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SOAKING AND BOILING EFFECTS ON THE PROXIMATE COMPOSITION AND FUNCTIONAL PROPERTIES OF UKPO (*MUCUNA FLAGELLIPES*), EGUSI (*COLOCYNTHIS CITRULLUS*) AND OGBONO (*IRVINGIA GABONESIS*)

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ABSTRACT

Processing (soaking and boiling) effects on the proximate composition and functional properties of Ukpo; Egusi and Ogbono flours were carried out. Soaking increased (10.50 to 10.94%) the crude protein of ukpo flour but decreased (28.35 to 21.26% and 15.91 to 15.09% respectively) that of Egusi and Ogbono flours. Boiling decreased (10.50 to 9.09%, 28.35 to 20.27% and 15.91 to 12.96% respectively) the crude protein of Ukpo and Egusi flours. Soaking and boiling increased (15.50 to 39.24% and 30.79%;3.97 to 16.15% and 11.34% respectively) the carbohydrate contents of Ukpo and Egusi flours while the same processing methods also decreased (7.87 to 3.76% and 7.61% respectively) the carbohydrate contents of Ogbono flour. Boiled Ukpo and Egusi flours respectively showed significant differences ($P<0.05$) between them and their raw and soaked flours. In the case of the functional properties, soaking and boiling increased (5.20 to 5.60ml/H_2O/gflour and 6.37ml/H_2O/gflour respectively) the water absorption capacity of Ukpo flour. Significant difference ($P<0.05$) existed in the emulsion capacities of processed flours of Ukpo, Egusi and Ogbono. Raw Ukpo, Egusi and Ogbono flours showed the least gelation properties while their boiled flours had the highest value.

Keywords: Ukpo, Egusi, Ogbono, boiling, soaking, proximate composition and functional properties

INTRODUCTION

At present, most of the indigenous edible plants which could be used as food thickners and gums in Nigeria and other West African countries have been neglected and have remained relatively unknown and under-utilized. Some of these indigenous legume plants are "*Ukpo*" (*Mucuna Flagellipes*), melon seed or "*Egusi*" (*Colocynthis citrullus*) and two varieties of African wild mango or bush mango or "*Ogbono*" (*Irvingia gabonensis var gabonensis*-sweet type and *Irvingia gabonensis var excelsa,* known as *Irvingia gabonensis var wombulu*-bitter type).

The three mentioned legumes are used as ingredients (thickners) of local soups. Besides, the culinary utilization, soup thickners of the legumes have been used as additives in other foods to impart desirable textural and functional properties such as enabling fast coagulation in food preparation of the different finished products particularly the "convenience foods" which contain one or more gums (Glicksman, 1982; Dziezak, 1991; Uzomah and Ahiligwo, 1999). Consequent upon this, the utilization of most of our unknown, unconventional and available legumes will contribute as sources of gums to most of the manufactured food products.

In this study, the objective is to evaluate soaking and boiling effects on the proximate composition and functional properties of *Ukpo, Egusi* and *Ogbono* flours.

MATERIALS AND METHODS

Sample collection

Fresh samples of the three indigenous legumes namely *Ukpo* (*Mucuna flagellipes*), *Egusi* (*Colocynthis citrullus*) and *Ogbono* (*Irvingia gabonensis*) were purchased from Ekeonuwa market, Owerri, Imo State.

Preparation of Sample Flours

Wholesome *Ukpo, Egusi* and *Ogbono* seeds were cleaned, sorted and separately dehulled manually. The samples were divided into three equal parts of 100g each. One part was used as control while the second part was soaked in de-ionized water (1:3) in an aluminum bowl for 48hrs at room temperature. Soaking treatment was to allow the seeds to imbibe water. The water was decanted every 6hrs interval. The third part was boiled for 30mins at 100^0C. Soaked and boiled samples of the legumes were oven dried (Model No. 320 Gallenkamp, England) at 60^0C for 6hrs. The dry seeds of the legumes were milled to fine flour in a manually driven attrition mill (Manesty machines ltd, Liverpool) while the control was milled directly without any treatment. The flour obtained was sieved (1mm mesh screen) and kept separately in kilner jars for chemical analyses.

