FUNCTIONAL PROPERTIES OF PROTEIN ISOLATES FROM THE SEEDS OF *Delonix Regia* (FLAME OF THE FOREST) AND *Lonchocarpus Sericeus* (SENEGAL LILAC)

Abdulrasaq Oyedeji*, Oluwatobi Omoyeni and Korede Afuye
Department of Science Laboratory Technology
The Federal Polytechnic, Ilaro, Nigeria
olalekan.oyedeji@federalpolyilaro.edu.ng

ABSTRACT

The functional properties of protein isolated from the seeds of *Lonchocarpus sericeus* (LS) and *Delonix regia* (DR) were investigated. The proteins were isolated by alkaline solubilisation, and acid precipitated at pH 10.5 and 4.5, respectively and then freeze-dried. The functional properties evaluated include water absorption capacity that was 226.6 and 190.0 ml/g, respectively for *D. regia and L. sericeus* while the oil absorption capacity was 215 and 166.83 ml/g for the protein isolates (*D. regia and L. sericeus*). The two isolates exhibited similar bulk and tap density values of 0.5 and 0.51 g/cm3, respectively. The foaming capacity and stability for the isolates were 7.33 and 6.66% and 2.67 and 2.33% for *D. regia and L. sericeus* in that order. Swelling power was 2.34-7.47% and 2.71-3.59%, and solubility ranged from 12.75-35.5 and 34.00-100% respectively for *D. regia and L. sericeus* at a temperature of between 55 and 95^{o}C. pH from the acidic to the alkaline region affected the swelling power of the isolates similarly, but a reversed effect on the solubility. The emulsion capacity and stability obtained were 34.14 and 30.77% and 30.4 and 29.69% *D. regia and L. sericeus*. There was a significant difference between swelling power and solubility, the effect of pH on swelling power and solubility and water and oil absorption capacity. However, there was no significant difference between bulk and tap density, foaming capacity and stability, and emulsion capacity and stability. Both isolates were found to possess functional properties that were similar and in some instances, better than the protein isolates of some popular legumes.

KEYWORDS: Functional properties, protein isolates, *Lonchocarpus sericeus*, *Delonix regia*

INTRODUCTION

The functional properties of a protein are responsible for many of the factors that affect consumer acceptance of food products; therefore, they play a crucial role in food processing as well as in the development of food products (Boye, et al., 2010). The use of plant protein in the formulation of a new product or conventional food has been the focus of most researches in recent years. Legumes are used to minimise the problem of protein malnutrition in Africa (Lawal et al., 2005) because animal protein is beyond the reach of a large percentage of the people in developing countries. Seed protein provides essential amino acid, but they should also possess requisite functional properties for their successful utilisation in various formulations. Legumes are the edible fruits or seeds of plants that provide protein when consumed. They belong to the family of Leguminosae and are widely cultivated throughout the world (Ayodele & Ade-Omowaye, 2015). Vegetable proteins have been widely used in various food applications, due to their satisfactory functional properties, such as emulsification, fat and water absorption, bulk density, gelation and solubility.

The inadequate supplies and shortage of food protein have made the search for unconventional legumes as a new protein source for use in both functional food ingredient and nutrition supplement (Shahidi et al., 2001) necessary. To develop an alternative plant protein source for use as an ingredient or supplement, the functional properties of the plant source must be evaluated (Aluko & Adebiyi, 2011).

Lonchocarpus sericeus is a leguminous plant commonly called cube root or Senegal lilac (Oyedeji et al., 2015). It grows from 10 to 16 m high and has a purple flower, which makes it perfect for display purposes; and frequently planted in villages as a shade tree in the gardens. *Delonix regia* is a species of flowering plant in the bean family Fabaceae. *D. regia* is noted for its fern-like leaves and colourful display of flowers. It is commonly known as the flame of the forest. It is called Royal poinciana or flamboyant. The pods usually green, and flaccid when young and turn dark-brown and woody at full maturity, and can be up to 60 m long and 5 m wide. The seeds usually small, and on the average weighs 0.4 g (Sujak et al., 2006). In areas with a marked dry season, it sheds its leaves during the drought, but in other areas, it is virtually evergreen. *L. sericeus* and *D. regia* are examples of leguminous plants that

could serve as an alternative source of protein; this, therefore, seeks to evaluate the functional properties of protein isolates from the seeds for their practical applications.

