{a}	1.04±0.04^{a}	28.89±0.90^{a}	8.50±0.39c	75.00±3.50^{a}
E	0.79±0.01^{a}	1.20±0.03^{a}	1.10±0.03^{a}	29.39±0.41^{a}	9.34±0.27b	74.50±0.50^{a}
F	0.80±0.00^{a}	1.29±0.04^{a}	1.42±0.05^{a}	30.14±0.16^{a}	9.89±0.08a	74.50±0.50^{a}
LSD	0.03	0.23	0.48	1.9	0.67	6.58

Table 2: Functional Properties of Cowpea-Acha Flour Blends.
Means with different superscript in the same column are significant different (p<0.05)
Key:
Sample A = 100%cowpea, 0% acha
Sample B = 90%cowpea, 10% acha
Sample C = 80%cowpea, 20% acha
Sample D = 70%cowpea, 30% acha
Sample E = 60%cowpea, 40% acha
Sample F = 50%cowpea, 50% acha

Chemical Composition of Cowpea- Acha Flour Blend

The chemical composition of foods are necessary as they act as sources of nutrition to both humans and animals or structural components of large molecules with specific functions as stated in recommended daily allowance. Table 3 shows the chemical composition result of cowpea-acha flour blends. Moisture content of different cowpea-acha flour blends ranged from 8.85% to 9.50% with the highest value in sample D (70%cowpea: 30%acha) and sample A (100%cowpea) having the least value. The samples were not significantly different ($p>0.05$) from each other. The low moisture content in the present study is desirable since high moisture content affects the storage of flour and product quality Agu & Aluyah [35]. High-moisture products (>12%) usually have shorter shelf stability compared with lower-moisture products (<12%) as reported by Ashworth & Draper [36]. The low moisture content also indicates that the blends would have an extended shelf life if properly stored at appropriate conditions. This result is in line with the findings of Olapade, et al. [37].

Ash content is a measure of the total amount of mineral content or inorganic material that remains in flour after milling. The ash content in the present study ranged from 2.00 - 2.80% with sample F (50%cowpea: 50%acha) as the lowest and sample A (100%cowpea) as the highest. This result showed a decrease in ash content as the level of acha substitution increased. The ash content in the present study is lower than the value reported by Aworh & Olapade [38] for fonio and cowpea flour formulation in complementary foods. Samples A, B and C were significantly different ($p<0.05$) from sample D, E and F. The ash content of any flour is usually affected primarily by the source of raw material as well as its milling extraction rate.

Fat content of the flour blends ranged from 1.73 - 2.01% with sample B (90%cowpea, 10%acha) recording the highest and sample F (50%cowpea: 50%acha) the least value. Both samples were not significantly different ($p>0.05$) from all other blends. The storage life of the blend may be increased due to low fat content since high fatty foods are potentially susceptible to oxidative rancidity. Cowpeas are poor sources of oil, containing only small quantities which are less than 3% Aykroyd & Doughty [39], and further reduced by the inclusion of acha.

Protein content of the flour blends reduced from 22.25% - 10.62% with sample A (control) recording the highest and sample F (50%cowpea: 50%acha) the lowest. The samples were significantly different ($p<0.05$) from each other, showing a decrease in the protein content as the level of acha substitution increased. This is expected as the inclusion of acha with lower protein further reduced the cowpea protein. This result is in line with the findings of Aworh & Olapade [38].

Fiber content ranged from 1.73 - 2.01% with sample B (90%cowpea, 10%acha) recording the highest value and samples D and E as the lowest. Reduction in fiber content was observed after 20% inclusion of acha flour. The flour samples showed no significant differences ($p>0.05$) from each other and where in line with the findings of Aworh & Olapade [38].