Chemical Analyses

The protein content (%N x 6.25), ash content, moisture content, crude fibre and fat contents of the flour samples were analyzed by the standard method described by AOAC (2000). Crude protein was determined by the microkjeldahl method (Method 981.10), ash by dry ashing method (Method 900.02), fat by the soxhlet extraction method (Method 960.39). Moisture was determined by the hot air oven method (Polacchi, 1985) while carbohydrates were calculated by difference. Water absorption capacity (WAC) was determined by the method of Lin *et al*. (1974) with slight modification by Okaka and Potter (1979). Oil absorption capacity (OAC) by the method of Abbey and Ibeh (1988). Emulsion capacity was determined by the method described by Yatsumatsu *et al.* (1972) and Okezie and Bello (1988). Foam capacity was determined by the method of Narayana and Narasinga Rao (1982). Gelation property was determined by the method of Coffman and Garcia (1977) and modified by Sathe and Salunkhe (1981). The method by Okaka and Potter (1979) was adopted for the bulk density determination.

Statistical Analysis

Analysis of Variance (ANOVA) and the Least Significance Difference (LSD) test as described by Steel and Torrie (1981) was used to determine the levels of significant differences of the means and deviations.

RESULTS AND DISCUSSION

Proximate Composition

The proximate composition of raw, soaked and boiled "Ukpo" (*Mucuna flagellipes*), "Egusi" (*Colocynthis citrullus*) and "Ogbono" (*Irvingia gabonensis*) (Table 1) indicated that crude protein contents of *Ukpo, Egusi* and *Ogbono* flours showed no significant difference ($P>0.05$). The highest value (28.35%) of protein was observed in raw *Egusi* and the least in boiled *Ukpo* (9.09%). Soaking increased the crude protein content of "*Ukpo*" from 10.50% to 10.94% but decreased it in "*Egusi*" and "*Ogbono*" from 28.35% and 15.91% to 21.26% and 15.09% respectively. Edijale (1980) stated that the decrease in protein content was as a result of leaching loss and solubility of nitrogen as obtained in cowpea study. Boiled *Ukpo* and *Egusi* flours respectively were significantly different ($P<0.05$) from raw and soaked flours in

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crude fat content. Soaked flours of *Ukpo* and *Egusi* decreased in crude fat contents from 5.95% and 55.35% to 4.60% and 54.35% respectively while an increase from 64.10% to 72.55% was indicated in *Ogbono* flour. The decrease in fat agreed with the findings of Okigbo (1975) on soyabean and Albrecht *et al.* (1996) on beans. They attributed such a decrease to the loss of soluble materials on soaking. The highest values of crude fat were obtained in boiled *Egusi* flour (56.25%) and boiled *Ogbono* flour (72.85%). A similar result of a high value of crude fat was obtained for boiled Ofo (*D. Macrocarpum*) (Konn, 1979).

There were significant differences (P<0.05) in crude fibre between boiled *Ukpo* and *Egusi* flours and their respective raw and soaked flours (Table 1). Soaked *Ogbono* flour (1.60%) differed significantly (P<0.05) in crude fibre from the raw and boiled flours. Although, boiled *Ukpo* (3.80%) and boiled *Egusi* (4.10%) flours had the highest crude fibre values, the lowest value (1.40%) was obtained in boiled *Ogbono* flour.

Table 1. Mean values of the proximate compositon of raw, soaked and boiled flour samples of Ukpo (*Mucuna flagellipes*), Egusi (*Colocynthis citrullus*) and Ogbono (*Irvingia gabonensis*) on dry basis.