Materials and method

Sample collection and protein isolation

The seeds of *L. sericeus* and *D. regia* obtained at the East campus, Federal Polytechnic Ilaro, Ogun state by picking were cleaned of extraneous materials, washed with distilled water and air-dried. The cleaned seeds were milled into flour using grinding machine and stored in an airtight container at 4°C until required.

Protein was isolated and purified from the seeds flours following the procedure of Shahidi et al. (2001). Briefly, 1 kg of the milled sample (flour) soaked in 4 L of distilled water and the pH adjusted to 8.0 - 9.0 with 0.2% NaOH solution was constantly stirred at room temperature for 4 hours. The resulting suspension was centrifuged at 4600 rpm for 15 minutes, and the supernatant adjusted to pH 4.5 with 1 M HCl followed by centrifugation at 4600 rpm for 15 minutes. The residue obtained (protein) was washed free of acid with distilled water, and then freeze-dried and kept in an airtight glass container.

Evaluation of functional properties

Bulk density

Bulk density was determined using the method Ogunwolu et al. (2009). 50 g of sample was weighed into 250 ml graduated measuring cylinder. The sample was packed gently by tapping the cylinder 100 times until there was no decrease. The volume was recorded and the bulk density expressed in g/cm^3.

Swelling power and solubility

Determination of the effect of temperature on swelling power and solubility was carried out in the temperature range of 55 – 95°C, using the method of Neto et al. (2001). 0.2 g of protein isolate sample was carefully weighed and quantitatively transferred into a clear dried test tube and was weighed (W1). 20 ml of distilled water was added to the test tube, and the mixture was mixed vigorously for the 30 s. The resulting slurry was heated at desired temperatures, varied between 55 and 95°C for 30 minutes (using a temperature-regulated water bath). The mixture was cooled to room temperature and centrifuged (5000 g, 15 min). The residue after centrifugation with the water is retained, and the test tube was weighed (W2).

$$\text{Swelling of starch} = \frac{W_2 - W_1}{\text{Weight of starch } W_3}$$

Aliquot (10 ml) of the supernatant obtained after centrifugation was dried to a constant weight at 110°C. The residue obtained after drying the supernatant represented the amount of protein solubilized in water. Solubility was calculated as g/100 g of protein on dry weight basis.

Effects of pH on swelling power and solubility

Effects of pH on swelling power and solubility were investigated with the procedure of Sathe and Salunke (1998). 0.2 g of the sample weighed into a test tube with 10 ml of water was shaken for 30 sec. The pH was adjusted to the desired value (2 - 12) with either 0.1 M HCl or 0.1 M NaOH. The resulting slurry was transferred into a measuring cylinder, with little water added to make a total volume of 20 ml. The slurry was allowed to stand for one hour at room temperature, and thereafter centrifuged at 5000 g for 15 minutes. 10 ml of the supernatant was pipetted for solubility determination, the remaining supernatant discarded. The centrifuge tube with the sample in it was re-weighed. The pipetted supernatant in a weighed beaker was dried in the oven at 110°C, and the beaker with the residue after drying was weighed to determine the percentage solubility of the starch.

Oil and water absorption capacity

The method of Beuchat, (1977) was used to determine oil and water absorption capacity of the protein isolates. 10 ml of distilled water or oil (power oil) was added to the 1 g of the sample. The mixture was mixed vigorously for 30 s and allowed to stand for 30 min. The volume of the supernatant was recorded. The mass of oil and water absorbed was expressed as g/100g protein on a dry weight basis.

