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Effect of Processing Methods on the Organoleptic Qualities and Functional Properties of Soyflour (*Glycine max.* L)

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Abstract— Soybean (*Glycine max*) is one of the most important food crops and a primary source of food for reasonable percentage of the world's population. This study investigated the effect of processing methods on the organoleptic qualities, functional characteristics and proximate values of soybeans. Flours prepared using four different processing methods were subjected to various analyses. The study showed that the organoleptic properties of processed soybean were not significantly ($p \leq 0.5$) different except in taste. For functional characteristics, sample CCPM showed the highest foaming capacity of 10% while sample SRPM has the least value of 5%. The foaming stability of samples OCPM and CCPM have higher values of 80.0 and 83.3% respectively. Highest value of 20.00% for least gelation for sample SRPM and lowest value of 16.00% for sample CCPM were obtained. The water absorption capacity of the samples showed that sample OCPM has the highest value of 2.80 $g.g^{-1}$ while sample SRPM has least value of 2.00 $g.g^{-1}$. The data on oil absorption of the samples indicated that there was no significant ($p \leq 0.5$) difference in the values obtained. The least value of 2.70 $ml.g^{-1}$ for emulsion capacity for sample SRPM was observed while the values for other samples range from 3.20-3.71 $ml.g^{-1}$. The reconstitution index values showed that samples CCPM and SRPM had same value of 1.80 $ml.g^{-1}$ while samples OCPM and SCPM had 1.20 and 2.00 $ml.g^{-1}$ respectively while. The proximate parameters examined were not significantly ($p \leq 0.5$) different except that sample SRPM had the least moisture content. This study showed that the functional properties, organoleptic values and moisture content of soyflour were not affected by low heat processing.

Index Terms— Hammer mill, Functional properties, organoleptic qualities, proximate composition, Soybean

1 INTRODUCTION

Soybean (*Glycine max* (L.), a legume like all other peas and beans, belongs to the family Leguminosae (which includes some 500 genera and more than 12,000 species), in the subfamily Papilionideae. It was first cultivated in Africa in the late 1800s and is use as source of fiber, protein and minerals [1] with several available pharmacology evidence [2] [3]. Soybean has been named among important protein crops because its seed contains high concentrations of protein and oil [4]. However, soybean and other legumes have to be processed prior to consumption due to their content of anti-nutritional factors such as trypsin inhibitors, phytic acid and galactosides [5]. [6] noted that, leguminous flour under different processing conditions exhibited different functional properties and sensory values, which could be basis for selection in food application.

Proteins are essential food components because they are a source of amino acids needed for growth and maintenance of human and animal as they have been found to provide fundamental properties of foods. Commercially available proteins in foods are obtained from a range of animal and plant sources and are used as functional ingredients [7]. Due to the increasing costs and limited supplies of animal proteins, plant protein is playing significant role in human nutrition particularly in developing countries. A number of plant proteins such as alfafa leaf, cotton seed, winged bean, peanut and soybean are being investigated for possible incorporation into formulated foods [8] [9] [10].

Food proteins in general, are processed for many reasons ranging from the improvement of nutritional values, functional properties and textural characteristics to the removal of odour, flavor and toxic or anti-nutritional components [7]. Processing of soybeans into various foods and feeds does cause adverse change in their nutritive and functional values. The degree of heat employed during processing of protein food has been found to affect functional properties as well as physical and chemical properties [11].

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When soybeans are subjected to mild heat treatment trypsin inhibitors are inactivated and soybeans globulin are denatured making them more susceptible to proteolysis and improve soy protein [12]. On treatment of soy protein with alkali during processing of soy isolates, Hydrogen Sulfide can be lost from cystine in the presence of heat and alkali. Alkali catalyses browning reaction as well as heat and low moisture are reasons one must be careful about overheating soy meal to prevent the loss of lysine through millard reaction [13].

Heat treatment, roasting in most cases affects nitrogen solubility and formability which decrease with increase in product temperature. Protein insolubilization and denaturation are believed to be responsible for this effect. Roasted products show increased water absorption capacity; cold viscosities of roasted products were also notably higher than those of the non roasted products [14]. However, [15] reported that heat treatment had a decreasing effect on foaming capacity of processed cowpea flour. Solubility of protein is also a critical functional attributes required for its use as food ingredient, because solubility is greatly influence by other properties than heat such as emulsification, gelation and foaming characteristics [16].

Since Plant protein play significant roles in human nutrition, particularly in developing countries where protein intake is less than its required standard [10], this study therefore investigated the effect of different processing methods on the organoleptic qualities, nutritional values and functional properties of soybean under different processing conditions, which could be a basis for selection in food application.