Samples	*Moisture content (%)*	*Crude fat (%)*	*Crude fibre (%)*	*Crude protein (%)*	*Ash content (%)*	*Carbohydrate content (%)*
RMF	15.50^{b}±3x10^{-8}	5.95^{b}±3x10^{-3}	3.05^{b}±3x10^{-4}	10.50^{a}±3x10^{-4}	2.79^{b}±3x10^{-4}	15.50^{b}±3x10^{-6}
SMF	8.52^{c}±3x10^{-8}	4.60^{c}±3x10^{-3}	3.00^{c}±3x10^{-4}	10.94^{a}±3x10^{-4}	3.70^{a}±3x10^{-4}	39.24^{a}±3x10^{-6}
BMF	15.68^{a}±3x10^{-8}	7.85^{a}±3x10^{-3}	3.80^{a}±3x10^{-4}	9.09^{a}±3x10^{-4}	2.79^{b}±3x10^{-4}	30.79^{c}±3x10^{-6}
RCC	5.79^{a}±3x10^{-8}	55.35^{b}±3x10^{-3}	3.05^{b}±3x10^{-4}	28.35^{a}±3x10^{-4}	4.15^{b}±3x10^{-4}	3.97^{c}±3x10^{-6}
SCC	2.70^{b}±3x10^{-8}	54.35^{c}±3x10^{-3}	3.00^{b}±3x10^{-4}	21.26^{b}±3x10^{-4}	3.44^{c}±3x10^{-4}	16.15^{a}±3x10^{-6}
BCC	4.55^{c}±3x10^{-8}	56.25^{a}±3x10^{-3}	4.10^{a}±3x10^{-4}	20.27^{b}±3x10^{-4}	5.29^{a}±3x10^{-4}	11.34^{b}±3x10^{-6}
RIG	7.54^{A}±3x10^{-8}	64.10^{c}±3x10^{-3}	1.50^{B}±3x10^{-4}	15.91^{a}±3x10^{-6}	3.08^{a}±3x10^{-6}	7.87^{a}±3x10^{-6}
SIG	5.06^{c}±3x10^{-8}	72.85^{a}±3x10^{-3}	1.60^{a}±3x10^{-4}	15.09^{a}±3x10^{-6}	1.64^{c}±3x10^{-6}	3.76^{c}±3x10^{-6}
BIG	7.06^{B}±3x10^{-8}	68.65^{b}±3x10^{-3}	1.40^{c}±3x10^{-4}	12.96^{a}±3x10^{-6}	2.32^{b}±3x10^{-6}	7.61^{b}±3x10^{-6}

Values are means ± standard deviation of triplicate determinations Means in the same column not followed by the same superscript are significantly different (P<0.05).

Mean ± SD of three determinations

RMF - Raw *Mucuna flagellipes*
SMF - Soaked *Mucuna flagellipes*
BMF - Boiled *Mucuna flagellipes*
RCC - Raw *Colocynthis citrullus*
SCC - Soaked *Colocynthis citrullus*
BCC - Boiled *Colocynthis citrullus*
RIG - Raw *Irvingia gabonensis*
SIG - Soaked *Irvingia gabonensis*
BIG - Boiled *Irvingia gabonensis*

Soaking and boiling increased the carbohydrate contents of *Ukpo* and *Egusi* flours from their respective raw flours while soaking and boiling decreased carbohydrate content from 7.87% to 3.70% and 7.61% respectively for *Ogbono* flours (Table 1). Significant differences (P<0.05) were observed in all the processed flours and their raws in carbohydrate contents.

Soaked *Ukpo* (62.24%) and *Egusi* (16.15%) flours differed significantly (P<0.05) in carbohydrate content from their respective raw and boiled flours. Besides, soaking increased their respective carbohydrate contents from 15.50% to 39.24% (Ukpo) and 3.97% to 16.15% (Egusi). The raw Ogbono flour (7.87%) was significantly different (P<0.05) from the soaked and boiled flours in carbohydrate contents.

The analysis further showed that significant differences (P<0.05) were observed in the moisture contents of *Ukpo* and *Ogbono* flours respectively. Soaking and boiling decreased the moisture contents of *Egusi* and *Ogbono* flours. In the case of *Ukpo*, soaking also decreased the moisture content from 15.50% to 8.52% but boiling increased it to 15.68%. Soaked flours of *Egusi* decreased from 5.79% to 2.70% and *Ogbono*, 7.54% to 5.06%. The increase in moisture content was attributed to the absorption of water during boiling thereby resulting to the imbibitions of water into legume by simple diffusion (Rosario and Flores, 1981).

The processed flours differed significantly (P<0.05) in ash contents (Table 1). Soaked *Ukpo* flour (3.70%) differed significantly (P<0.05) in percentage ash content from the raw and boiled flours. In the case of *Ogbono* flour, raw flour (3.08%) was significantly different (P<0.05) from the boiled and soaked flours while boiled *Egusi* flour (5.29%) differed significantly from the raw (4.15%) and soaked flours (3.44%). The decrease in ash content in the soaked flour of *Egusi* (4.15% to 3.44%) and *Ogbono* flour (3.08% to 1.64%) might be due to the leaching of nutrients into the water.

