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EFFECT OF SOY SUPPLEMENTATION ON THE PHYSICOCHEMICAL AND SENSORY QUALITIES OF 'AKARA' FROM COWPEA FLOUR.

M. O. OLUWAMUKOMI

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ABSTRACT

Effect of supplementation on the physiochemical properties of cowpea flour and the sensory qualities of its akara balls were investigated. Akara is a deep-fat-fried product prepared from cowpea (*Vignia unguinculata*) flour or paste consumed in some parts of West and East Africa. Cowpea flour was supplemented with Soy flour in ratios 0, 20, 30 and 100% levels. The mixtures of the flours were subjected to physicochemical analyses while the akara balls were subjected to sensory evaluation. Analyses showed that as the level of supplementation increased, the protein content, specific gravity, bulk density, swelling capacity and the foaming capacity decreased while on the other hand the water absorption capacity initially decreased before increasing gradually. Supplementation up to 20% level produced pastes of good dispensing and frying characteristics which were well separated upon contact with the frying oil and formed uniformly shaped balls that floated and retained their integrity during frying. Above 20% supplementation level, the pastes exhibited opposite characteristics. They had a thick batter-like consistency, with difficulty in dispensing and failure to separate into individual balls and were submerged during frying. They were distorted and scattered in shape. However, they produced Akara of higher nutrient contents.

KEYWORDS: Akara, Cowpea flour, Soybean flour, supplementation, frying.

INTRODUCTION

Cowpea (*Vigna unguiculata*) is an important grain legume in the West, East Africa, India and Brazil with more than 90% of world crop being produced in that region of the world (Dovlo *et al*, 1976, McWatter, 1983). It is consumed either as steamed paste (moinmoin) or fried (Akara) (Phillip *et al*, 1988). Akara bas been described as the most common cowpea based food product in Africa. (Reber *et al*, 1983). Akara is made from whipped cowpea paste flavored with salt, fresh onion, fresh or bell pepper (McWatters *et al*, 1990, McWatters *et al*, 1992). The batter is dropped into hot peanut oil in spoonful portion forming spongy balls during frying. Although cowpea is a favored and readily consumed legume in West Africa, the major constraint to its wider use is the labour intensiveness and time consuming task of preparing it for consumption. This involves soaking dry peas in water to loosen seed coat, decorticating by either manual rubbing or stirring the wetted peas in a mortar and floating off the seed coat in water and grinding to paste either on a stone, in a mortar or an electric blender (Dovlo *et al*, 1976, McWatters, 1983). Studies carried out to improve this laborious process have resulted in development of technologies for producing ready-to-use cowpea meal and flour specifically for use in Akara and moin – moin (Ngoddy, *et al*, 1986, McWatters *et al*, 1990). These products have also been noted as not being highly accepted by housewives because of poor water absorption of the flour, and production of Akara that were heavy, lacked crispness and normal cowpea flavor. Williams (1980) also concluded that cowpea mildlings, which were intermediate particle size between flour and grits, were more suitable for Akara preparation than cowpea flour. Previously efforts were made in Nigeria to supplement some food products with soybean. Akara happened to be one of such food products. The aims of supplementing akara with soybean were (i) to increase the awareness and utilization of soybean among the populace (ii) improve the nutritional quality of Akara and (iii) also reduce the cost of producing akara from mainly cowpea sources, since soya bean used to be comparatively cheaper than cowpea and produced higher comparative protein quality. 11g of soybean would produce as much protein as 2kg of cowpea or 45 cups of milk or 2kg of boneless beef or 5 dozen eggs(Emovon, 1987). The akara produced from such formulations however suffered some rejection due to lack of standardization in the formulation, with traces of some off flavors and inability of akara to maintain its shelf life soon after production. There is little or scanty information on supplementation of akara with protein sources. However, Prinyawiwatkul *et al*, (1994) supplemented akara with peanut flour in form of defatted, and fermented, defatted peanut flour and they studied its effect on some selected physical properties such as water absorption, specific gravity, apparent viscosity, proximate composition, colour and foaming capacity. They observed that there was decreased water absorption capacity of the cowpea meal with addition of peanut flour. Also the specific gravity of the whipped paste increased while the volume was reduced. This was suggested to be due to the presence of lipids in the air/water interphase (Cheftel *et al*, 1985).