2 Material and Methods

2.1 Experimental Material

Glycine max seeds were purchased at at the Institute of Agricultural Research and Training, (IITA) Ibadan. The beans were cleaned, sorted and preliminary studies were carried out before processing [5] [6].

2.2 Laboratory Experiment/Preoaration of Soyflour

The experiment was conducted in two phases. First was to carry out four different processing methods such as Ordinary conditioned processing method (OCPM), Soda Ash conditioned processing method (SCPM), Citric acid conditioned processing method (CCPM) and Sand roasted processing method (SRPM) as adapted by [12]. Secondly, milling of grits into flour of 500 μm particle size using hammer mill (FITZPATRICK J Homoloid Hammer Mill- Stainless Steel swinging hammers, Waukesha metal(136278) housing, 3 hp 3485 rpm, 230/460 3 phase motor, SN 551).

2.3 Sensory Evaluation

Panel of 8 trained members were used to determine the colour, taste and flavour of the milk samples. A 5-point descriptive hedonic scale was used. The evaluation was carried out in the laboratory at room temperature and the panelist were called one after the other to judge the samples by smelling (flavour), observing (colour) and tasting (taste) [17] [18].

2.4 Fuctional Properties

For foaming capacity, method described by [19] was employed, while procedure employed by [20] as modified by [21] was used for gelation. Water and oil absorption was conducted using a method described by [19] was used. Emulsion capacity and stability were determined following the method of [22] and the Reconstitution index of flour was carried out using method postulated by [23].

2.5 Proximate Analysis

Moisture content, ash content, crude protein, carbohydrate and crude fat were determined by the method of [24].

2.6 Statistical Analysis

Mean, standard deviation and analysis of variance were calculated on the data obtained. Least significance differences (LSD) among means were also calculated. Results recorded as Mean ± SD and the significance level applied was $p > 0.05$. All data were analyzed statistically on GraphPad Prism5.

3 Results and Discussions

The results in Table 1, show that there is no significant ($p \leq 0.5$) difference in colour, flavor and general acceptability of samples OCPM and SCPM, but they are significantly ($p \leq 0.5$) different in taste. Samples CCPM and SCPM have similar values for flavour, taste and general acceptability but differ significantly ($p \leq 0.5$) in colour attributes as sample CCPM has higher value. This is an indication that the acidic buffer solution improved the colour significantly ($p \leq 0.5$). Sample SRPM possessed the least values for colour, flavour and general acceptability for soyflour. This is as a result of dry heat employed in its processing which impact negatively on these properties. The low values observed in colour for samples SCPM and SRPM was as a result of the millard reaction caused by the heat and the alkali solution used during processing as reported by [12]. It can be deduced that roasting on a bed of sand and conditioning with ash impaired negatively on the organoleptic properties of soyflour.

From the results of foaming characteristics in Table 2, sample CCPM had highest foaming capacity of 10% while sample SRPM had the least foaming capacity of 5%. The foaming capacity values for samples OCPM and SCPM were 8 and 6% respectively. The results of foaming stability revealed that samples OCPM and CCPM have higher values of 80.0 and 83.3% respectively, while on the contrary samples SCPM and SRPM showed lower foaming stability values of 60.0 and 62.5% respectively. The low foaming capacity and stability observed in samples SCPM and SRPM may be as a result of the heat and alkali employed during processing as reported by [12].

The results in Table 3 show that sample SRPM has the highest value of 20.00% for least gelation while the lowest value of 16.00% was obtained for sample CCPM. Samples OCPM and SCPM averaged 18.00% respectively. The observed differences in the gelation values could be due to varied effect of processing on the proteins of the soy flour. Since protein concentration, temperature and time as well as mechanical force are known to affect gelation of protein [12] [13]. Water absorption capacity of the samples show that sample OCPM has the highest value of 2.80 $g.g^{-1}$, while sample SRPM has least value of 2.00 $g.g^{-1}$. Samples CCPM and SCPM have water absorption values of 2.40 $g.g^{-1}$ and 2.40 $g.g^{-1}$ respectively. These show that water absorption capacity of soyflour varied with processing method as reported by [15]. Evidence on oil absorption of the samples indicate that there was no significant ($p \leq 0.5$) difference in the values obtained except for SRPM with highest value of 2.91 $g.g^{-1}$. Sample CCPM has the least oil absorption value of 2.41 $g.g^{-1}$, while samples OCPM and SCPM have 2.61 $g.g^{-1}$ and 2.51 $g.g^{-1}$ respectively. The high value observed in sample SRPM may due to heat employed during processing as reported by [14]. The emulsion capacity also show that sample CCPM has the highest emulsion capacity of 3.71 $ml.g^{-1}$ follow by sample SCPM which has value of 3.30 $ml.g^{-1}$. Samples OCPM and SRPM also had 3.20 and 2.70 $ml.g^{-1}$ respectively. The observed difference may be due to varied effect of processing on the protein of the soyflour [16]. The reconstitution index show that samples CCPM and SRPM have same value of 1.80 $ml.g^{-1}$ while samples OCPM and SCPM had 1.20 and 2.00 $ml.g^{-1}$ respectively. It can be inferred that the alkali used in processing of sample SCPM has effect on reconstitution index compared to the other processing method employed.

