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Website: www.mutagens.co.in
E-mail: submit@mutagens.co.in
researchsubmission@hotmail.com

Research Paper

STUDIES ON THE PHYSICAL AND FUNCTIONAL PROPERTIES OF PRIDE OF BARBADOS *(Caesalpinia pulcherima)* SEED FLOUR

Akoja, S.S.

Department of Food Technology,
The Federal Polytechnic,
P.M.B 50, Ilaro, Nigeria.

Abstract

The physical and functional properties of Pride of Barbados (*Caesalpinia pulcherima*) seed flour were investigated using standard analytical methods. The result of physical parameter revealed that Pride of Barbados seed weight, volume and density were in the range reported for some commonly consumed legumes, however, lower hydration and swelling co-efficient were exhibited by the seed. The seed flour exhibited a good gel forming properties of 10%, The water and oil absorption capacities of 420% and 270% respectively indicated that the seed is more hydrophobic, but less lipophilic in nature. It exhibited poor foaming and emulsion qualities. Protein solubility was found to be pH dependent and showed minimum solubility at pH4.0.The seed flour could be used in food system where the above qualities are desirable.

Key words: Physical & Functional Properties, *Caesalpinia pulcherima*, flour.

INTRODUCTION

Protein- energy malnutrition is among the most serious problems tropical developing countries are facing today and the quest of these developing countries to make progress meeting *milennium* development goal (MDG) in reducing protein malnutrition and poverty among the populace has necessitated research effort on the introduction of cheaper, reliable and affordable vegetable protein sources in the diets of the less privileged and low income groups.

Legumes have been recognized to be the second most valuable plant source for human and animal nutrition, [1]. In this regard, nutritional quality potential of the under-exploited leguminous seed of *Caesalpinia pulcherima* has been reported [2]. This therefore, adds to the list of food legumes such as *Cajanus cajan, Vigna unguiculata,* Glycine max and *Afzelia african* that have been earlier targeted in the campaign for increased consumption to prevent incidence of protein malnutrition among the populace.

However, acceptability of *Caesalpinia pulcherima* seed as ingredients in prepared food requires knowledge of its physical and functional properties. The objective of this study was to investigate the physical and functional properties of *Caesalpinia pulcherima* seed. The information will assist in predicting useful applications of the seed flour in prepared foods.

MATERIALS AND METHODS

The seeds of *Caesalpinia pulcherima* used for this study were obtained from mature and ripe fruits of the plants located as hedges on the Federal Polytechnic Campus, Ilaro, Ogun State, Nigeria. The pods were split manually to liberate the seeds and stored at 5^0C throughout the experimental period.

Determination of Physical Properties

Physical properties of seeds were studied in accordance with the procedures of [3]. Weight of randomly sampled 100 seeds was taken, and the volume was measured by absolute displacement using distilled water. Apparent density of the seeds was calculated by dividing weight of seeds by their volume. Percentage seed coat was calculated by manually decorticating 100 seeds. Hydration coefficient and swelling coefficient were determined by soaking 50 g, of seeds in 150 ml distilled water for 32 h, while noting the weight and the volume of soaked seeds at intervals of 4 h. Hydration coefficient was calculated as the percentage increase in weight of seeds, while swelling coefficient was calculated as the percentage increase in volume of seeds.

Determination of Functional Properties

The tester of the seeds were removed manually and the kernels oven-dried at 60^oCfor. 24 h; milled in Wiley mill to pass through a 80mm mesh sieve, then stored in an air-tight container and kept in a refrigerator at 4^0C prior to use. Triplicate samples were taken from the milled seed sample for functional properties determination.

Water &oil absorption capacities.

Water and oil absorption capacities of the flour samples were determined using the method of [4] and expressed as percentage increase of the sample weight.