Carbohydrate and starch contents of the composite flour samples increased from 81.07 - 83.90% and from 59.82-65.85% respectively, with sample A (control) having the lowest and sample F (50%cowpea: 50%acha) the highest value in both cases. The carbohydrate and sugar contents increased as the level of acha substitution increased, with no significant difference ($p>0.05$) amongst the blends in carbohydrate and a significant difference ($p<0.05$) in starch content. This trend is expected due to the reduction in the fat and protein contents of the blends as the level of acha substitution increased.

Sugar content of cowpea-acha flour blends reduced from 6.21% - 5.13% with samples A (control) recording the highest and F (50% cowpea: 50% acha) the lowest value with samples showing significant difference ($p<0.05$). The decrease in the present study collaborates the fact that in Nigeria, acha sellers identified diabetic patients as their major customers IPGRI [40] because it has relatively low-sugar content and low glycemic index which ensures less fluctuation in blood glucose [41].

Amylose and amylopectin content ranged from 21.74 - 24.83% and 38.08 - 43.22% respectively, with sample A as highest and F (50%cowpea: 50%acha) as lowest in both cases. Amylose and amylopectin increased with an increase in the level of acha substitution. Results show that there was a significant difference ($p<0.05$) among the flour blends. The amylose and amylopectin content of starches significantly influences its functional properties. The amylose content of cowpea varieties has been reported to range from 6.92 to 39.30 % with an average of 17.73% Aremu [42]. Such variation in amylose/amylopectin ratio would most likely have an effect on cooking characteristics of cowpea such as water absorption capacity. Upon cooling, cowpea starch paste has a high tendency of retrogradation resulting in the formation of a gel possibly due to the high amylose content of cowpea starch Henshaw, et al. [43]. According to Foster-Powell, et al. [44] the ratio of amylose to amylopectin in carbohydrate has important implication on food quality, industrial application and health. Hence, high level of resistance starch in food decrease glycemic index and as such it can improve control of diabetes mellitus by altering the glycemic impact of ingested carbohydrate Sajilata, et al. [45].

Sample	Moisture	Ash %	Fat %	Protein %	Fiber %	CHO %	Starch	Sugar	A/lose	A/pectin
A	8.85±0.05^{a}	2.80±0.10^{a}	1.96±0.01^{a}	22.25±0.00^{a}	1.77±0.09^{a}	81.07±0.06^{a}	59.82^{c}	6.21^{a}	21.74^{a}	38.08±0.33^{d}
B	9.05±0.15^{a}	2.65±0.25^{ab}	2.01±0.03^{a}	18.87±0.00^{b}	1.93±0.07^{a}	81.34±0.30^{a}	66.11^{a}	5.82^{b}	22.90^{d}	43.22±0.45^{a}
C	9.05±0.05^{a}	2.30±0.20^{abc}	1.95±0.01^{a}	16.87±0.00^{c}	1.81±0.13^{a}	82.23±0.15^{a}	62.95^{c}	5.41^{c}	23.43^{c}	38.53±0.62^{c}
D	9.50±0.10^{a}	2.20±0.15^{bc}	1.87±0.31^{a}	14.68±0.00^{d}	1.61±0.06^{a}	82.48±0.31^{a}	61.62^{a}	5.51^{c}	23.97^{b}	37.70±0.09^{d}
E	9.40±0.40^{a}	2.03±0.03^{c}	1.79±0.17^{a}	12.45±0.02^{e}	1.61±0.12^{a}	82.98±0.64^{a}	64.39^{b}	5.21^{d}	24.83^{a}	39.56±0.01^{cd}
F	9.10±1.00^{a}	2.00±0.10^{c}	1.73±0.47^{a}	10.62±0.00^{f}	1.57±0.07^{a}	83.90±1.64^{a}	65.85^{a}	5.13^{d}	24.30^{b}	41.55±0.28^{b}
LSD	1.66	0.51	0.96	0.01	0.36	2.85	1.06	0.18	0.34	1.41