From the results presented in Table 4, sample SRPM had the least moisture content while all other proximate parameters examined were not significantly ($p \leq 0.5$) different. This indicated that roasting on the bed of sand conduct greater heat than the oven. It is also clear that the proximate composition of the soy flour was not affected by processing methods.

4 Conclusions

Data obtained show that the variation obtained in the organoleptic qualities and functional properties are as results of varying degree in heat employed and the conditioning process used on soyflour. It can also be concluded the similar nutritive values obtained are proof that proximate composition of soyflour were not affected by processing method used except that roasting on bed of sand lower moisture content compare to oven dry method. Thus, soyflour possessed higher functional qualities and sensory characteristics when low heating processing methods were employed.

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References

[1]. USDA, NRCS. 2011. The PLANTS database (*Glycine max*.)(http://plants.usda.gov , September 2011). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

[2]. Christie DR, Grant J, Darnell BE, Chapman VR, Gastaldelli A, Sites CK. 2010. Metabolic effects of soy supplementation in postmenopausal Caucasian and African American women: a randomized, placebo-controlled trial. *Am J Obstet Gynecol* .203(2):153.e1-153.e9.

[3]. Santo AS, Santo AM, Browne RW, et al. 2010. Postprandial lipemia detects the effect of soy protein on cardiovascular disease risk compared with the fasting lipid profile. *Lipids* . 45(12):1127-1138.

[4]. Liang, J.H. (1999): Flourescence due to interactions of oxidizing soybean oil and soy proteins. *Food Chem.*, 66: 103-108

[5]. Vidal-valverde, C., Frias, J., Sierra, I., Blazquez, I., Lambien, F. and Kuo, Y.H. (2002): New functional legume food by germination: effect on the nutritive value of beans, lentils and peas, *Eu Food Res. Tec.*, 215: 472-476

[6]. Cepeda, E., Villaran, M.C., Aranguiz, N. (1998): Functional properties of faba bean (Vicia faba) protein flour dried by spray drying and freeze drying by spray. J. *Food Eng.*, 36:303-310.

[7]. Periago, M.J., Vidal, M.L. and Ros, G. (1998): Influence of enzymatic treatment on the nutritional and functional properties of pea flour. *Food Chem.*, 63: 71-78.

[8]. Achouri, A., Zhang, W., Shiying X. (1999): Enzymatic hydrolysis of soy protein isolate and effect of succinylation on the functional properties of resulting protein hydorlysates. *Food Res. Int.*, 31: 617-623

[9]. Sze-Tao, K.W. and Sathe, S.K. (2000): Functional properties and in Vitro digestibility of almond (Prunus dulcis L.) protein isolate. *Food Chem*. 69:153-160.

[10]. Onweluze, J.C., Obanu, Z. A. and Onuoha, K.C. (1994): Functional properties of some lesser-known tropical legumes. J Food Sci. Tec., 13: 302-306

[11]. Han, J. and Khan, K. (1990): Functional properties of pin-milled and air –classified dry edible bean fractions. *Cereal chem.*, 67(4):390-394

[12]. Synder, H.E. and Kwon, T.W. (1987): Soybean utilization.2nd edition AVI publication, New York.

[13]. Hutton, C. W. and Cambel, A. M (1977): Function Properties of soy concentrate and soy isolate in simple system and in a food system: emulsion properties thickening function and fat absorption. *J. Food Sci.*, 42(2):

457-460

[14]. Aguiler, J.M., Lusas, E.W., Uebersaz, M.A., and Zabik, M.E. (1982): Roasting of Navy beans (*Phaselolus vulgaris*) by particle-to particle heat transfer. *J. Food Sci.*, 47: 996-1000,1005

[15]. Giami, S. Y. (1993): Effect of processing on the proximate composition and functional properties of cowpea (Vigna ungniculata) flour. *J. Food Sci.*, 40:850-807

[16]. Mashair, A. S., Abdullahi, H. E., Abd Elmoneim, O. E., Elfadi, E. B. and Elhadi, A. E. (2006): Solubility as influenced by pH and concentration and functional properties of lentil protein isolate. *Pakistan J. Nutr.*, 5 (6): 589-593.