Least gelation concentration

Least gelation concentration was carried out as described by [4]

Emulsion properties

Emulsion capacity and stability were determined according to the procedure of [5]

Foaming properties:

The method described by [6] was used for the determination of foam. Capacity (Fc) and foam stability (Fs)

Protein solubility in water

Protein solubility profile was determined in the pH 2 to 12 for the sample at room temperature (30^0C) by the method described by [7]

Statistical Analysis

Data collected from all experiment were in triplicate and subjected to statistical analysis, using univariate analysis of variance and significant treatment of means were separated by the multiple range test of Duncan according to the procedure stated by SPSS package [8]

RESULTS AND DISCUSSION

Table1: Physical properties of Pride of Barbados seeds

Parameter	Mean	±SD
100 seed weight (g)	14.84	1.025
100seed volume (cm)	12.02	1.004
Apparent density (g/cm^2)	1.23	0.004
Seed cost (%)	28.00	2.123
Hydration coefficient (%) at:		
4h	10.88g^x	1.921
8h	17.60f	2.482
12h	25.57e	2.112
16h	40.51d	3.272
20h	47.73c	4.621
24h	60.57b	4.636
28h	89.91a	5.231
32h	89.91a	5.821
Swelling coefficient (%) at:		
4h	18.75x	2.812
8h	25.63w	3.432
12h	39.48v	3.252
16h	50.37u	4.482
20h	60.75t	5.528
24h	83.64s	5.452
28h	100.00r	6.813
32h	100.00r	6.672

*Mean values denoted by different subscripts a-g within the column for a parameter differ significantly at $p<0.05$.repeat for r-x

Table 2: Functional properties of Pride of Barbados seed flour

Parameter	Mean	± Mean
Least gelation concentration (%)	10.00	0.452
Water absorption capacity (%)	420.00	11.085
Oil absorption capacity (%)	270.00	8.152
Foaming capacity (volume increase (%)	20.50	1.031
Emulsion capacity (%)	10.60	1.732
Emulsion stability (%)	47.50	2.021

Mean ± standard deviation of the mean of three (3) determinations

DISCUSSION

The results of the physical properties of *Caesalpinia pulcherima* are shown in table 1. The seed weight and volume were comparably similar to values reported for Pea and Teprary bean [9] but lower than those of *Cicer arietinum and Phoseolus lunatus* [3];[9] however, higher than *Cajanus cajan;* Rice bean and lentil [10],[9].The seed coat (as percent of the whole seed)of *Caesalpina pulcherima* was relatively higher when compared with those reported for *cajanus cajan* and *Vicia faba* [10],[9] but similar to sword bean[9].The apparent densities of *Cicer arietinium and Cajanus cajan* are similar to that of *Caesalpinia pulcherima* [3],[10]

Hydration and swelling efficient of *Caesalpinia pulcherima* were comparatively low when compared with those reported for *Cicer arietiunm and Cajanus cajan* which might be due to its higher percent seed coat more so that seed coat act as a barrier for water migration into seeds [11].The rates of hydration and swelling of *Caesalpinia pulcherima* were slow within 20 h of soaking and approaching zero after 28 h.

Table 2 shows the results of functional properties of *Caesalpinia pulcherima* seed flour. The least gelation concentration of *Caesalpinia pulcherima* seed flour in the present investigation is similar to that reported for Great northern bean flour and cashew nut protein concentrate, less than that shown by *Lupinus mutabilies* seed flour but higher than that for *Cajanus cajan* flour [12],[13],[10]. The result thus revealed that *Caesalpinia pulcherima* is a good gel forming agent. Differences in the gelling properties of legume flour have been ascribed to the relative ratios of different constituents. (i.e. protein, carbohydrate and lipids) and the interaction between such components have a significant role in the functional properties [12]. According to [14], for a given type of protein a critical concentration is required for the formation of a gel and the type of gel varies with the protein concentration Indeed *Caesalpinia pulcherima,* Great Northern bean, Lupinus *mutabilis and Cajanus cajan* seed flour differ in their chemical composition [2]; [12], [5],[15] ;[9] and thus might have accounted for the differences in the least gelation concentrations.

Water Absorption Capacity (WAC)

Water absorption capacity (WAC) value, (420%) was higher than those reported for Glycine max, sunflower, *Lupinus mutablis seed, Phaseolus vulgaris, Pra and P.glabra and A.african seed* flour [12],[10],[16] and [17], but lower than 512% for full fat *Cassia fistula* seed flour.[18].The water absorption capacity described flour-water association ability under limited water supply. The degree of water retention is useful as an indication of performance in several food formulations [19] in which the value ranging from 149.1 to 471.5% is considered critical in viscous food [20].

