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Full-Length Research Paper

Quality Evaluation and Mineral Composition of "*Ojojo*" (Fried Yam Cake) Produced from Water Yam (*Dioscorea alata*) and Cowpea Flour Blends

Aminu Barde[1]*, Badau, M. H.[2], Kabir A. A.[3], and Ndanusa, F. H.[1]

[1]Department of Food Science and Technology, Kano University of Science and Technology Wudil, Kano State, Nigeria.
[2]Department of Food Science and Technology, University of Maiduguri, Borno State, Nigeria.
[3]Department of Food Science and Technology, Federal University Dutsin Ma, Katsina, Katsina State, Nigeria.
Corresponding author email: aminubarde@yahoo.com

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ABSTRACT: In this study, proximate, functional, minerals and sensory qualities of Ojojo produced by substituting water yam flour with cowpea flour, were evaluated at different proportions (10, 15, 20,30 of cowpea flour). *Ojojo* prepared with 100% of water flour was served as control. Results showed that "*Ojojo*" (fried yam cake) had significantly higher protein attribute to sample WyCp (70:30) (21.25%), ash (1.78-2.32%) and carbohydrate contents (50.78-54.50%) than that of wheat chapatis which served as control (11.49, 1.77% and 51.62%, respectively). As for the fat content, this ranged from 1.19% to 1.03%, corresponding to the levels of Jering seed flour substitution. In terms of physical characteristics, the puffed height and extensibility of the composite chapatis decreased progressively as the level of Jering seed flour substitution increased. On the other hand, the peak load required to rupture chapatis showed an inverse trend. It increased significantly from 3.26 to 15.96 N. Further, the colour values of composite chapatis showed significant changes when the level of Jering seed flour substitution was increased. The *L** and *b** values decreased while *a** value increased. Regarding sensory properties, control wheat chapatis had better acceptability than the composite chapatis. However, all the composite chapatis had significantly higher nutritional values. Based on the generated results, novel chapatis could be formulated by substituting wheat with Jering seed flour.

Keywords: Mineral composition, Ojojo, cowpea flour

INTRODUCTION

Water yam (*Dioscorea alata*.) is the most widely spread species throughout the world, which is cylindrical, white and "watery" in texture. The species of *D. alata* are white, brown or brownish red in appearance (Lebot et al., 2005). Traditionally, water yam is processed into boiled yam, fried yam and fried yam balls by grating the peeled tuber, mixing the grated product with spices and condiments and frying in groundnut or vegetable oil to produce (Onwueme, 2006). *Ojojo* is a delicacy most popular traditional food product from the North Central and South Western Nigeria, particularly *Nupes'* and the *Yorubas'*. It is made from water yam (*Dioscorea alata*) and other spices into crisp spicy balls by traditional processors who have no knowledge about the need for assessing the nutritional quality of the product (Aminu et al., 2018). Attempts have been made by other researchers in the region to substitute yam and cowpea based traditional products such as *Ojojo* and *akara* with soybeans and results obtained were awesome by improving the nutritional well-being of the people through the

incorporation of low cost legume flour with better nutrient profile leading to higher protein content (Olapade and Akinyanju, 2014). Therefore, there is the need to produce *Ojojo* from the blend of water yam and cowpea flour. The objectives of this study were to determine the characteristics of "*Ojojo"* at various proportions of water yam and cowpea.

MATERIALS AND METHODS

A measured quantity of grated yam and cowpea flour were blended according to the experimental design of 100% yam, 90% yam, 10% cowpea flour, 85% yam, 15% cowpea flour, 80% yam, 20% cowpea flour and 70% yam flour, 30% cowpea flour respectively. Finely chopped onions, spices, a pinch of salt and ground pepper were added and mould into balls, fried with groundnut oil, cooled and served (Table 1).

The proximate composition, functional properties and sensory attributes of *Ojojo* produced from several formulations were determined by standard procedures of AOAC (1990) method of analysis. The *Ojojo* samples were subjected to sensory evaluation using selected sensory attributes to determine their overall acceptability. A nine 9-point hedonic scale was used to evaluate *Ojojo* produced from several formulations as described by Larmond (1976). All determinations were done in duplicate and replicated thrice, and data collected were analyzed using statistics version 8.0 for windows. The study was conducted in the food processing laboratory of the department of Food Science and Technology, Kano University of Science and Technology, Wudil Kano State, Nigeria.