The objectives of this study are therefore to determine the appropriate formulation for soy supplementation of akara from cowpea, and the effects of soy supplementation on the physicochemical, and sensory properties of akara supplemented with soy bean flour.

MATERIALS AND METHODS

Sources of materials

Cowpea (*Vigna unguiculata*), soybean (*Glycine max*), vegetable soil, table salt and pepper were purchased from the market in Akure, Nigeria and held at

M. O. OLUWAMUKOMI, Department of Food Sciences & Technology, Federal University of Technology, Akure - Nigeria

4°C until required for use. All laboratory chemicals used were of analytical grades.

Preparation of Ingredients.

Cowpea Flour: The beans were cleaned to remove dirt, stones, metals etc., and soaked for 30 minutes after which they were dehulled by rubbing with hands until the seed coat loosened. The loosened coats were floated off in water while the dehulled cotyledons were drained properly and dried in an oven at 60°C for about 24 hours. The dried beans were milled in an attrition mill to a particle size of about 265μm. The flour was then packaged in high density polyethylene bag and tightly sealed and kept at 4°C until needed for analysis.

Soy beans flour:. The soybeans were manually sorted, cleaned and boiled for 20 minutes to remove the beany flavor and also enhance easy dehulling. The boiled beans were cooled, dehulled, drained and dried at 60°C for about 24 hours. The dried beans were milled in an attrition mill to a particle size of about 525μm and the resultant flour packaged in High Density Polyethylene (HDPE) tightly sealed and kept under 4°C until needed for further analysis.

Preparation of Akara

Akara was prepared from the mixture of cowpea and soybean flours. Cowpea flour was supplemented with soybean flour at the supplementation levels of 0, 20, 30, and 100% according to the methods of McWatters, (1983) and Dovlo et al, (1976). A predetermined amount of water was added gradually and then whipped properly inside the mixer at a speed of 3 for 10 minutes to a smooth paste consistency (Dovlo *et al*, 1976, McWatters, 1983). The formulations for akara prepared from each treatment are shown in Table 1. Whipping incorporates air into the batter and produced desirable light spongy textures in the cooked product. Seasoning of salt and finely chopped green pepper and onion were stirred into the whipped batter which was then dropped in portions of about 12g into peanut oil at 140°C and fried in an automatic fryer (Moulinet model) for about 5–10 minutes until brown resulted. The fried products were drained from the oil on absorbent paper. One portion was subjected to sensory evaluation immediately, while the second portion was packaged in a High Density Polyethylene (HDPE), stored at 4°C until needed for further analysis.

Analyses

Physical analysis of the flour samples

Water absorption capacity: This was determined by the method of Beuchart (1977). 1 g of the sample was mixed with 10 ml of distilled water in a 50ml centrifuge tube. After 15 min of intermittent stirring in a Gallenkamp mixer the slurry was centrifuged for 30 minutes at 3500 rpm. The volume of the supernatant was noted in the 10 ml graduated cylinder. The density of water was assumed to be 0.88 g/ml. Means of triplicate samples were determined. Water absorbed was the initial volume of water minus the final volume of water.

$$\text{WAC (\%)} = \frac{\text{Density x Volume of water absorbed}}{\text{Original weight of sample}} \times 100$$

Specific gravity: Determined according to the method of Campbell *et al*, (1979) by determining the weight of the flour that filled to a 50ml mark in a measuring cylinder and dividing it by the weight of water that filled the 50 ml mark in the same cylinder.

$$\text{Specific gravity} = \frac{\text{weight of the flour}}{\text{Weight of equal volume of water}}$$

Bulk density: The method of Okaka and Porter (1979) was used. 50g samples were weighed into a 100 ml graduated cylinder. The cylinder was tapped ten times against the palm of the hand and the bulk density was expressed as grams per cubic volume.