The high water absorption capacity of *Caesalpinia pulcherima* seed flour might be due to its low fat content and predominance polar amino acids in protein structure [9] [2] and [21] while polar amino acids have shown to be the primary site for water binding sites on the protein [22];[23]and [24]. Thus, *Caesaplinia pulcherima* seed flour may be found useful as functional ingredients in soups, gravies and baked products [17].

Oil Absorption Capacity (OAC)

Oil absorption capacity (OAC) is another important functional property since it plays an important role in enhancing the mouth feel and retains the flavor of food products [25]. The OAC of *Caesalpinia pulcherima* flour (270%) showed that it absorbed less oil than water thus suggesting the seeds protein is less lipophilic, While it absorbed more oil than soybean flour, wheat flour, full-fat *fluted* pumpkin, full fat *C.fistula, Cajanus cajan and P.glabra.* [25], [12], [27]; [18],[10]; [17].It absorbed less oil than isolated protein concentrate from soybean, *lupin* seed, Great northern seed and sunflower seeds. [26],

[12],[27] The result showed that *Caesalpinia pulcherima* seed flour may be a better flavor retainer than Soybean and wheat flour, but lower than isolated protein concentrates from *lupin* seed flour and Great northern seed flour. It has been reported that variations in the presence of non-polar side chains, which might bind the hydrocarbon side chains of oil among the flour, explain differences in the oil binding capacity of the flour [28].The high OAC of *Caesalpinia pulcherimia* makes it a good ingredient for the cold meat industry, particularly for sausages where the protein can bridge the fat and water in these products [13].

Emulsifying Activity

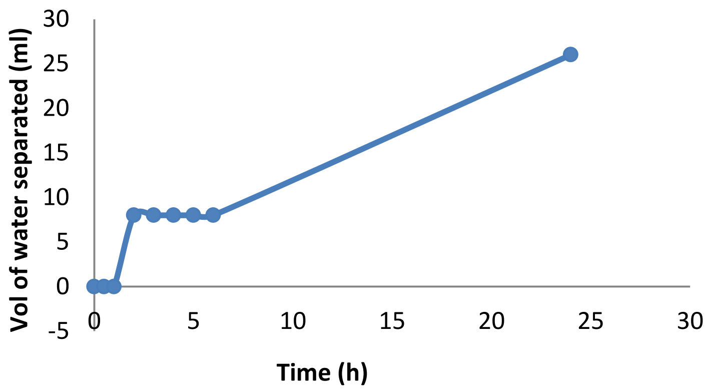


Figure1.Effect of keeping time on emulsion stability of Pride of Barbados seed flour.

The emulsion activity shows the ability and capacity of a protein to help in the formation of an emulsion and is related to protein ability to absorb to the interfacial area of oil and water in an emulsion [29] Emulsion capacity (EC) of *Caesalpinia pulcherima* (10.60%) was in the range reported for wheat flour (11%) [26] but less than those of soy flour, sunflower, *Cajanus cajan* Calabash seed flour, *P.glabra and A. african*[12] [10],[30], [17]. Emulsion capacity value of *Caesalpinia pulcherima* suggests that its seed flour could be utilized as substitute of wheat and sunflower flour in complementary/weaning food, meat additive, meat extender/binder formation and in stabilizing colloidal food system[31]. Emulsion stability normally reflects the ability of the protein to impact strength to an emulsion for resistance to stress and charges[32]. The emulsion stability of *Caesalpinia pulcherima* 47.50% was higher than 11.5% and 29.5%for gourd seed and yellow melon respectively[33]. Figure1 revealed that the emulsion stabilized for only 1 h after which separation of water began. The emulsion broke down rapidly within 5 to 24h on standing at 30^{0}C and it was considered poor.