Table 3: Chemical Composition of cowpea-acha Flour Blend Means with different superscript in the same column are significant different (p<0.5).
Key:
Sample A = 100%cowpea, 0%acha
Sample B = 90%cowpea, 10%acha
Sample C = 80%cowpea, 20%acha
Sample D = 70%cowpea, 30%acha
Sample E = 60%cowpea, 40%acha
Sample F = 50%cowpea, 50%acha

Pasting Properties (RVU) of Cowpea-Acha Flour Blends

(Table 4) shows the pasting properties of cowpea-acha flour blends such as peak, trough, breakdown, final viscosity, set back viscosity, pasting time and pasting temperature. Peak viscosity ranged from 161.46 - 186.80RVU with sample C (70%cowpea: 30%acha) recording the highest and sample F (50% cowpea: 50%acha) the lowest value. The slight variation observed in the peak viscosity of the study is associated with the swelling power of the starch blend and the rate of disruption of the starch granules, with results revealing no significant difference (p>0.05) among the various samples. Peak viscosity usually indicates the water binding capacity of a mixture in a product Ingbian & Adegoke [46]. It is often correlated with final product quality and also an indication of the viscous load likely to be encountered by a mixer.

Trough viscosities ranged from 142.84 - 158.04 RVU with sample A (control) as the lowest and sample E (60%cowpea, 40%acha) as the highest. The observed variations in the blends may be attributed to the addition of varying quantities of acha to cowpea. Trough viscosity also known as holding period is the point at which viscosity reaches its minimum during heating or cooling process, while final viscosity of cowpea-acha blends ranged from 233.92 - 365.17RVU with sample A (control) and F (50%cowpea: 50%acha) as the lowest. Final viscosities increased with an increase in the level of acha substitution. This viscosity is important in determining the ability of flour to form gel during processing [47].

Set back viscosity ranged from 91.09 - 221.13RVU with sample A (control) recording the highest and sample F (50%cowpea: 50%acha) the lowest, with no significant different (p>0.05) between the flour blends. The low setback viscosity value observed in the control sample (100% cowpea) indicated a low rate of starch retrogradation since the starch component was less, while the higher setback values observed with an increase in substitution of acha flour connoted higher water holding capacity within the blend as a result of the starch component.

Breakdown viscosity ranged from 17.42-37.09RVU with sample A (control) recording the highest value of breakdown while sample F (50%cowpea: 50%acha) recorded the lowest. This showed that the gelling stability reduced with increase in acha substitution. There was no significant difference (p>0.05) between the flour blend. The breakdown is the difference between the peak viscosity and trough and it is an indication of the rate of gelling stability which is dependent on the nature of the product [48].

Pasting time ranged from 5.27 - 5.53min with all pasting parameters showing no significant difference (p>0.05). Pasting time is a measure of the cooking time.

Pasting temperature ranged from 49.00 - 50.50oC with sample B and E recording the highest value and sample A the lowest. The result showed no significant difference (p >0.05) among the sample blends. The low pasting temperature of the blends in the present study indicates lower resistance towards swelling, which will affect the gelling of the product. Pasting temperature provides an indication of the minimum temperature required to cook a sample which can have implication on the stability of other components in a formulation, and also indicates energy loss, Panozza & McCormick [49,50].

Sample	Peak viscosity (RVU)	Trough Viscosity (RVU)	Breakdown Viscosity (RVU)	Final Viscosity (RVU)	Setback Viscosity (RVU)	Peak Time (min)	Pasting Temp (°C)
A	179.92±22.27^a	142.84±13.20^a	37.09±9.07^a	233.92±21.92^a	91.09±8.72^a	5.30±0.14^a	49.00±0.00^a
B	177.99±7.20^a	143.09±4.72^a	34.92±2.47^a	245.46±4.89^a	102.38±0.18^a	5.27±0.00^a	50.50±0.00^a
C	186.80±4.67^a	151.21±4.54^a	35.59±0.12^a	276.71±2.18^a	125.50±2.36^a	5.30±0.14^a	49.70±1.20^a
D	171.67±3.54^a	148.46±0.18^a	23.21±3.71^a	308.55±0.53^a	160.08±0.71^a	5.47±0.09^a	49.63±1.10^a
E	185.15±5.16^a	158.04±3.95^a	27.13±1.24^a	347.25±6.83^a	189.21±2.88^a	5.53±0.00^a	50.50±0.07^a
F	161.46±6.42^a	144.05±6.54^a	17.42±0.12^a	365.17±22.27^a	221.13±15.73^a	5.27±0.00^a	49.68±1.17^a
LSD	29.23	18.85	11.69	36.65	20.76	0.24	2.25

