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## The Chemical Composition of Pigeon Pea (*Cajanus cajana*) Seed and Functional Properties of Protein Isolate

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**Abstract:** Pigeon pea obtained from Khartoum North market were milled at the milling laboratory Food Research Center in Shambat. The chemical composition and functional properties were carried out in the Food Analysis Laboratory, Department of Food Science and Technology, University of Gezira. The proximate analysis in terms (%) of moisture (8), crude protein (21), crude fat (1.7), ash (3.2) and fiber contents (2.5). A protein isolate from defatted Pigeon pea seed flour was extracted and evaluated for its functional properties. The water retention capacity of the isolate (250.3 ml/100 g). The fat absorption capacity was (130 ml/100 g). At the pH 3 gave the highest foam volume (130%). The emulsification capacity (120%) was highest at the pH 4.5 was recorded. Other functionalities such as formation of gels are also reported. Pigeon pea seed protein isolate can be considered of great potential for incorporation into human food products in the Sudan as well as for promotion the functional property in different food.

**Key words:** Pigeon pea, food protein, fat absorption capacity

### INTRODUCTION

World demand for proteins is increasing and so more food protein is required from both conventional and new sources of protein. Accepting that all proteins will have nutritional value, then in both cases successes in the food industry, requires that the protein have good functional properties to be acceptable as a food ingredient.

Market potential for new proteins is great both for supplementation of existing foodstuff and fabrication of new food-stuff. Therefore very important for protein biochemist to understand what functional properties are and how they can be improved in both existing proteins and new proteins.

No one legume or cereal can provide adequate amounts of all nutrients to meet the nutritional requirements of a child. However, even before knowledge on protein content, protein quality, digestibility and the nutrient requirements of humans, to become available it was recognized that mixing legumes with cereal in the diet could improve overall nutrition. The present and newly drive knowledge in these area makes it possible into blend, mix or fortify one food material with others, so that the resulting fortified mix has not only better nutritional quality but also the necessary attributes for consumer acceptance (Hickey and King, 1997).

The plant proteins have been widely used as meat and cereal extenders in recent years nutritional adequate and the unique functional properties of these proteins. However, plant proteins perform an important role in the world food supply.

Pigeon pea is a member of the family Fabaceae. The cultivation of the pigeon pea goes back at least 3000 years. The centre of origin is most likely Asia, from where it traveled to East Africa. Today pigeon peas are widely cultivated in all tropical and subtropical regions of both the old and new world, with temperature range 20-40°C.

In Sudan is traditionally grown along irrigated channel in Gezira, central Sudan or demarcate small farm holding in north Sudan along the Nile.

The objectives of this study were as follows:

- To examine the chemical composition of pigeon pea
- To examine the functional properties of pigeon pea seed protein isolate.
- Focus attention and its compatibility in food system.

### MATERIALS AND METHODS

**Source of material:** Pigeon pea obtained from Khartoum North market were milled at Food Research Center in Shambat. The chemical composition and functional properties were carried out in the Food Analysis Laboratory, Department of Food Science and Technology, University of Gezira.

**Sample preparation:** Pigeon pea seeds were washed and dried before milling and pass through a 60mm mesh sieve (British Standard), the flour was extracted from defatted flour with n-hexane in a sox let for 9 h at room temperature (27±2°C).

**Proximate analyses:** Proximate analysis was carried out on raw pigeon pea flour for moisture content, crude protein (Kjeldahl method), crude fat (sox let extraction), crude fiber and ash were determined according to AOAC (1984). Total carbohydrate was obtained by difference.

**Determination of water and oil absorption capacity:** Water absorption capacity was determined using the method of Sathe and Salunkhe (1981) with slight modifications. 10 mL of distilled water was added to 1.0 g of the sample in a beaker. The suspension was stirred using a magnetic stirrer for 5 min. the suspension obtained was thereafter centrifuged at 3555 rpm for 30 min and the supernatant measured in a 10 mL graduated cylinder. The density of water was taken as 1.0 g/cm<sup>3</sup>. Water absorbed was calculated as the difference between the initial volume of water added to the sample and the volume of the supernatant. The same procedure was repeated for oil absorption except that oil was used instead of water.