Table1: Standard recipe for fried '*ojojo*' from water yam and cowpea blend.

Ingredients	Weight
Water yam	1000g
Cowpea flour	100g
Onion	45g
Pepper	30g
Maggi	10g
Salt	1g
Ginger	3g
Water	100ml
Groundnut oil	500ml

Source: Established based on preliminary study

Preparation of samples

The flow chart for the production of water yam flour are shown in (Figure 1), cowpea flour (Figure 2), while production of *Ojojo* was provided in (Figure 3), as described by Ihekoronye and Ngoddy, (1985). Essentially, the water yam was cleaned (to remove adherent soil and stones) and grated. The cowpeas were steeped in water for about 30mins. At the end of steeping, the steeped water was decanted and beans sun-dried for 3 days. The dried beans were then milled with a hammer mill with 315 micron sieves to obtain fine flour and packaged in a clean polyethylene bags and kept for analysis in the Laboratory of Food Science and Technology, Kano University of Science and Technology, Wudil, Kano State until use. Sample were blended according to the experimental design and Coded A, B, C, D and E respectively.

Proximate composition of the sample (dry basis)

Each sample of *Ojojo* was evaluated for moisture, protein, fat, ash and crude fiber using standard methods of AOAC (2000). Total carbohydrate content was calculated by subtracting the sum of value of the remaining proximate composition from 100.

Determination of functional properties of samples

The functional properties (Water absorption capacity, Swelling, Solubility and Bulk density) of samples were determined based on standard methods of the Association of Official Analytical Chemist AOAC (2000).

Determination of mineral contents of the samples

The minerals content of each sample was carried out to determine the concentration by the used of atomic absorption spectrophotometer (Perkin A Analyst 400 SP.). The phosphorus content was determined with the use of flame photometry according to AOAC, (2004).

Sensory evaluation of *Ojojo* samples

The sensory evaluation was conducted by a panel of fifteen (untrained) judges drawn from staff and students of Kano University of Science and Technology, Wudil. The samples of *Ojojo* were rated for taste, colour, aroma, texture and overall acceptability based on nine point hedonic scale where 9 representing like extremely and 1 representing dislike extremely as described by Larmond (1976), Ihekoronye and Ngoddy (1985). The panelists were served in white and transparent glass cups and were asked to rinse their mouth with water before next serving. The sample were coded and kept far apart to avoid overcrowding and for independent judgment,

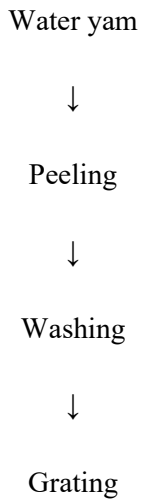

Figure 1: Flow chart of grated water yam.

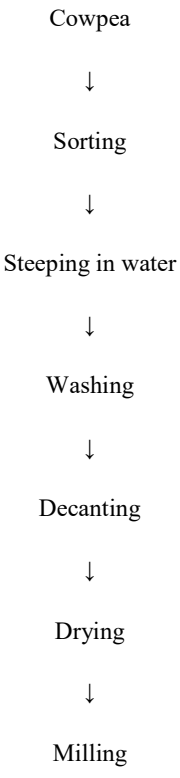

Figure 2: Flow chart of cowpea flour production.

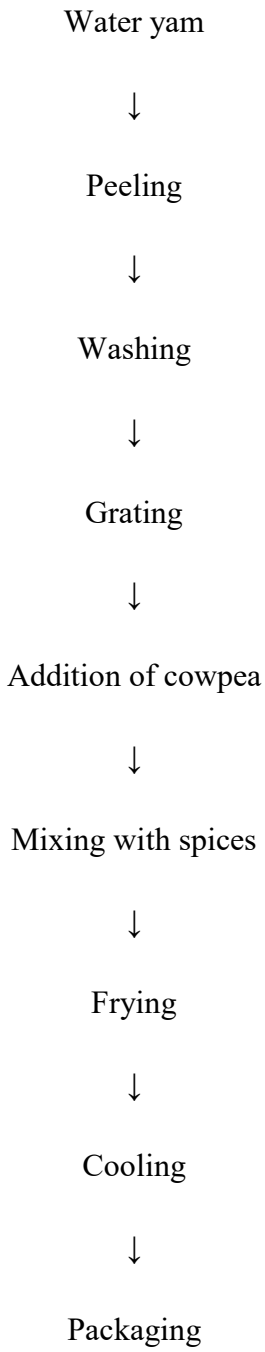

Figure 3: Flow chart for the production of *ojojo*

although the panelists were not trained, they were selected based on basic requirement of a panelist such as availability within the entire period of evaluation, interest, willing to serve, good health (not suffering from cold) not allergic or sensitive to the products evaluated.