Table 4: Pasting Properties of Cowpea-acha Flour Blends.
Means with different superscript in the same column are significant different (p<0.5)
Key:
Sample A = 100%cowpea, 0%acha
Sample B = 90%cowpea, 10%acha
Sample C = 80%cowpea, 20%acha
Sample D = 70%cowpea, 30%acha
Sample E = 60%cowpea, 40%acha
Sample F = 50%cowpea, 50%acha

Proximate Composition of Pudding from Cowpea -Acha Flour Blends

The result of evaluation of the proximate composition of the developed pudding (moin-moin) made from cowpea-acha flour blend is shown in Table 5. The moisture content ranged from 59.10% to 62.20% with sample F (50% cowpea: 50% acha,) as the highest and the lowest value in sample A (100%cowpea). The moisture content of the pudding (moin-moin) increased with the addition of acha. This is expected as the increase in acha increased the ability of the blends to absorb and retain more water as a result of increased starch content.

Ash Content of the pudding ranged from 1.98% to 2.70% with sample F(50% cowpea: 50% acha) recording the least ash content and sample A (control) the highest, While the results of fat content ranged from 3.06 - 4.59% with the highest value observed in sample C (80%cowpea-20%acha) and the least value in sample A (control). The result of fat in the present study is within the range recorded for maize - cowpea blend by Abegunde, et al. [51]. Ash and fat content showed no significant (p>0.05) differences amongst the samples.

Protein content of the pudding decreased from 23.13% -14.68%, as the level of acha substitution increased, with sample A (control) having the highest and sample F (50%cowpea:50%acha) as the lowest. The protein content of the sample blends varied according to the percentage of acha. This is due to the low protein content in acha which has affected the protein content of the control sample. However there was significant (p<0.05) difference between the blends. This result is within the range recorded for cowpea - maize blend for moin-moin production by Akusu & Kiin-Kabari [52].

The crude fiber content of the pudding reduced from 1.72%- 1.44% with sample A having the highest and sample F the lowest, with no significant (p>0.05) difference amongst the samples. Fiber content may contribute to bulk and encourage bowel movement, discourage constipation and piles, reduce blood cholesterol and help prevent cancer of the colon [53]. The result is in agreement with the range recorded for cowpea - maize blend for moin-moin production by Akusu & Kiin-Kabari [52].

Total available carbohydrate (TAC) ranged from 10.30-15.26% with sample A recording the lowest and not significantly different (p>0.05) from the other blends while sample F recorded the highest. Carbohydrate increased with increase in the level of substitution of acha, while energy decreased with the inclusion of acha and ranged from 147.54 - 164.53kcal. Acha grain is the ideal meal for weight loss as it provides a greater deal of fibre that gives a feeling of fullness, Pietta [54-59], while been a good source of energy.