Foaming capacity and stability

The foaming capacity and stability of the protein isolates were determined according as described by Neto et al. (2001). A 3% (w/v) mixture of protein isolate was prepared in distilled water. 50 ml portion of the mixture was immediately transferred into a graduated cylinder and the volume noted. The mixture was whipped in a blender at high speed for 4 min and the volume after whipping was recorded. Foaming capacity was expressed as percentage volume change induced by whipping. The percent change in volume of foam after 60 min of standing at room temperature was recorded as foam stability.

$$\% \text{ Volume change} = (V_2 - V_1) \times 100$$

Results and discussion

Bulk capacity and tap density

The results of bulk capacity and tapped density for the protein isolates are as shown in Fig. 1. The bulk density of *D. regia* (0.5 g/cm^3) is found to be lower than that of L. sericeus (0.53 g/cm^3). There was no significant difference with respect to tap density in both samples, however, significant difference existed between the samples in terms of bulk capacity. The bulk capacities obtained for the isolates in this study are comparable to that of cowpea protein isolate as reported by Suleiman et al., (2006). Bulk capacity depends on the mutual effect of related factors that includes the intensity of attractive force and particle sizes.

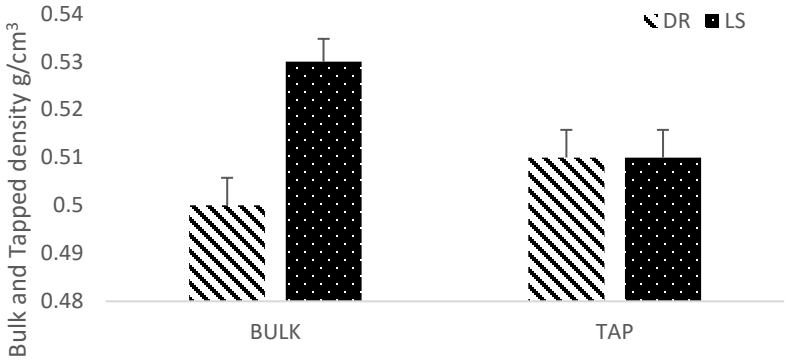

Figure. 1: Bulk and tapped density of protein isolate of D.R and L.S.Error bar standard deviation.Result are means triplicate determinations

Swelling power and solubility

The swelling power and solubility are shown in Fig 2. The swelling power and solubility of protein isolates is temperature dependent ranging from 55 to 95ºC. The solubility of both samples increased similarly from 75 to 95% when temperature was increased from 55 to 95ºC. The minimum solubility of *L. sericeus* and D. *regia* were 34 and 12.75%, respectively at 55ºC. There is significant different between the swelling and solubility of the two protein isolates.

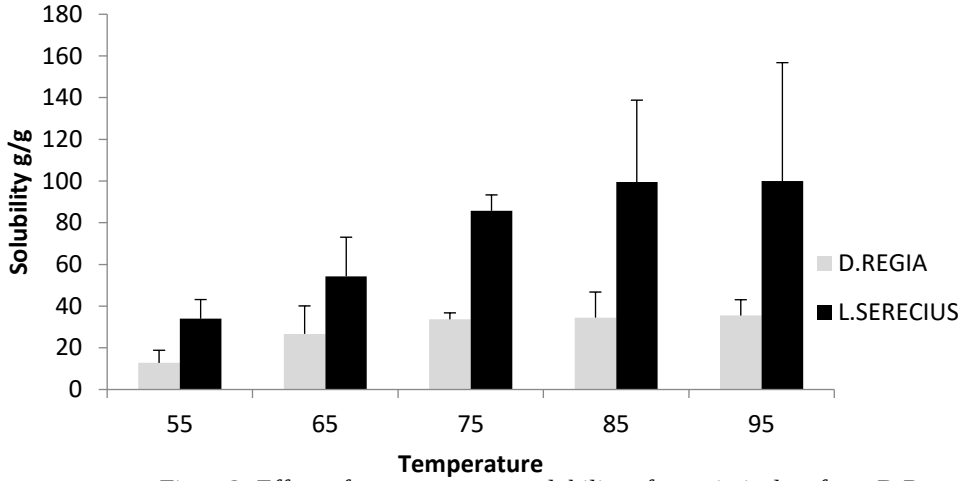

Figure2: Effect of temperature on solubility of protein isolate from D.R and L.S. Error bar,standard deviation. result are means triplicate determination. D. R: *Delonix regia* ,L. *S:Lonchocarpus sericeus*

