Available online at www.sciencedirect.com
SCIENCE DIRECT®
Food Chemistry 92 (2005) 681–691
Food Chemistry
www.elsevier.com/locate/foodchem

On the functional properties of globulin and albumin protein fractions and flours of African locust bean (*Parkia biglobossa*)

O.S. Lawal [a,*], K.O. Adebowale [b], B.M. Ogunsanwo [a], O.A. Sosanwo [a], S.A. Bankole [c]

[a] *Department of Chemical Sciences, Olabisi Onabanjo University, P.M.B 2002, Ago-Iwoye, Ogun State, Nigeria*
[b] *Department of Chemistry, University of Ibadan, Ibadan, Nigeria*
[c] *Department of Biological Sciences, Olabisi Onabanjo University, P.M.B 2002, Ago-Iwoye, Ogun State, Nigeria*

Received 8 March 2004; accepted 31 August 2004

Abstract

Albumin (ALBa) and globulin (ALBg) fractions of African locust bean were isolated and the functional properties were compared with its defatted (ALBdf) and undefatted flours (ALBf). Albumin had minimum % solubility (56.7%) at pH5, while minimum solubility was observed at pH4 for globulin and the flours. In all the samples studied, maximum solubility was observed at pH 10. A pH-dependent gelation study revealed that all of the samples had the highest least gelation concentration at pH10 apart from ALBf which had 16% w/v LGC at pH 2. Initial increase in ionic strength of the medium, to 0.4 and 0.6 M, enhanced the gelation capacity of protein fractions and flours, respectively, while further increase in ionic strength reduced it. Oil absorption capacity was maximal in ALBa while ALBf had the least value of 1.05 ml/g. Initial increase in ionic strength, up to 0.4 M, increased the water absorption capacity (WAC) of albumin fractions while WACs of the globulin fraction and flours were reduced when the ionic strength of the media reached 0.4 M. Foam capacity increased as the concentration of protein solution increased but was reduced by 6% w/v in ALBf. Initial increase in ionic strength enhanced both foam capacity and stability. Maximum EA was observed at pH 10 in all samples apart from ALBf, which reached a peak EA value at pH 2. ES (emulsion stability) was maximal at pH 10 for ALBa and ALBg while the same values were observed for ALBdf and ALBf at pH 2 and 10. Increasing the ionic strength, to 0.4 M, enhanced the EA and ES of ALBa while further increase in ionic strength, to 0.7 M, improved EA of ALBf but reduced the ES. Both EA and ES of ALBf reached peak values in 0.2 M solutions but no fixed pattern was observed in the response of ALBdf to various ionic strengths of the solutions.

Keywords: Functional properties; Albumin; Globulin; African Locust bean

1. Introduction

In Africa, where the per capita consumption of essential diet any components is generally very low, legumes represent the major source of proteins (Araujo et al., 2002). Although the production of grain legumes is relatively small when compared to cereals, they make a greater relative contribution to human nutrition (FAO, 1980). However, previous studies have revealed that some legumes are still underutilized (Adebowale & Lawal, 2003, 2004; Lawal & Adebowale, 2004). African locust bean, a leguminous tree plant that grows naturally in the tropical forest and savannah belt of Nigeria, is known to produce abundant seeds that are only utilized as food condiment (Lawal, 2004).

In legume seeds, globulins (7S vicilins and 11S legumins) account for 30–80% of the total seed protein, with albumin constituting the remainder (Derbyshire, Wright, & Boulter, 1976; Mackuka, 2000; Peterson,

* Corresponding author. Tel.: +234 8028293036.
E-mail address: laidelawal2@yahoo.com (O.S. Lawal).

0308-8146/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodchem.2004.08.043

1987; Borroto & Dure, 1987; Gorinstein, Zemser, Fiedman, Vasco-Mendez, & Paredes-Lopez, 1996).

A typical seed storage protein occurs as oligomers composed of two or more subunits that are in turn made up of a number of polypeptide chains. In the report of Bewley and Black (1994), 7S vicilins and 11S legumins in legumes were found to consist largely of multisubunit complexes with molecular masses of 145–190 and 320–400 kDa, respectively. Also, the legumins consist of six non-identical subunits (52–65 kDa), with each subunit containing an acidic (33–42 kDa) and a basic (19–23 kDa) polypeptide. Proteins within the albumin class are more diverse, both structurally and functionally (Ward, Uknes, & Ryals, 1994).