Sample	Moisture %	Ash %	Fat %	Protein %	Fibre %	Carbohydrate %	Energy /Kcal.
A	59.10±0.00^{d}	2.70±0.00^{a}	3.06±0.23a	23.13±0.00a	1.72±0.23a	10.30±0.00a	161.22±2.025^{a}
B	60.05±0.85^{cd}	2.45±0.05^{a}	4.27±0.97a	20.31±0.00b	1.70±0.25a	11.23±1.62a	164.53±2.225^{a}
C	60.53±0.85^{bc}	2.20±0.00^{a}	4.68±0.89a	18.72±0.04c	1.62±0.04a	12.25±0.04a	159.54±7.710^{ab}
D	61.65±0.85^{bcd}	2.00±0.00a	4.38±0.42a	17.18±0.00d	1.56±0.20a	13.20±1.50a	161.08±2.080^{a}
E	62.05±0.85^{ab}	2.00±0.00a	4.59±0.48a	15.62±0.00e	1.53±0.15a	14.21±1.48a	154.21±1.625^{ab}
F	62.20±0.85^{a}	1.98±0.08a	4.44±1.24a	14.68±0.00f	1.44±0.09a	15.26±0.37a	147.54±9.615^{b}
LSD	2.59	0.12	2.68	0.05	0.38	4.31	12.74

Table 5: Proximate Composition of Pudding made from Cowpea-Acha Flour Blend.
Means with different superscript in the same column are significant different (p<0.05)
Key:
Sample A = 100%cowpea, 0%acha
Sample B = 90%cowpea, 10%acha
Sample C = 80%cowpea, 20%acha
Sample D = 70%cowpea, 30%acha
Sample E = 60%cowpea, 40%acha
Sample F = 50%cowpea, 50%acha

Mean Sensory Scores of Pudding Produced from Cowpea-Acha Flour Blends

(Table 6) shows the result of the sensory evaluation of the pudding produced from cowpea-acha blends. Color, taste and flavor, ranged from 6.75-6.90, 6.35 - 8.30, and 6.50-8.55 respectively, while texture, sogginess, structure and overall acceptability ranged from 6.55 -7.95, 6.65 - 7.45, 6.40 - 8.00, and 6.50 - 8.70 respectively. The result showed no significant (P>0.05) difference in sogginess of all the sensory parameters evaluated

S Sample	Colour	Taste	Flavour	Texture	Sogginess	Structure	Overall Acceptability
A	7.75^{a}	8.30^{a}	8.55^{a}	7.95^{a}	7.45^{a}	8.00^{a}	8.70^{a}
B	6.80^{b}	7.15^{b}	7.15^{b}	7.30^{ab}	7.45^{a}	6.95^{b}	7.65^{b}
C	7.30^{ab}	6.75^{b}	6.70^{b}	7.00^{b}	6.95^{a}	6.80^{b}	7.00^{bc}
D	6.90^{ab}	7.05^{b}	6.80^{b}	7.15^{ab}	7.00^{a}	7.05^{b}	7.00^{bc}
E	6.75^{b}	6.35^{b}	6.50^{b}	6.70^{b}	6.70^{a}	6.65^{b}	6.90^{bc}
F	6.85^{b}	6.40^{b}	6.50^{b}	6.55^{b}	6.65^{a}	6.40^{b}	6.50^{c}
LSD	**0.88**	**0.84**	**0.82**	**0.86**	**0.92**	**0.83**	**0.79**

Table 6: Mean Sensory Scores of pudding produced from cowpea-acha flour blend.
Means with different superscript in the same column are significant different (p<0.05)
KEY:
Sample A = 100%cowpea, 0%acha
Sample B = 90%cowpea, 10%acha
Sample C = 80%cowpea, 20%acha
Sample D = 70%cowpeas, 30%acha
Sample E = 60%cowpea, 40%acha
Sample F = 50%cowpea, 50%acha

Conclusion

The study has shown that cowpea-acha composite flour blend positively affected starch, amylose and amylopectin, while reducing the sugar content when compared with the 100% cowpea flour. Pasting properties also gave acceptable results which did not differ significantly from the control. Inclusion of acha in cowpea flour for the production of pudding (moin-moin) gave an acceptable product in term of improved fat, carbohydrate and total energy. Sensory evaluation result showed preference for pudding produced from 100% cowpea, which may be attributed to familiarity with pudding from cowpea, although pudding from acha substitution up to 30% inclusion were acceptable.

References

1. Summerfield RJ, Huxley PA, Steelle W (1974) Cowpea *(Vigna unguiculata L. Walp.)* Field Crop Abstracts 53(1-3): 187-204.