**Determination of the gelation concentration:** The least gelation concentration was determined by the method of Sathe and Salunkhe (1981). East tubes containing suspensions of 2, 4, 6, 8 up to 20% (w/v) flour in 5 ml distilled water were heated for 1 h in boiling water, followed by cooling in ice and further cooling for 2 h at 4°C. The least gelation concentration was the one at which the sample did not fall down or slip when the test tube was inverted.

**Determination of foaming properties:** The foam capacity and stability were studied by the method of Coffman and Garcia (1977). A known weight of the mucuna sample was dispersed in 100 mL distilled water. The resulting solution was homogenized for 5 min at high speed. The volume of foam separated was noted. The total volume remaining at interval of 0.00, 0.30, 1, 2, 3, 4 up to 24 h was noted for the study of foaming stability.

$$\text{Foaming capacity (\%)} = \frac{\text{Vol. after homogenization} - \text{Vol. before homogenization}}{\text{Vol. before homogenization}} \times \frac{100}{1}$$

$$\text{Foaming stability (\%)} = \frac{\text{Foam volume after time (t)}}{\text{Initial foam volume}} \times \frac{100}{1}$$

**Emulsion capacity:** The emulsion capacity and stability were studied by the method of Coffman and Garcia (1977).

Emulsions were formed inside a 600 ml beaker using a continuous stirring apparatus. The apparatus consisted of a regulated/ stabilized 6 V power supply, burette, a stirrer, a beaker with emulsion and a digital millimeter. The stirrer was made up of stainless steel rod holding a Perspex bridge was fixed to a 6 V D.C. motor spindle by means of a plastic adaptor. The motor itself was

driven by a regulated and stabilized 6 V D.C. power supply. The millimeter monitored the current drop by the stirrer motor to maintain a constant speed. The greater the viscosity of the emulsion, the greater will be the current drawn. The protein sample (0.2, 0.5, 0.75, 1.00 and 1.25 g) was dissolved in 25 ml of distilled water making 1, 2, 3, 4 and 5% Slurries (w/v), respectively. Necessary pH adjustment was made to ensure maximum solubilization of the protein. The mixture was stirred for 30 min in order to disperse the sample. Oil was then added at a rate of 1.00 ml/s from a burette until emulsion collapsed indicated by a shape fall in motor current. The volume of oil added up to inversion point was noted and the emulsion capacity expressed as ml oil per g of sample. The emulsion stability was determined by allowing the emulsion prepared to stand in a graduated cylinder and the volume of oil separated at time of 0.00, 0.5, 1, 2, 3 up to 24 h was noted each case. The emulsion stability was determined by following the procedure used for emulsion capacity except that 100 ml of oil was added rather than adding oil until the emulsion breakdown.

The good capacity of FRC pigeon pea seed protein isolate qualifies for use in products such as confections, soups and sausage emulsions.

Wet ability was estimated according to the method of Coffman and Garcia (1977).

Two grams isolate powder were weighed in a sieve (20 mech) and transferred to a beaker containing 80 ml. distilled water without stirring the water. The behavior of the powder was observed on the water surface immediately after adding the sample. After 30 min. observation, the material was stirred sufficiently fast enough to form a vortex to reach the bottom of the beaker. The stirring continued for one min. after which the grade describing wet ability was recorded as excellent, good fair or poor according to the time and behavior of the dispersion.

## RESULTS AND DISCUSSION

**Chemical composition:** The results of proximate analysis of the pigeon pea flour are shown in Table 1. The pigeon pea is higher content of protein (21%). The protein content was within the range of 19-23% as reported by Duke (1981). The moisture content is in the range of 8-15% that was reported by NAS (1980).

**Water retention capacity (WRC):** WRC of Pigeon pea seed protein isolate was (250.333 ml/100 g) (Table 2). This result of protein isolate is similar to value reported by Lin *et al.* (1987) on sunflower meal products and less than the value of watermelon (320 ml/100 g) reported by Hayat *et al.* (1999). These result less than double the value (140) reported by Elkhatim (1994) for cottonseed protein isolate. The WRC was reported to increase with increasing level of protein content (Rhee *et al.*, 1981; Kinsella, 1979; Lin and Leeder, 1974).

Table 1: Proximate chemical composition of pigeon pea

Component	Percentages
Moisture	8.0
Protein	21.0
Fat	1.7
Fiber	2.5
Ash	3.2
CHO by difference	

Table 2: Water and oil absorption of pigeon pea protein isolate

	Pigeon pea	
	Protein (g/100 g)	Average
Water absorption	250	250.3
	252	
	249	
Oil absorption (%)	131	130
	129	
	130	

WRC is a critical function of protein various food products like soups, dough and baked product (Sosulski *et al.*, 1976).