The use of plant proteins as food hydrocolloids is based on their functional properties, such as emulsification, solubility, foaming properties, water and oil absorption capacities and gelling properties (Kinsella & Phillips, 1989). Also, it is expedient to study these functional properties in relation to the prevalent environment of the protein, and pH and ionic strength are paramount (Myers, 1988; Aluko & Yada, 1995). Extensive literature has been published on protein functionality in relation to pH, ionic strength, varying protein concentration, presence of various salts and presence of other food hydrocolloids (Schwenke, 2001; Prakash, 1986; Mitchell, 1986; Shimizu, Saito, & Yamauchi, 1985; McWatters & Holmes, 1979). These efforts were aimed at effective utilization of inexpensive proteins for nutritional and functional purposes.

In previous studies, functional properties of plant protein fractions (globulin and albumin) have been reported. These include: pea (Koyoro & Powers, 1987), cowpea (Aluko and Yada, 1985), lentil (Bora, 2002), rapeseed (Gueguen, Bollecker, Schwenke, & Raab, 1990), canola seed (Gruener & Ismond, 1997) and great northern bean (Sathe & Salunkhe, 1981a; Sath & Salunkhe, 1981b).

The purpose of this study was to determine the functional properties of globulin and albumin fractions of African locust bean protein and its flours. Specifically, protein solubility, gelation, water and oil absorption capacity, foaming and emulsifying properties were studied in relation to the effects of pH, ionic strength, and various protein concentrations.

2. Materials and methods

2.1. Materials

African locust beans were bought from Bodija market in Ibadan, Nigeria. The seeds were identified at the International Institute of Tropical Agriculture Ibadan. All other chemicals used were of analytical grade.

2.2. Preparation of flours

Foreign objects in African locust bean were removed by picking, following which they were ground to pass through a BS-60 mesh screen. A flour mill (Braun multimix Deluxe Germany) was used for the milling; 0.5 kg of the flour was defatted with hexane for 16 h under constant shaking. The hexane was changed four times to enhance removal of fat, following which the solvent was decanted and the flour air-dried. Another 0.2 kg flour was left undefatted for comparative experiments.

2.3. Fractionation of albumin- and globulin-enriched fractions

Globulin and albumin were prepared using the method described by Rudger (1993), as modified by Mackuka (2000). Defatted African locust bean flour was extracted with 0.05 M tris-HCl buffer (pH 8.0) containing 0.1 M NaCl, 1 mM $CaCl_2$ and 1 mM $MgCl_2$ in a ratio of 10 ml buffer/g of flour for 3 h at 4 °C. The slurry was centrifuged at 20,000*g* for 30 min at 4 °C and the supernatant filtered through Whatman number 1 paper. The pH of the filtrate was adjusted to 4.5 by slowly adding 1 M acetic acid and the proteins were recovered by centrifugation at 19,000*g* for 20 min at 4 °C. The precipitate obtained was resuspended in distilled water and lyophilised as the globulin fraction. The albumin-enriched supernatant solution was adjusted to pH 8.0 with 1 M NaOH, dialysed against distilled water for 48 h, and lyophilised.

2.4. Protein solubility profile

The method of Were, Hettiarachchy, and Kalapathy (1997) was employed for the determination of pH-dependent solubility, profile. One hundred and twenty five milligrammes (125 mg) of the sample were dispersed in 25 ml of distilled water and the solution pH was adjusted to 2–10, using 0.5 M NaOH or 0.5 M HCl. The slurries were mixed for 1 h at 24 °C, using a magnetic stirrer before centrifuging at 12,000*g* for 20 min at 4 °C. The supernatant was filtered through glass wool to obtain a clear solution. Protein content in the supernatant was determined by the Kjeldahl method. Triplicate determinations were carried out and solubility profile was obtained by plotting averages of protein solubility (%) against pH. The percentage soluble protein was calculated as follows:

$$\text{Solubility (\%)} = \frac{\text{Amount of nitrogen in the supernatant}}{\text{Amount of nitrogen in the sample}}.$$