2. International Institute of Tropical Agriculture (IITA) Agency Report (2012) Cowpea Driving Silent Economic Revolution in Nigeria.

3. Ashaye OA, Fasoyiro SB, Kehinde RO (2000) Effect of Processing on quality of Ogi fortified with full fat cowpea flour. Moor Journal of Agricultural Research 1: 115-122.

4. Fasoyiro SB, Akande SR, Arowora KA, Sodeko OO, Sulaiman PO, et al. (2010) Physico-chemical and sensory properties of pigeon pea (Cajanus cajan) flours. African Journal of Food Science 4: 120-126.

5. Olu M, Rotimi A, Emmanuel AA (2017) Development of Spiced Instant Moin-moin‟ produced from Precooked Cowpea Flour using Maize Starch as Binder. International Journal of Food Science and Nutrition Engineering 7(4): 75-90.

6. Dolvo FE, Williams CE, Zoaka L (1976) Cowpeas. Home preparation and use in West Africa, IDRC - 055e. Int. Dev. Res. Centre, Ottawa, Canada, pp: 29-30.

7. McWatters KH (1983) Compositional, physical and sensory characteristics of “akara” processed from cowpea paste and Nigerian cowpea flour. Journal of Cereal Chemistry 60: 333-336.

8. Henshaw FO, Lawal SA (1993) Effects of Processing Methods on the Functional Properties of Cowpea Flour. Journal of Tropical Science 33: 377-385.

9. El Faki HA, Venkatarama L, Desikachar H (1984) Effect of processing on the in vitro digestibility of proteins and carbohydrates in some Indian legumes. Plant Foods for Human Nutrition 34(2): 127-133.

10. Adeparasi EO (1994) Evaluation of the nutritive potential of cooked pigeon pea (Cajanus cajan) meal as a plant protein source for clearias gariepinus fingerlings. Journal of Agricultural Science and Technology 2(1): 48-57.

11. Achinewhu SC (1987) Protein quality evaluation of weaning food mixture from indigenous fermented foods. Nigerian Journal of Nutritional Science 81: 23-33.

12. Machaiah JP, Pednekar MD (2002) Carbohydrate Composition of Low Dose Radiation-Processed Legumes and Reduction in Flatulence Factors. Journal of Food Chemistry 79(3): 293-230.

13. Philip TK, Itodo IN (2006) Acha (Dgitaria SPP.) a “RediscoveredIndigenous Crop of West Africa. Agricultural Engineering International: the CIGR Journal 8(23).

14. Belton PS, Nuttall JR (2002) Pseudocereals and less common cereals: Grain Properties and Utilization Potential, Springer-Verlag, Berlin Heidelberg, pp: 199.

15. Belton PS, John JR (2002) Pseudocereals and less common cereals; Grain Properties and utilization potential, Springer-Verlag Berlin Heidelberg. Table of amino acids in white and black fonio, pp: 201.

16. Balami YA, Christiana BNO, Obafunmi MO (2009) Acha as a Potential Substitute Raw Material for the Product of Malt Drink. Paper present at the International Seminar on Raw Material Research. Development and Utilization of Raw Material Research and Development Council (RMRDC) Headquarters Abuja.

17. Barber LI, Beleya E, Eke Ejiofor J, Owuno F (2010) Effect of Cowpea Supplementation on the Physico-Chemical and Sensory Characteristics of 'Epiti'-a Steamed Maize/Plantain Pudding. Nigerian Food Journal 28(2).

18. Ihekoronye AI, Ngoddy PO (1985) Integrated Food Science and Technology for the Tropics. Macmillan publishers Ltd. London and Basingstoke.

19. AOAC (1990) Official methods of analysis of AOAC international (19^{th} Edn.). Washington DC.

20. Obiegbuna JZ, Baba SS (2001) proximate composition and secondary properties of peanut and melon seed butter blends. Journal of Sustainable Agriculture and the Environment 3: 326-330.