Functional Properties

The result of the effect of boiling and soaking on the functional properties (Table 2) showed that there was significant difference (P<0.05) in water absorption capacity (WAC) of *Ukpo* and *Egusi* flours. However, soaking and boiling increased the WAC of *Ukpo* from 5.20ml/H_2O/g flour to 5.60ml/H_2O/g flour and 6.37ml/H_2O/g flour respectively. The increase in the soaked flour of *Ukpo* was similar to the report of Onweluzo and Morakinyo (1996) on soaked and roasted *A. Africana* flour. Boiled *Egusi* flour increased in WAC from 1.03ml/H_2Og flour to 1.10ml/H_2O/g flour while there was a decrease in soaked flour to 0.40ml/H_2O/g flour. The result further indicated that raw *Ogbono* flour did not absorb water but soaking and boiling caused imbibition of water.

Processing (soaking and boiling) decreased the oil absorption capacities (OAC) of *Ukpo* and *Ogbono* flours but an increase was observed in soaked and boiled *Egusi* flours (5.20ml/Oil/g flour to 5.60ml/Oil/g flour and 6.37ml/Oil/g flour) respectively. The raw *Ukpo* and *Ogbono* flours were significantly different (P<0.05) from their soaked and boiled flours in OAC. Soaked and boiled *Ukpo* flours decreased in OAC from 1.37ml/Oil/g flour to 1.20ml/Oil/g flour and 1.30ml/Oil/g flour respectively while soaked and boiled *Ogbono* flour decreased in OAC from 1.47ml/Oil/g flour to 0.47ml/Oil/g flour and o.67ml/Oil/g flour respectively. The flours of raw, soaked and boiled *Egusi* compared well (P>0.05) in OAC. The rise in OAC of soaked and boiled *Egusi* flours can be explained by the variations in the amounts and physical properties of the other food components such as fat and carbohydrates (Kinsella, 1976).

There were significant differences (P<0.05) in the emulsion capacity of all the processed flours of *Ukpo, Egusi* and *Ogbono*. Raw *Ukpo* flour (42.65%) and *Ogbono* flour (24.85%) differed significantly (P<0.05) from their soaked and boiled flours in emulsion capacities. The decrease in emulsification capacity of the processed flour samples might be due to heat denaturation of protein during processing. Abbey and Ibeh (1988) observed the same trend of decrease in cowpea. The soaked (0.80%) and boiled (0.80%) flour samples of *Egusi* differed

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significantly (P<0.05) in foam capacity from their raw (0.50%) while raw (0.65%) and soaked (0.65%) flour samples of *Ogbono* also differed significantly (P<0.05) from boiled *Ogbono* flour. Soaking and boiling decreased the foam capacity of *Ukpo* flour from 0.90% (raw) to 0.75% and 0.67% respectively. The decrease in the foam capacity of boiled *Ukpo* and *Ogbono* flours agreed with the reports of Yatsumatsu *et al.* (1972) that heat processing reduced the foam capacity of soya beans.

Table 2. Functional properties of raw, soaked and boiled flour samples of Ukpo (*Mucuna flagellipes)* Egusi, (Colocynthis citrullus) and Ogbono (*Irvingia gabonsensis*) on dry basis.

1	2	3	4	8
Samples	*Water absorption capacity(WAC) ml/H_2O/g flour*	*Oil absorption capacity(OAC) (ml/oil/g/flour)*	*Emulsion capacity (%)*	*Gelation property*
RMF	$5.20^c±3x10^{-4}$	$1.37^a±3x10^{-4}$	$42.65^a±3x10^{-4}$	Least
SMF	$5.60^b±3x10^{-4}$	$1.20^c±3x10^{-4}$	$40.39^b±3x10^{-4}$	Medium
BMF	$6.37^a±3x10^{-4}$	$1.30^b±3x10^{-4}$	$39.42^b±3x10^{-4}$	Highest
RCC	$1.03^b±3x10^{-4}$	$5.20^a±3x10^{-4}$	$40.60^b±3x10^{-4}$	Least
SCC	$0.40^c±3x10^{-4}$	$5.60^a±3x10^{-4}$	$35.67^c±3x10^{-4}$	Medium
BCC	$1.10^a±3x10^{-4}$	$6.37^a±3x10^{-4}$	$42.23^a±3x10^{-4}$	Highest
RIG	$1.20^a±3x10^{-4}$	$1.47^a±3x10^{-4}$	$24.85^a±3x10^{-4}$	Least
SIG	$0.66^b±3x10^{-4}$	$0.47^c±3x10^{-4}$	$23.64^b±3x10^{-4}$	Medium
BIG	$0.86^a±3x10^{-4}$	$0.67^b±3x10^{-4}$	$22.87^b±3x10^{-4}$	Highest