Statistical analysis

All experimental data obtained were subjected to analysis of variance (ANOVA) procedure of SPSS version 15.0 (SPSS, 2006) at 5% level of significant.

RESULTS AND DISCUSSION

Proximate composition of *Ojojo* produced from several formulations

The results of the proximate analysis of the samples are presented on (Table 2). The moisture, protein, fat, ash, crude fibre and carbohydrate contents ranged from 27.02 to 19.86, 21.25 to 5.50, 14.03 to 11.33, 4.80 to 1.50, 1.34 to 0.91 and 53.74 to 19.46% respectively. It was observed that the moisture content of the *Ojojo* reduced with increased rate of substitution, while the dry matter content increased gradually. The reduction in the moisture content of the *Ojojo* may be due to the increase in protein content of the *Ojojo* as a result of the addition of Cowpea flour. Protein has been reported to have some functional attributes such as water sorption, viscosity, elasticity, formability, foam stability and fibre formation (Sunful *et al*., 2010; Dixit *et al., 2011*). The ability of the proteins of these flours to bind with oil makes it useful in food system where optimum oil absorption is desired. As the rate of substitution increased, the moisture and carbohydrate content decreased with increased in protein, fat, crude fibre and ash content respectively. Sample WyCp (70:30) was found to have more protein, fat, crude fibre, ash and less carbohydrate content, with calorie value of 366.15 Kcal. Fat content shows a significant different in the range of samples. The higher the fat content could be attributed to oil absorption of the *Ojojo*. According to Schneeman, (2002), crude fibre contributes to the health of the gastrointestinal system and metabolic system in human; increased in crude fibre and ash content could be from cowpea flour addition. This implies that the *Ojojo* would be a source of high energy and nutrient dense food for consumers. The addition of cowpea flour to water yam was expected to increase the protein content of the final product, since legumes generally contain more proteins than tubers. Carbohydrate ranged showed a significant difference ($p>0.05$). as the level of protein increases, carbohydrate content decreases in composition respectively.

Physical and functional properties of *Ojojo* produced from several formulations

The weight and volume of *Ojojo* produced from several formulations are shown in (Table 3). The weight and volume of *Ojojo* ranged from 20.40 to 18.00 g and 20.00 to 17.62 cm^3 respectively. There was a significant difference in weight and Volume ($p<0.05$). *Ojojo* with 100% water yam had the highest volume and bulk density of 0.90 g/ml. As the weight increases the volume decreased with increased in substitution with cowpea. Bulk density 0.9 to 1.16 g/ml within the column showed a significant difference, as the substitution rate increased. Bulk density of flour was reported to increase with increased in starch content Bhattackaya and Prakash, (1994). The Water Absorption Capacity of the water yam-cowpea flour blend ranged from 1.65 to 2.15% in which sample E had the highest valued while sample A had the lowest valued. The water absorption is due to increase in quality of flour mixture which also ensures the retention of moisture during paste processing for fried products. Water is a basic component that helps to get a homogenous mixture of other components in dough, and providing it with a desired viscous elastic structure as well as very effective on final product quality. The Swelling Power of the water yam cowpea flour blend range from 1.68% to 2.00% in which sample E had the highest amount of swelling power. As the rate of substitution increased, swelling power and solubility increased, this depends on the variety and particle size of the flour (Suresh, 2013).