21. Appiah F, Asibuo JY, Kumah P (2011) Physicochemical and functional properties of bean flours of three cowpea (Vigna unguiculata L. Walp) varieties in Ghana. African Journal of Food Science 5(2): 100-104.

22. Elkhalifa AEO, Schiffler B, Bernhardt R (2005) Effect of fermentation on the functional properties of sorghum flour. Journal of Food Chemistry 92(1): 1-5.

23. Leach HW, McCowen LD, Schoch TJ (1959) Structure of the starch granule I. Swelling and solubility patterns of various starches. Journal of Cereal Chemistry 36: 534-543.

24. Eke J (2006) Chemical, functional and pasting properties of starch hybrid cassava (Manihot esculenta crantz) Unpublished PhD Thesis, pp: 51.

25. Wahua TAT (1999) Applied statistics for scientific studies, Aba, Nigeria African-Link press.

26. Berchie JN, Adu-Lapaah HK, Dankyi AA, Nelson-Quartey F, Plahar WA (2010) Practices and constraints in bambara groundnut production marking and consumption in the BrongAhafo and upper East Region of Ghana.

27. Jones LJ, Tung MA (1983) Functional properties of modified oilseed protein concentrates and isolates. Canadian Institute of Food Science and Technology Journal 16(1): 57-62.

28. Olapade AA, Adeyemo AM (2014) Evaluation of cookies produced from blends of wheat, cassava and cowpea flours. International Journal of Food Studies 3: 175-188.

29. Chau CF, Cheung PCK (1998) Functional Properties of Flours Prepared from Three Chinese Indigenous Legume seeds. Journal of Food Chemistry 61(4): 429-433.

30. Finney KF (1994) Contribution of individual chemical constituents to the functional (bread making) properties of wheat. Cereals 78 better nutrition for the Worlds Millions St. Paul: AACC Publication, pp: 139-158.

31. Adebowale AA, Sanni LO, Awonarin SO (2005) Effect of Texture Modifiers on the Physio-Chemical and Sensory Properties of Dried Fufu. Journal of Food Science Technology 11(5): 373-385.

32. Oladipo FY, Nwokocha LM (2011) Effect of Sida Acuta and Corchorous Olitorius Mucilages on the Physico-Chemical Properties of Maize and Sorghum Starches. Asian Journal of Applied Science 4: 514-525.

33. Osundahunsi OF, Fagbemi TN, Kesselman E, Shimoni E (2003) Comparison of the physicochemical properties and pasting characteristics of flour and starch from red and white sweet potato cultivars. Journal of Agricultural Food Chemistry 51: 2232-2236.

34. Agu HO, Aluyah E (2004) Production and Chemical Analysis of Weaning Food from Maize, Soybean and Fluted Pumpkin Seed Flour. Nigerian Food Journal 22: 171-177.

35. Ashworth A, Draper A (1992) The potential of traditional technologies for increasing the energy density of weaning foods. Diarrhoeal Disease Control Programme.

36. Aworh OC, Olapade AA (2012) Evaluation of extruded snacks from blends of acha (Digitaria exilis) and cowpea (Vigna unguiculata) flours. International Journal of Agricultural Engineering 14(3): 210-217.

37. Aykroyd WR, Doughty J (1964) Legumes in human nutrition. Food and Agricultural Organization of the United Nations, Rome.

38. International Plant Genetic Resources Institute (IPGRI) (2002) Final report on: Promoting fonio production in West and Central Africa through germplasm management and improvement of post-harvest technology.

39. Balde NM, Besamco S, Sidibe TA (2008) Glycemic index, Fonio (Digitariaexilis). Interest in Feeding Diabetes Subjection West Africa. Diabetes Metab 34(3): 93.

40. Aremu CY (1991) Selected physicochemical properties of five varieties of cowpea. Journal of Food Chemistry 41(2): 123-128.