Effect of pH on swelling power and solubility

Effect of pH on swelling power and solubility are as shown in Fig. 3 and 4. The swelling power of *D. regia* protein increased with an increase in pH while that of *L. sericeus* decreased in like manner. The minimum swelling power for the isolates was exhibited at pH 2 and 10 for *D. regia* and *L. sericeus*, respectively. The maximum solubility of the protein isolates occurred at pH 10 and 2 for *D. regia* and *L. sericeus*, respectively. The effects of pH on swelling power and solubility was significantly different in the two protein isolates. The results of this study are similar to those obtained from green pea as reported by Prakash and Narasinga, (1998).

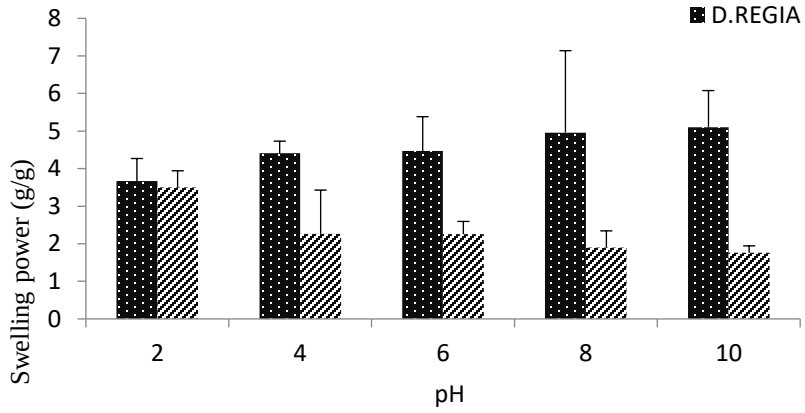

Figure. 3: Effect of pH on swelling power of protein isolate from D.R and L.S.Error bar; standard deviation. Result are means triplicate determinations.D.R; *Delonix regia* L.S; *Lonchocarpus sericeus.*

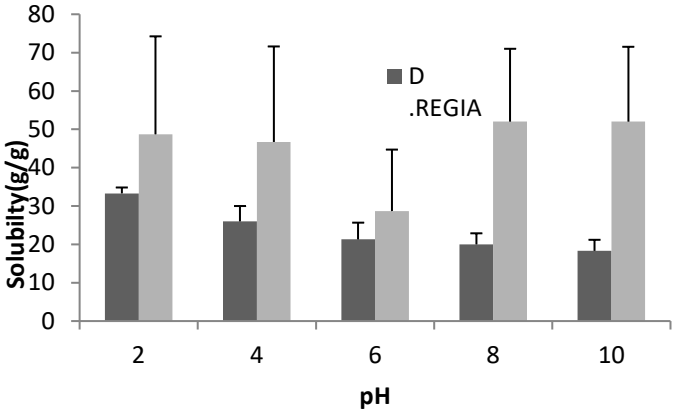

Figure 4: Effect of pH on solubility of protein isolates from D.R and L.S.Error bar;standard deviation. Result are means triplicate determinations. D.R: *Delonix regia*, L.S: *Lonchocarpus sericeus*.

Water and oil absorption capacity

The result of water and oil absorption capacity for *D. regia* and *L. sericeus* is shown in Fig. 5. The water and oil absorption capacity ranged between 215 - 266.67 and 166 - 190 ml/g for *D. regia* and *L. sericeus*, respectively thus showing *D. regia* as having higher water and oil absorption capacity. Water absorption of proteins affects the swell ability, dissociation and unfolding to reveal additional binding sites. Water absorption of protein is predicated on the polarity amino acids make-up of the protein (Kuntz, 1971). Oil absorption capacity of *L. sericeus* was found to be higher than that of *D. regia* and they were different from one another. Oil absorption capacity is of pronounced significance from an industrial standpoint, as it reveals the emulsifying capacity of the protein, a highly desirable characteristic in products such as mayonnaise (Silva et al., 2003).