**Fat absorption capacity (FAC):** The result of FAC are presented in Table 2. The FAC is (130 ml/100 g). The value of FAC differ depending of the nature of the oil used for the study (Booma and Prakash, 1990). Akobundu *et al.* (1982) reported a value of 2.1 ml/g FAC watermelon seed flour and 2.1 ml/g for cottonseed protein isolate and 2.3 ml/g for egg protein. FAC of casein was 0.7 ml/g as reported by Booma and Prakash (1990).

**Emulsion capacity:** The EC of Pigeon pea seed protein isolate was more efficient in emulsifying the oil at the pH 4.5 (120 ml oil/g isolate) (Fig. 1). Ramanatham *et al.* (1978) reported that groundnut and soy protein isolate were more efficient in emulsifying oil at pH 3.0 (100 ml oil/g sample) than at alkaline pH 8.0 (82 oil/g sample). The experimental conditions, such as equipment design, shape of the container, temperature, speed of blending, nature of blades in the blender, rate and mode of addition, pH, protein, solubility, concentration, preence of salt and water, would all individually contribute to the emulsifying capacity of proteins (Kinsella, 1976). The Emulsion Stability (ES) of the isolate taken at the time is 0.25, 0.5, 0.75, 1, 2, 12, 24, 48h, this suggests the isolate has stable activity which is not affected by heat treatment (Fig. 2). The decrease of emulsion increase when the time (h) increase.

**Foaming capacity:** The effect of pH on FC is shown in Fig. 3. Maximum increase in foam volume (170) was observed at the pH 3. The FC of cottonseed protein isolate was found to be better at pH 7.0 than at pH 4.0 while its maximum solubility was at pH 7. The FS of Pigeon pea seed protein isolate taken at extreme pH 3, 4.5, 6, 7.5 and 9 presented in Fig. 4. It can be seen that the falling rate of FS at the pH 3 compared with the others pH. Generally the FS decreased gradually at the first min standing as about 50% of the initial foam