41. Henshaw FO, McWatters KH, Akingbala JO, Hung YC (2002) Functional Characterization of Flour of Selected Cowpea (Vigna unguiculata) Varieties:

Canonical Discriminant Analysis. Journal of Food Chemistry 79: 381-386.

42. Foster-Powell KF, Holt SHA, Brand-Miller JC (2002) International table of glycemic index and been worth glycemic load. American Journal of Clinical Nutrition 76: 5-56.
43. Sajilata MG, Singhal RS, Kulkarni PR (2006) Resistant starch? A review. Comprehensive Reviews in Food Science and Food Safety 5: 1-17.
44. Ingbian EK, Adegoke GO (2007) Proximate Composition, Pasting and Rheology Properties of "mumu" a Roasted Maize Meal. International Journal of Food Science and Technology 42: 762-767.
45. Liang XM, King JM (2003) Pasting and crystalline property differences of commercial and isolated rice starch with added lipids and β-cyclodextrin. Cereal Chemistry 79: 812-818.
46. Newport Scientific Method ST.OO (1998) General method for testing starch in the Rapid Visco Analyzer, Revision 3, RVA Super 3.
47. Crosbie GB (1991) The Relationship between Starch Swelling Properties, Paste Viscosity and Boiled Noodle Quality in Wheat Flours. Journal of Cereal Science 13: 145-150.
48. Pannoza JF, McCormic KM (1993) The rapid visco analyzer as a method of Testing for Noodle Quality in Wheat Breeding Programme. Journal of Cereal Science 17: 25-32.
49. Abegunde TA, Bolaji OT, Adeyemo TB (2014) Quality Evaluation of Maize Chips (Kokoro) Fortified with Cowpea Flour. Nigerian Food Journal 32: 97-104.
50. Akusu OM, Kiin-Kabari DB (2012) Protein quality and Sensory Evaluation of, Moin-Moin‟ Prepared from Cowpea/Maize Flour Blends. African Journal of Food Science 6(3): 47-51.
51. Hung HC, Joshpura KJ, Jiang R (2004) Fruit and Vegetable Intake and Risk of Major Chronic Disease. Journal of National Cancer Institute 96(21): 1577-1584.
52. Pietta P (2003) Functional foods and nutraceuticals in cancer prevention. Watson, R.R, editor. Lowa state press. A Blackwell publishing company, pp: 199-212.
53. Adebowale AA, Sanni LO, Fadaunsi EL (2008) Functional properties of cassava sweet potato starch blend proceeding of the 32nd Annual Conference of Nigerian Institute of food Science and Tech, pp: 304-305.
54. Adoukonou Sagbadja H, Danis A, Vodouhe R, Akpagana K (2006) Indigenous knowledge and traditional conservations of fonio millet (Digitariaexilis and Digitariaiburu) in Togo. Article in Biodiversity and Conservation.
55. Duncan DB (1955) Multiple Range and Multiple F test. Biometrics 11(1): 1-11.
56. Olapade AA, Oke OV, Olaokun OO, Okafor JNC (2002) Consumer Acceptability of Kokoro Prepared from Maize, Supplemented with Bambara Nut. Proceedings of 26th Annual Conference and General Meeting of Nigerian Institute of Food Science and Technology.
57. Olapade AA, Aworh OC, Oluwole OB (2012) Quality attributes of biscuit from acha (Digitariaexilis) flour supplemented with cowpea (Vigna unguiculata) flour. African Journal of Food Science and Technology 2: 198-203.
58. Olapade AA, Oluwole OB (2013) Bread Making Potential of Composite Flour of Wheat-Acha (Digitaria exilis staph) Enriched with Cowpea *(Vigna unguiculata L. walp)* Flour, Nigerian Food Journal 31(1): 6-12.
59. Okeme S, Omale PI, Gwamis AA (2017) Acha (Digitaria SPP) Production and Utilization in West Africa: The Way Forward. International Journal of Agricultural and Veterinary Sciences 3(2): 16-25.