Minerals content of Ojojo produced from formulations of water yam and cowpea

Minerals (dietary minerals) are among the constituents of a food product or a diet that are vitals, required in a specified amount for physiological and biochemical processes of the body by various reactions. Some of the major and significant of this elements includes; Sodium (Na), Calcium (Ca), Potassium (K), Phosphorus (P), Magnesium (Mg), Iron (Fe) etc. which are required for daily intake, they play roles in the transportation across biological membrane, as enzyme cofactors, in the bone formation and strength, relaxation and contraction of muscles, maintenance of acid base balance, blood formation, energy transduction etc. Minerals as an inorganic nutrient are required in some small quantities from less than 1 to 2500mg per day, depending on the mineral (Soetan et al., 2010). World health organization described the important of sodium and potassium ratio in the reduction of blood pressure (Hypertension). Table 4 shows the results obtained for each samples as follows; sample A is 25.10mg/kg, 80.41mg/kg, 120.56mg/kg, 11.21mg/kg, 13.68mg/kg, 154.02mg/kg of Na, Ca, K, Mg, Fe and P respectively, Sample B is 29.30 mg/kg, 101.01 mg/kg, 135.21 mg/kg, 15.55 mg/kg, 16.81 mg/kg, 189.60 mg/kg of Na, Ca, K, Mg, Fe and P respectively, sample C is 32.81 mg/kg, 105.07 mg/kg, 141.13 mg/kg, 17.64 mg/kg, 17.07 mg/kg, 192.31 mg/kg of Na, Ca, K, Mg, Fe

Table 2: Proximate composition of *Ojojo* produced from several formulations.

Sample	Percentage formulation %	Moisture	Protein	Fat	Crude fibre	Ash	Carbohydrate	Calories
A	Wy(100)	27.02±3.34^{a}	5.50±1.23^{e}	11.33±1.05^{c}	0.91±0.10^{d}	1.50±0.91^{d}	53.74±5.30^{a}	338.93±1.01^{e}
B	WyCp(90:10)	25.56±2.34^{b}	14.37±1.35^{d}	11.66±0.69^{c}	1.05±0.03^{c}	2.70±0.31^{c}	44.66±2.38^{b}	341.06±0,01^{d}
C	WyCp(85:15)	23.65±0.95^{c}	16.00±1.24^{c}	13.07±1.56^{b}	1.11±1.00^{b}	3.80±0.33^{b}	42.37±1.51^{c}	351.11±1.05^{c}
D	WyCp(80:20)	22.45±2.50^{d}	18.99±2.34^{b}	13.34±0.91^{b}	1.20±0.00^{b}	3.90±0.10^{b}	40.12±1.81^{d}	356.48±0,00^{b}
E	WyCp(70:30)	19.86±4.30^{e}	21.25±4.38^{a}	14.03±1.53^{a}	1.34±0.01^{a}	4.80±0.18^{a}	38.72±0.96^{e}	366.15±0,88^{a}

Values are mean of three replicates ± Standard Deviation, number in the same column followed by the same letter are not significantly different at p> 0.05 level. KEY: Wy = Water yam, Cp = Cowpea

Table 3: Physical and functional properties of *Ojojo* produced from several formulations.

Sample	Percentage formulation %	Weight (g)	Volume (cm^3)	Bulk density(g/ml)	Water absorption capacity (g//g)	Swelling power (%)	Solubility (%)
A	Wy(100)	18.00±0.20^{e}	20.00±0.03^{a}	0.90±0.01^{e}	1.65±0.10^{e}	1.68±0.11^{e}	13.70±0.60^{e}
B	WyCp(90:10)	18.80±0.00^{d}	19.51±0.00^{b}	0.96±0.58^{d}	1.80±0.00^{d}	1.81±0.03^{d}	15.46±0.12^{d}
C	WyCp(85:15)	19.20±0.10^{c}	18.67±0.01^{c}	1.03±0.53^{c}	1.85±0.10^{c}	1.87±0.20^{c}	16.82±0.14^{c}
D	WyCp(80:20)	19.60±0.00^{b}	18.30±0.10^{d}	1.07±0.00^{b}	2.01±0.02^{b}	1.93±0.01^{b}	17.32±0.20^{b}
E	WyCp(70:30)	20.40±1.00^{a}	17.62±0.12^{e}	1.16±0.07^{a}	2.15±0.10^{a}	2.01±0.02^{a}	19.69±0.10^{a}

Values are mean of three replicates ± Standard Deviation, number in the same column followed by the same letter are not significantly different at p> 0.05 level. KEY: Wy = Water yam, Cp = Cowpea

Table 4: Minerals content (Mg/Kg) Of *Ojojo* produced from several formulations.