Foaming Capacity: This was determined according to the method of Coffman and Garcia(1977). A 2g sample was homogenized with 100 ml distilled water for 5 minutes at maximum speed. The sample was then whipped in a 250 ml graduated cylinder. Foaming capacity was determines after observing the foam for 2 hours as the percentage increase in volume after whipping.

Chemical Analysis of Akara balls

Proximate compositions of the Akara samples were determined using standard methods (AOAC, 1990). The crude protein was obtained by multiplying the nitrogen content by 6.25 and the carbohydrate content by difference. All analysis were carried out in triplicate and result expressed on dry basis.

Sensory Analysis of Akara balls

A ten member panel who were previously familiar with the sensory evaluation of Akara and trained in the scoring guidelines were used for the test. The 4 point hedonic scale was used based on the attributes of quality of shape, color, sponginess, taste and flavor as suggested by McWatters *et al*, (1988) where 1 represent (very poor) and 4 represents (excellent). Coded samples consisting of whole akara balls from each treatment were arranged in random order on aluminum plates (Fig. 1) and served warm to the panelists who evaluated them under incandescent lightening. Fresh akara samples produced from cowpea supplemented at 0%, 20%, 30% and 100% levels with Soy flour were used for the sensory evaluation. All panelists were instructed on the use of sensory evaluation procedures.

Table 1. Ingredients for Akara at various supplementation levels.

% Level of supplement	Cowpea flour (g)	Soybean flour (g)	Water (ml)	Pepper (g)	Onion (g)	Salt (g)
0	200	-	260	36	36	8.0
20	160	20	260	36	36	8.0
30	140	60	260	36	36	8.0
100	-	200	260	36	36	8.0
Nigerian cowpea flour	200	-	170	36	36	8.0

Statistical Analysis

All the results were analysed using Analysis of Variance while the means were separated by Duncan Multiple Range Test using the IBM – Computer SPSS 10.0 version (Oloyo, 2001).

RESULTS AND DISCUSSION

Physical analyses of the flour

The results of the physical analyses of the flour samples are shown in Table 2.

Water Absorption Capacity: Water absorption capacity is an index of ability of protein to absorb and retain water which in turn influences the sensory quality of foods (Prinyawiwatkul et. al, 1994). The capacity of cowpea meal to absorb water when hydrated to form foam when whipped to produce paste with an appropriate viscosity is essential in akara preparation (Phillips and McWatters, 1991). Addition of soy flour into cowpea flour initially reduced the water absorption capacity of the cowpea flour but later increased as the level of supplementation increases. In an earlier report, addition of defatted peanut flour to wheat flour (Khan *et al*, 1975) and sorghum meal (Ahmed and Ramanathan, 1988) was reported to improve water absorption capacity. But in a similar study on the other hand, addition of more than 37.50% partially defatted peanut flour and / or fermented or non-fermented peanut flour to cowpea meal tended to decrease apparent water absorption capacity. The higher fat content of the peanut flour which is non-polar and of low affinity for water may have lessened the ability of the mixture to bind water, thereby reducing the water holding capacities of the flours (Prinyawiwatkul *et al*, 1994). There was however as surprising jump in the water absorption capacity as the level of supplementation increases in akara flours. This sudden increase must have been due to the effect of the mainly predominant protein system (Iwe and Onuh, 1992). Chauhan and Bains, (1985) showed that the higher the protein content of foods the more their capacity to hold or retain water.

Bulk density: The bulk densities (loosed and packed) decreased with increase in the soy flour supplementation. This shows that the particles of the soy flour are lighter than those of the particles of the cowpea flour but with a disadvantage that less quantity/weight can be packed within a constant volume (Fagbemi, 1999). This may be as a result of decreasing starch, content of the mixture (Iwe and Onadipe, 2001) which tends to make the mixture less bulky and lighter.