Foaming Properties

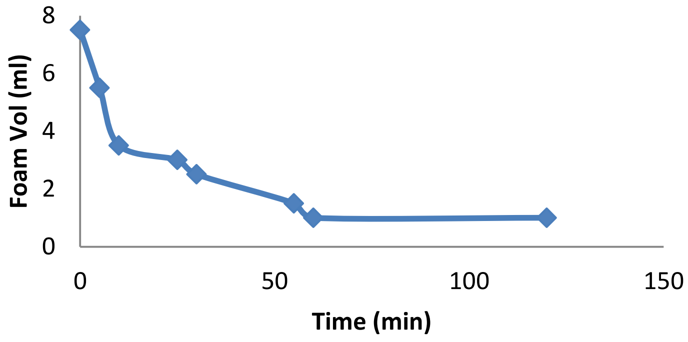
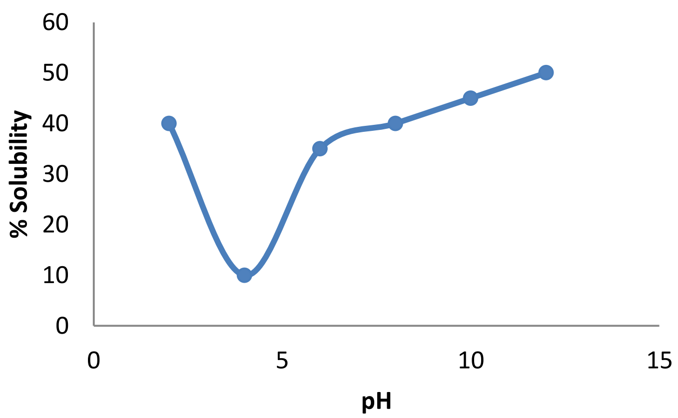


Figure 2 Foaming stability of Pride of Banbados seed flour.

The foaming capacity of *Caesalpinia pulcherinia* seed flour (20.50%) was higher than those reported for *P.glabra, A.African, Calabash Kernel* (seed) flour, full-fat *pumpkin* seed flour and *Cajanus cajan* seed flour[17] [30] [31]&[10] but comparatively lower than that of *C.fistual* flour (33.3%), and Pra flour (39.6%) [18] [16]. Foam formation is governed by three factors: including transportation, penetration and reorganization of the air-water interface, therefore , to exhibit good foaming, a protein must be capable of migration at the air water interface unfolding and rearranging at the interface [34]. The value of foaming capacity for *Caesalpinia pulcherinia* is suggesting that the flour may not be rich in flexible protein molecules which rapidly reduce the surface tension to give a good foaming ability [35]. The foaming stability of *Caesalpinia pulcherima* seed flour as shown in Figure 2 indicated that it was poor as it collapsed within 1hr of standing at 30^{0}C. Foam characteristic of flour and protein isolate or concentrates had been associated with the concentration of protein, fat and carbohydrate in the substrates while protein causes an increase in foaming capacity and stability, the reverse was true for fat and carbohydrate [36], [5],[12]. The poor foaming capacity and stability of *Caesalpinia pulcherima* flour, therefore may be attributed to the lower protein and higher carbohydrates contents of the seed flour, compared to those of soybean, sunflower and *lupin* seeds flour [24], [9],[12] [2].

Protein Solubility



The solubility of protein in the seed flour as a function of pH is shown in Figure 3. The minimum solubility was found to be 10% at pH 4 (acidic medium) and it increased with the increase of pH. The result indicated that the Isoelectric pH of *Caesalpinia pulcherima* seed flour is about pH 4.The solubility of protein observed in the present study agreed with the solubility profiles of *Iupini* seed flour. Full fat fluted *pumpkin* seed flour and *Cajanus cajan* seed flour [12],[27] and [10] where least solubility was recorded at pH 4, while the *Caesalpinia pulcherima* seed flour is fairly soluble in both acidic and basic region is suggestive that it can be used in the production of milk beverages as well as thickening agent in food formulation especially in soups, gravies and pastries.[17]

CONCLUSION

The results of this work indicate that *Caesalpinia pulcherima* under investigation, may prove useful as functional ingredients in food formulations. This, would add some economic value to the existing uses of the plant and expand its cultivation.

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