Sample	Percentage formulation %	Sodium (Na)	Calcium (Ca)	Potassium (K)	Magnesium (Mg)	Iron(Fe)	Phosphorus (P)
A	Wy(100)	25.10±0.80^{e}	80.41±0.25^{a}	120.56±0.68^{e}	11.21±0.16^{e}	13.68±0.76^{e}	154.02±0.79^{e}
B	WyCp(90:10)	29.30±0.04^{d}	101.01±0.50^{b}	135.21±0.48^{d}	15.55±0.90^{d}	16.81±0.81^{d}	189.60±0.65^{d}
C	WyCp(85:15)	32.81±0.11^{c}	105.07±1.00^{c}	141.13±0.04^{c}	17.64±0.19^{c}	17.07±0.26^{c}	192.31±0.44^{c}
D	WyCp(80:20)	33.05±0.40^{b}	117.30±0.57^{d}	149.35±0.90^{b}	18.00±0.43^{b}	17.93±0.71^{b}	207.04±0.60^{b}
E	WyCp(70:30)	38.40±0.66^{a}	120.12±0.22^{e}	155.43±0.12^{a}	20.15±0.11^{a}	20.01±0.08^{a}	218.77±0.62^{a}

Values are mean of three replicates ± Standard Deviation, number in the same column followed by the same letter are not significantly different at p> 0.05 level. KEY: Wy = Water yam, Cp = Cowpea,

Table 5: Sensory evaluation of *Ojojo* produced from several formulations.

Sample	Percentage formulation %	Aroma	Texture	Colour	Taste	General acceptability
A	Wy(100)	5.93±1.32^{a}	5.73±1.22^{c}	5.00±1.72^{e}	5.80±1.32^{a}	4.24±1.10^{d}
B	WyCp(90:10)	5.86±1.24^{b}	5.86±0.80^{b}	6.33±0.73^{b}	5.60±1.32^{c}	5.36±1.01^{c}
C	WyCp(85:15)	4.66±1.29^{d}	5.33±1.12^{d}	5.26±1.34^{d}	5.60±1.22^{c}	5.73±1.20^{a}
D	WyCp(80:20)	5.20±1.08^{c}	5.33±1.24^{d}	6.26±0.96^{c}	5.60±1.30^{c}	5.53±1.04^{b}
E	WyCp(70:30)	4.66±1.29^{d}	6.40±0.82^{a}	6.40±1.14^{a}	5.73±1.53^{b}	4.12±1.00^{e}

Values are mean of three replicates ± Standard Deviation, number in the same column followed by the same letter are not significantly different at p> 0.05 level. KEY: Wy = Water yam, Cp = Cowpea

and P respectively, sample D is 33.05 mg/kg, 117.30 mg/kg, 149.35 mg/kg, 18.00 mg/kg, 17.93 mg/kg, 207.04 mg/kg, of Na, Ca, K, Mg, Fe and P respectively, sample E is 38.40 mg/kg, 120.12 mg/kg, 155.43 mg/kg, 20.15 mg/kg, 20.01 mg/kg, 218.77 mg/kg of Na, Ca, K, Mg, Fe and P respectively. From the results obtained, the different in the formulations shows significant increment in the minerals content in the production of *Ojojo* using incorporation of cowpea flour, sample E has the highest minerals content, the iron content in samples C and D shows no significant variations, it's important to consumed diet with balance nutritional content, therefore consumption of *Ojojo* incorporated with cowpea flour is of utmost concerns.

Sensory evaluation of *Ojojo* produced from several formulations

Table 5 shows the general acceptability of *Ojojo* quality attributes (aroma, texture, colour, taste, and general acceptability) of each of the samples analyzed. The sensory evaluation of *Ojojo* showed a significant difference with variations in colour ranging from light brown to golden brown. The details of these are shown in

(Table 5). The sample A (100% water yam) became lighter when compared to samples B, C, D and E, that had higher substitution with cowpea flour. Samples A, B and E showed a significant different, while samples C and D had the same texture when compared with the control sample (A 100% water yam). The aroma of samples A, B, C, D and E are significantly different from each other. This is due to the rate of substitution with cowpea. The taste of sample B, C, D are not significantly different from each other, which contained less quantity of cowpea flour but with the exception of A and Bare significantly different. The samples were rate on the general acceptability, which shows that samples C and D were the most acceptable samples, followed by samples B, A and E respectively. This is due to rate of substitution with cowpea flour.

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