Specific Gravity and Foaming Capacity: They are indices of texture lightness of food products (Prinyawiwatkul, et al., 1994). The desirable spongy texture of akara is due to whipping, which incorporates air into the paste to form foam. Uniform distribution of fine bubbles usually imparts body, smoothness, and lightness to foods (Cheftel *et al*, 1985). The specific gravity and foaming capacity of the whipped cowpea pastes were affected by supplementation with soy flour. The addition of the soy flour decreased the foaming capacity and the specific gravity of the whipped paste. The process of preparing the soybean flour involved a heat treatment which could have denatured the protein and consequently reduced its foaming capacity and its specific gravity. Also, the presence of lipids in the soy flour may have reduced the foaming properties of the proteins (Yasumatsu *et al*, 1972) by situating themselves at the air/water interface (Cheftel *et al*, 1985, Priyawiwatkul *et al*,1994). Cherry and McWatters (1991) reported that specific gravity and foam capacity are indices of dispensing and frying characteristics of whipped paste in the preparation of akara. Cowpea paste from 100% whole cowpea flour exhibited good dispensing and frying characteristics. Paste was well separated upon contact with the frying oil and formed uniformly shaped balls that floated and retained their structural integrity during frying. Formation of a stable foam by whipping the cowpea paste is essential in the preparation of Akara (Ngoddy, et al., 1986). The foam consists of gas/air) droplets encapsulated by a liquid foam containing soluble surfactant protein. The trapped air cells impart body and

Table 2: Physical Properties of Cowpea Flour at various supplementation Levels

	Soy Supplementation			
	0	20	30	100
Bulk density (g/cm^3)	0.508	0.487	0.449	0.376
Specific gravity	0.527	0.505	0.463	0.351
Water absorption capacity (g/100g)	167	133	132	240
Swelling capacity %	37.5	32.0	30.3	30.5
Foaming capacity (%)	18.0	10.0	10.0	8.0

Table 3: Proximate Composition of Control and Soy supplemented Akara Balls

	% Soy flour	Moisture^d	Protein^d	Fat^d	CH0^d
A	0 (Control)	40.81 (0.05)^{*a}	18.96(0.11)^c	20.62(0.13)^b	25.92(1.02)^a
B	20	40.14(0.02)^a	22.69(0.13)^b	25.53(0.09)^b	17.81(0.07)^a
C	30	39.12(0.04)^a	26.2(0.09)^b	26.2(0.11)^b	14.23(0.06)^b
D	100	36.43(0.01)^a	33.51(0.06)^a	33.4(0.12)^a	12.96(1.12)^b

$^{(a,b,c)}$ mean values in columns with different superscripts are significantly different ($P \leq 0.05$).

^{d} %Dry weight basis

* values in parenthesis are standard deviations of three replicates.

Sample A = Control (100% cowpea flour)
Sample B = 20% Soy flour
Sample C = 30% Soy flour
Sample D = 100% Soyflour

Fig 1 The picture of Akara balls as presented to the taste panelists.

smoothness, ensures uniform rheological properties and facilitate flavor dispersion (Kinsella, 1981). Factors such as proteins source, method of preparation, pH and presence of salt influence foaming characteristic (Bulgarelli and Beuchart, 1990). Cowpea pastes from 20% soy supplementation and above exhibited opposite characteristics. They had a thick batter- like consistency which was difficult in dispensing. They failed to separate into individual balls and were submerged during frying and were distorted and scattered in shape (Fig. 1). The lower foaming capacity and lower specific gravity with supplementation containing soy flour exhibited poor dispensing and frying properties (Prinyawiwatkul *et al*, 1994). McWatters and_Brantley (1982) observes that proper paste consistency is essential for ease of dispensing, shape formation and retention during frying and also for acceptable product quality, while lower foaming capacity and greater specific gravity contribute to poor dispensing and frying properties. This is contrary to the findings above which showed a lower foaming capacity and a lower specific gravity. With a lower specific gravity one would have expected a better contribution to foaming and dispensing ability (Prinyawiwatkul *et al*, 1994) but the presence of fat in the full fat soy flour sample with the increase in the particle sizes might have reduced this influence.