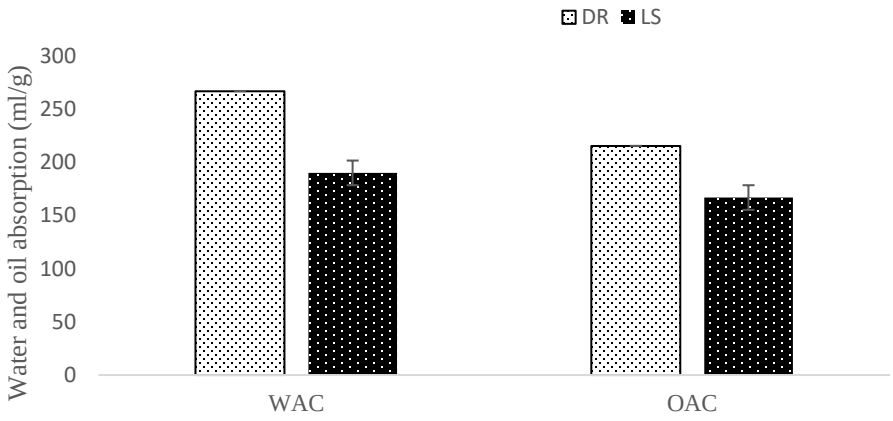

Figure.5: Water and oil absorption capacity of protein isolate. Error bar:Standard deviation.Result are means of triplicate determination D. R: *Delonix regia* L.S*: Lonchocarpus sericeus* .

Foaming capacity and stability

Foaming capacity and stability for the protein isolates of *D. regia* and *L. sericeus* is as shown in Fig.6. *D. regia* had greater foaming capacity and stability compared with *L. sericeus*. Foam formation is determined by three factors that include transportation, infiltration and re-organization of the molecules of the air-water interface. Therefore, to demonstrate good foaming capacity, a protein must be capable of migrating through the air – water interface, unfolding

and rearranging at the interfaces (Ogunwolu et al., 2009). The foam capacity and stability of proteins are enhanced by greater protein concentration because this increases the viscosity and enables the formation of a multilayer cohesive protein film at the interface (Damodaran, 1997).

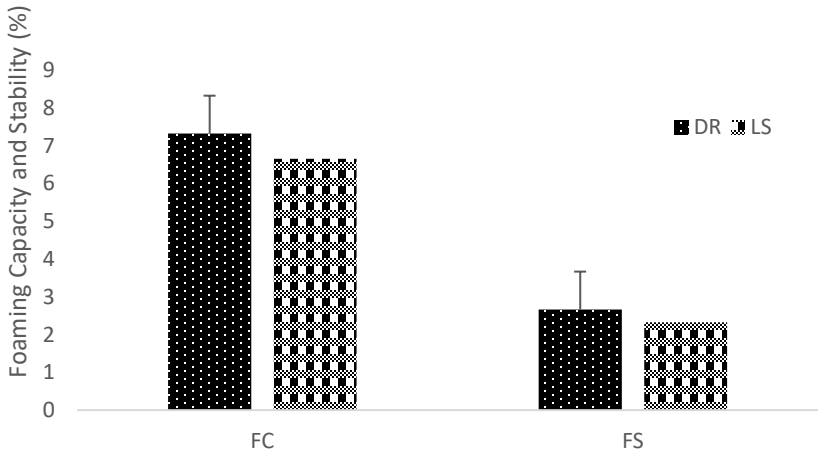

Figure.6: Foaming capacity and stability of protein isolates of D.R and L.S. Error bar standard deviation.Result are means triplicate determinations. D.R; *Delonix regia*, L.R*; Lonchocarpus sericeus*

CONCLUSION

The functional properties of protein isolated from the seeds of D. *regia* and *L. sericeus* were investigated and both samples were found to possess higher values of foaming capacity and stability, bulk and tapped density, water and oil absorption capacity, swelling power, emulsion properties and gelation properties. The solubility of the two protein samples is high enough to suggest that they could be potentially useful in some food formulations.