1	5	6	7	8
Samples	*Foam capacity (%)*	*Bulk density (%)*	*Swelling index (ml/g)*	*Gelation property*
RMF	$0.90^a±3x10^{-4}$	$0.29^b±3x10^{-6}$	$1.31^a±3x10^{-4}$	Least
SMF	$0.75^b±3x10^{-4}$	$0.29^b±3x10^{-6}$	$1.20^b±3x10^{-4}$	Medium
BMF	$0.67^c±3x10^{-4}$	$0.38^a±3x10^{-6}$	$1.11^c±3x10^{-4}$	Highest
RCC	$0.50^b±3x10^{-4}$	$0.45^a±3x10^{-6}$	$1.21^a±3x10^{-4}$	Least
SCC	$0.80^a±3x10^{-4}$	$0.38^b±3x10^{-6}$	$1.71^c±3x10^{-4}$	Medium
BCC	$0.80^a±3x10^{-4}$	$0.38^b±3x10^{-6}$	$1.05^b±3x10^{-4}$	Highest
RIG	$0.65^a±3x10^{-4}$	$0.39^a±3x10^{-6}$	$1.64^c±3x10^{-4}$	Least
SIG	$0.65^a±3x10^{-4}$	$0.38^a±3x10^{-6}$	$2.44^a±3x10^{-4}$	Medium
BIG	$0.50^b±3x10^{-4}$	$0.38^a±3x10^{-6}$	$2.02^b±3x10^{-4}$	Highest

Values are means ± standard deviation of triplicate determinations Means in the same column not followed by the same superscript are significantly different (P<0.05).

RMF - Raw *Mucuna flagellipes*
SMF - Soaked *Mucuna flagellipes*
BMF - Boiled *Mucuna flagellipes*
RCC - Raw *Colocynthis citrullus*
SCC - Soaked *Colocynthis citrullus*
BCC - Boiled *Colocynthis citrullus*
RIG - Raw *Irvingia gabonensis*
SIG - Soaked *Irvingia gabonensis*
BIG - Boiled *Irvingia gabonensis*

Significant difference (P<0.05) was observed in the bulk density of both raw and processed *Ukpo* flours. Bulk densities of raw and soaked *Ukpo* flour ($0.29g/cm^3$) compared well (P>0.05) but the boiled flour differed significantly (P<0.05) from the raw and soaked flours. A decrease was noticed in the bulk density of the soaked and boiled flours of *Egusi*

($0.45g/cm^3$ to $0.39g/cm^3$) respectively. All the processed *Ogbono* flours showed no significant difference (P>0.05) in bulk densities. However, processing decreased ($0.39g/cm^3$ to $0.38g/cm^3$ and $0.38g/cm^3$ respectively) slightly the bulk densities of soaked and boiled *Ogbono* flours. Higher bulk densities are desirable since it helps to reduce paste thickness. This is an important factor in convalescent and child feeding (Padamshree *et al*., 1987).

The result of the swelling index indicated that there were significant differences. The raw *Ukpo* flour differed significantly (P<0.05) from the soaked and boiled flours but the swelling index of *Ukpo* flour decreased from 1.31ml/g to 1.20ml/g and 1.11ml/g for soaked and boiled flours. In the case of *Ogbono* flour, soaked flour was significantly different (P<0.05) from the raw and boiled flours. *Egusi* flour increased in swelling index from 1.21ml/g to 1.71ml/g during soaking while *Ogbono* flour increased from 1.64ml/g to 2.44ml/g and 2.02ml/g during soaking and boiling. The increased swelling indices of *Ukpo* and *Ogbono* flours agreed with the report of Onweluzo and Morakinyo (1996) on soaked *Afzelia africana* that increased solubilization of proteins also increased the ability of the legumes to absorb water. Furthermore, the result indicated that the three raw legumes (*Ukpo, Egusi* and *Ogbono*) flours possessed the least gelation property while boiled flours had the highest gelation property.

CONCLUSIONS

There is a need for readily available, high quality, alternative vegetable protein and energy sources that are inexpensive and capable of reducing production costs of meat and other animal products. The work showed that some under-utilized tropical legumes, such as Ukpo (*Mucuna flagellipes*), Egusi (*Colocynthis citrullus*) and Ogbono (*Irvingia gabonensis*) possessed high protein content and also good functional properties.

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