Proximate composition of akara balls

The proximate composition of the akara balls is given in Table 3.

The Control akara sample contained 40.8% moisture, 18.96% protein and 20.02% fat. Increasing the soy flour level increased its protein and fat contents while the carbohydrate content decreased correspondingly. The protein varied from 18.96% in Control sample to 22% in 30% supplement. This is similar to results of Prinyawiwatkul *et al*, (1994) and McWatters and Brandley (1982). The fat content also increased from 20.62% in control sample to 26.01% is 30% supplement. These increments in protein and fat were due to the higher protein and fat contents of soy flour more than cowpea flour which was used to supplement the cowpea akara.

This is also similar to the finding of Prinyawiwatkul (1994). The carbohydrate content calculated by difference decreased as the soy flour supplementation increased. This progressive decrease must have been due to proportional increase in fat content caused by fat adsorption during the frying of akara and the increase in the protein contents of the akara due to supplementation (Idouraine *et al*, 1989). Supplementing cowpea akara with soy flour therefore resulted in increase in its nutrient content.

Sensory evaluation of akara balls

The scores of the sensory attributes of the Akara balls are shown in Table 4 and the picture of their presentation to the taste panelists is shown in fig.1.

Among the sensory attributes measured, supplementation with soy flour did not have significant adverse effect ($P \geq 0.05$) up to 20% level. As from 20% level there was significant effect of supplementation ($P \leq 0.05$) in term of color, shape, sponginess, tenderness, flavor and taste. Below 20% level (samples A & B) the akara was soft tender, with good shape, appealing color, attractive flavor and taste. As from 20% and above (sample C & D) the akara became crispy, crunchy, with distorted shape, less attractive color, beany flavor and offensive after taste. The 100% soy (Sample D) could not form normal akara ball shape and were scattered during frying. It was scored lowest in all the attributes.

This shows that cowpea akara could be supplemented with soy flour up to 20% without any adverse effect on its quality attributes.

Table 4: Sensory scores of Control(sample A) and Soy supplemented Akara balls

Sample	% Soy flour	Taste	Shape	Color	Sponginess	Flavor
A	0 (Control)	3.9^a	3.8^a	3.7^a	3.9^a	3.8^a
B	20	3.8^a	3.7^a	3.7^a	3.8^a	3.6^a
C	30	2.1^b	2.1^b	3.6^a	2.4^b	2.2^b
D	100	1.2^c	1.1^c	1.3^c	1.2^c	1.3^c

(a, b, c) values in a column with different superscripts are significantly different ($P \leq 0.05$).

Cost of Supplementation with Soybean

Assuming the cost of 1kg of Cowpea was N120:00 and the cost of Soybean was N100:00 and supplementation was at 20%. Then supplementation would have reduced the cost of akara by 16.7%. This shows that supplementing akara with soybean will not only increase its nutrient content but will also reduce the cost of akara. Also, akara which is a relish by children will be another ready route of improving the nutritional status of that vulnerable group in the society.

CONCLUSION

This study has shown that incorporating soy flour into akara was very successful up to 20% level without any impairment in the qualities of cowpea akara but above this level, supplementation affected the chemical composition, physical and sensory qualities of cowpea akara. Supplemented cowpea flour absorbed less water and were of lower specific gravity, lower density and lower foaming capacity than un-supplemented cowpea flour. Above 20% supplementation level the paste formed was of a thick-batter consistency with difficulty in dispensing. It submerged in oil during frying and were distorted, scattered in shape and failed to separate into individual and distinct balls.

In conclusion, the supplemented akara balls were acceptable in term of sponginess, tenderness, shape, color, flavor and taste, up to 20% level but above 20% level the attributes became less appealing. Also, there was an increase in the nutrient content, and decrease in the cost of the supplemented akara. Therefore, cowpea akara can be successfully supplemented with soy flour up to 20% level and still be acceptable in terms of physical, chemical and sensory qualities.

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