REFERENCES

Aluko, E. A., & Adebiyi, A. P. (2011). Functional properties of protein fraction obtained from commercial yellow field pea (*Psiumsatiouml*). Seed protein isolate. *Food Chemistry*, **128**:902-908.

Ayodele, O.M., & Ade-Omowaye, B. I. O. (2015). Some functional and physical properties of selected underutilised hard-to-cook legumes in Nigeria. *American Journal of Food Science and Nutrition*, **2(5)**:73-81.

Beuchat, L.R. (1977). Functional and electrophoretic characteristics succinylated peanut flour protein. *Journal of Agricultural and Food Chem*istry, **25**:258-265.

Boye, J., Zare, F., & Pletch, A. (2010). Pulse proteins: Processing, characterization, functional properties and applications in food and feed. *Food Research International*, **43(2)**:414-431.

Damodaran, S. (1997). Food proteins: an overview in Food Proteins and Their Applications. *Marcel Dekker Inc*., 1-30.

Escamilla-Silva, E.M., Guzman-Maldonado, S. H., Cano-Medinal A., & Gonzalez-Alatorre G (2003). Simplified process for the production of sesame protein concentrate differential scanning calorimetry and nutritional, physicochemical and functional properties. *Journal of the Science of Food & Agriculture*, **83**:972–979.

Kuntz, I. D. (1971). Hydration of macro-molecules III: hydration of polypeptides. *Journal of American Oil Chemical Society*, **93**:514–516.

Lawal, O. S., Adebowale, K. O., Ogunsanwo, B. M., Sosanwo, O. A., & Bankole, S. A. (2005). The functional properties of globulin and albumin protein fractions and flour of African locust bean (*Parkia biglobossa*). *Food Chemistry*, **92**:681-691.

Neto, V. Q., Narain, N., Silva, J. B., & Bora P. S. (2001). Functional properties of raw and heat processed cashew nut (*Anarcardiumoccidentale,* L). kernel protein isolate. *Nahrung/Food,* **45**:258-262.

Ogunwolu, S. O., Henshaw, F. O., Mock, H. P., Santos, A., & Awononorin, S. A. (2009). Functional properties of protein concentrate and isolate produced from cashew (*Anacardiumoccidentale*L.). *Food Chemistry,* **115**:852-858.

Oyedeji, O. A., Azeez, L., Adewuyi, S. O., Osinfade, B. G., & Bamimore, M. O. (2015). Flavonoid profile anthocyanin, carotenoid, sugar and vitamin composition of *Lonchocarpus sericeus* seed. *African Journal of Food Science & Technology,* **6(5)**:136-138.

Prakash, V., & Narasinga, R. M. S. (1986). Physico-chemical properties of oilseed proteins. *CRC Critical Review in Biochemistry,* **20**:265-363.

Sathe, S. K., Despande. S. S. & Salunkhe, D. K. (1982). Functional properties of winged bean (*Psophocarpus tetragonolobus L*) protein. *Journal of Food Science,* **47(2)**:503 -509.

Shahidi, F., Chavan, U. D., & Mckenzies, B. B. (2001). Functional properties of protein isolate from beach pea (*Lathyrus maritimus L*). *Food Chem*istry, **74**:177-187.

Sujak, A., Koltlarz, A., & Strobel, W. (2006). Composition and nutritional evaluation of several lupin seed. *Food Chemistry,* **98**:711-719.

Suleiman, A. M., Hassan, B. A., Osman, A. G., El-Tyeb, M. M., El-Khalil, A. I. E., El-Tinay, H. A., & Babiker, E. E. (2008). Changes in total protein digestibility, fractions, content and structure during cooking of Lentil Cultivars. *Pakistan Journal of Nutrition*, **7(6)**:801-805