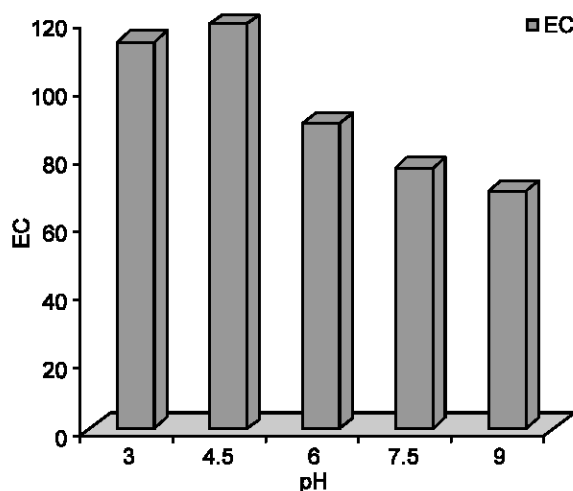


Fig. 1: Emulsion capacity

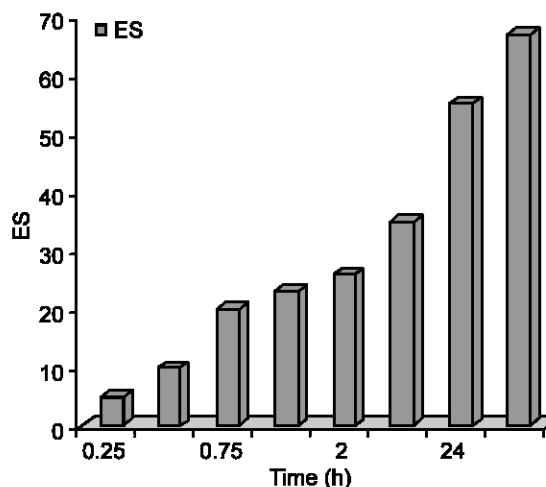


Fig. 2: Emulsion stability

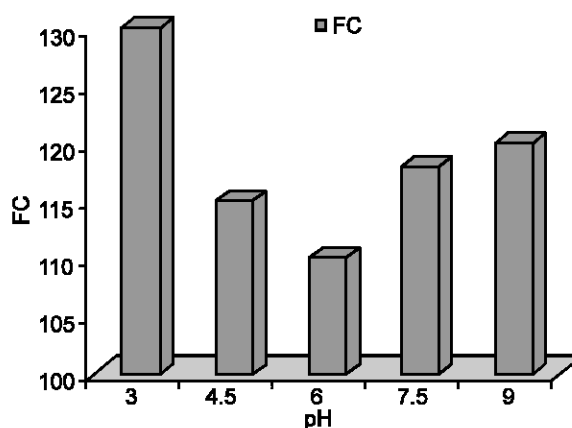


Fig. 3: Foaming capacity

collapsed. After 15-20 min standing the remaining foam was stable nearly for one hours.

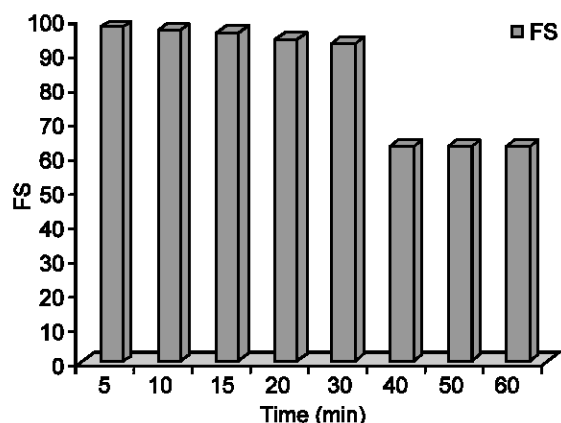


Fig. 4: Foaming stability

Table 3: Least gelation concentration (%) of pigeon pea protein isolate

Sample	Concentration (%) at nitrate pH	Gel formation
Pigeon pea	2-14	Liquid
	16 and above	Viscous

Having seed foaming properties, may be useful for in food systems to improve textural and leavening characteristics such as ice-cream, cake topping and confectionery products.

**Gelation:** The gelling property of pigeon pea protein isolate was determined at various solid desparation concentration. Gelling of protein depends on protein concentration; pH balance of cat ions and anions (Meganne and Ralph, 1987). Viscous gel formation did not occur at below a concentration 16% at neutral pH show that at Table 3.

The gelation formed at 16% these values compared favorably with those reported for African yam bean (16 to 20% by Abbey and Ayuk, 1991).

Gelation properties are interrelated to water absorption capacities hence the low water absorption capacity recorded by the protein isolates flours could explain the deficient gel formation capacity. Gelation takes place more readily at higher protein Concentration because of greater intermolecular contact during heating. High protein solubility is always necessary for gelation as Observed by Wiltoon *et al.* (1997).

**Wettability:** The wettability of the pigeon pea protein isolate was good since is took 27 min. for complete wetness. This time of witting was less than that of watermelon protein isolate reported by Hayat *et al.* (1999) and also less than cotton seed protein isolate reported by Elkhatim (1994).

**Conclusion and recommendations:** (WAC) of pigeon pea protein isolate is highly show that in Table 2. This is a critical function to great use in bakery products.

The pigeon pea protein isolate added at various ratio to produced ice cream due to its highly foaming properties at neutral pH show at Fig. 3 and 4.

The high protein content of the pigeon pea, could be used as a protein supplement to increase the protein content of any convenience food making a highly nutritious probably low cost product.

In addition to the nutritional contribution, the pigeon pea and protein isolate was found to exhibit some good functional properties which it a possible good quality protein source for food application for instance. The high solubility of the isolate of both acidic acid position in terms of being used as functional ingredient for its emulsification, foaming, water and gelling properties in various food systems such as meat products, salad dressing, dairy product etc.

The possible used of the protein isolates can be summarized as follows:

- It could be incorporated into liquid food and beverage due to its good solubility at both the acidic and alkaline pH.
- The water retention capacity of the isolate makes it of great use in bakery products as well as in meat product.
- The fat absorption capacity for the isolate allows its use in sausages where it can be a good alternative to casein.
- The isolate can be used to enhance and stabilized fat emulsion in chapped and comminuted meats, cake batters, milk, mayonnaise and frozen desse.
- It could also be used in whipped toppings, chiffon deserts and ice cream specialties due to its foaming proprieties.
- Its gelation properties can be utilized in cheese and other milk products.
- Its good wettability allows its use in texture and/or comminuted meats as well as bakery product.

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