[17]. Fashina-Bombata, H.A., Hammed, A.M., Ajepe, R.G. and Jimoh, A.A. (2005): Comparative Organoleptic Assessment of "Wesafu" (an ecotype Cichlid of Epe Lagoon), Oreochromis niloticus and Tilapia mariae. Proceedings of the 4th Faculty of Science Annual Conference, 28-29

[18]. Ihekoroye, A.I. and Ngoddy, P.O. (1985): Integrated food science and technology for Tropics. 2nd edition, Macmillan Publishers Ltd; London.

[19]. Okezie, B.O. and Bello, A.B. (1988): Physico - chemical and functional properties of winged bean flour and isolate compare with soy isolate. *J. Food Sci*. 53 (2): 450-455.

[20]. Coffman, C.W and Garcia, V.V.(1977) Functional properties and amino acid content of protein isolate from mung bean flour. *Journal of Food Technology* 12: 473-484.

[21]. Sathe, S.K. and Salunkhe, D.K. (1981): Functional properties of the great northern bean (Phaseolus vulgaris L.) protein; emulsion, foaming, viscosity and gelation properties. *Journal of Food Science*.46:71 -74.

[22]. Beuchat, L.R. (1977): Functional and electrophoretic characteristic of succinylated peanut flour proteins. *J. of Agricultural and Food Chem.*, 24:258.

[23]. Banigo, E.B. and Akpapunam, M.A. (1987): Physiochemical and Nutritional evaluation of protein - enriched fermented maize flour. *Nigerian Food Journal*, 5:30-36.

[24]. AOAC (1984): Official methods of analysis, association of official analytical Chemists. Washington D. C.

Table 1: Effect of processing methods on the organoleptic qualities of soy flour (milk)

Sample	Colour	Flavour	Taste	General acceptability
OCPM	$3.5_b \pm 0.53$	$4.5_a \pm 0.76$	$3.5_c \pm 0.53$	$3.8_a \pm 0.64$
SCPM	$3.1_b \pm 0.99$	$4.1_a \pm 0.35$	$4.3_a \pm 0.35$	$3.9_a \pm 0.53$
CCPM	$4.6_a \pm 0.53$	$4.3_a \pm 0.35$	$4.3_a \pm 0.52$	$3.8_a \pm 0.83$
SRPM	$2.0_c \pm 0.53$	$2.9_b \pm 0.46$	$3.8_b \pm 0.46$	$2.9_b \pm 0.64$

Mean ± STD, mean value in the same column with different letter are significantly different ($p \le 0.05$)

Table 2: Foaming capacity (%) and foaming stability (%) values

Sample	0 min	I min	10 min	30 min	60 min	90 min	120 min
OCPM	(10.0) [100.0]	(10.0) [100.0]	(10.0) [100.0]	(9.0) [90.0]	(8.0) [80.0]	(8.0) [80.0]	(8.0) [80.0]
SCPM	(10.0) [100.0]	(10.0) [100.0]	(8.0) [80.0]	(6.0) [60.0]	(6.0) [60.0]	(6.0) [60.0]	(6.0) [60.0]
CCPM	(12.0) [100.0]	(12.0) [100.0]	(12.0) [100.0]	(12.0) [100.0]	(11.0) [91.7]	(10.0) [83-3]	(10.0) [83.3]
SRPM	(8.0) [100.0]	(8.0) [100.0]	(8.0) [100.0]	(6.0) [75.0]	(5.0) [62.5]	(5.0) [62.5]	(5.0) [62.5]

Replicate readings were determined and the mean taken.

** (foam capacity) [foam stability]

Table 3: Least gelation, Water absorption, Oil absorption, Emulsion capacity and Reconstitution index

Sample	Least gelation (LG) %	Water absorption (WA) $g.g^{-1}$	Oil absorption (OA) $g.g^{-1}$	Emulsion capacity (EC) $ml.g^{-1}$	Reconstitution index (RI) $ml.g^{-1}$
OCPM	18.00	2.80	2.61	3.20	1.20
SCPM	18.00	2.10	2.51	3.30	2.00
CCPM	16.00	2.40	2.41	3.71	1.80
SRPM	20.00	2.00	2.91	2.70	1.80

Values are means of triplicates of samples

Table 4: The proximate composition of soy flour

Sample	Moisture content% (MC) %	Ash content% (AC)%	Crude protein% (CP) %	Crude fat%	Crude Fibre%	Carbohydrate (CHO) %
OCPM	5.00	5.00	41.52	20.00	4.80	23.68
SCPM	5.40	5.20	41.32	20.00	4.22	23.86
CCPM	4.80	5.20	41.69	20.00	4.30	24.01
SRPM	3.20	5.40	41.40	20.30	4.18	25.52

Values are means of duplicates samples