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Functional properties of peanut protein isolates

TAMBA S. SONDA AND SANPHA KALLON

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Both developed and developing nations are today faced with continuous threats posed by the emergence of contagious animal diseases that have had and may continue to have serious health consequences on the world population. Considering the fact that animals are our traditional protein sources and that they are becoming more and more expensive, it is important for scientists to intensify research into alternative and affordable protein sources. Peanut is a rich and underutilized protein source that is cultivated worldwide. However, most peanuts grown are principally used for oil production, confectionaries and peanut butter (Tate *et al.,* 1990). According to Basha and Pancholy (1982) the extraction of vegetable oil from peanut yields partially defatted peanut flour (PDPF) which is essentially a protein-rich, inexpensive and underutilized by-product of the peanut industry.Functional properties of peanut protein have been the subject of limited studies that focused mainly on peanut flour (Prinyawiwatkul *et al.,* 1993) and limited information is available in the literature on the development and functionality of peanut protein isolate (PPI) as affected by oil extraction method. Therefore, the objectives of this study were to develop a protein isolate from defatted peanut meal flour obtained from two different oil extraction methods and study the functional properties of the peanut protein isolates as indicators of their potential use by the food industry; and evaluate the effects of oil extraction methods on the functionality of peanut protein isolate.

Protein-energy malnutrition is becoming prevalent in third world countries as animal protein sources (our traditional protein source) become more and more expensive. It therefore becomes important for food scientists and other responsible organizations to explore cost-effective and affordable plant protein sources so as to combat the growing occurrence of protein-energy malnutrition in developing countries. This study therefore seeks to explore nutritionally functional protein sources from by-products obtained from different peanut oil extraction methods. Considering the millions of tons of by-products obtained from peanut industries, a reasonably high quantity of protein can be obtained that could be used in a variety of food formulations. This study could also be environmentally friendly as it seeks to convert potential wastes into functional and cost-effective food ingredients. Peanut industries, food processors and consumers stand to gain from the practical implementation of this work.

Cold pressed peanut meal cake and heat treated peanut meal cake were purchased from Qingdao Kerry Peanut Oil Co. Ltd. (Shandong province-China).Glucose and molecular weight standards were obtained from the

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Author for correspondence :
TAMBA S. SONDA, Institute of Food Technology, Nutrition and Consumers Studies, Schools of Agriculture, Njala University, SIERRA LEONE (WEST AFRICA)
Email : tssonda@njala.edu.sl/sondats@hotmail.com

Associate Authors' :
SANPHA KALLON, Department of Animal Science, School of Agriculture, Njala University, SIERRA LEONE (WEST AFRICA)
Email : Kallonsanpha@yahoo.com

Shanghai Branch of Sigma Co., Shanghai, PR China All other chemicals used, were of reagent grade and obtained from the chemical department of Jiang Nan University, Wuxi, P. R. China. Cold pressed and heat pressed defatted peanut meal flours were extracted in 10 per cent (W:V) suspension of water at pH 9 for 1h and used as starting materials to develop peanut protein isolates (PPI) using isoelectric precipitation and centrifugation separation methods.Protein recovery tests were conducted at different water/flour ratio to determine the conditions for optimum protein recovery. Flours obtained from both cold pressed and heated treated peanut cakes were mixed with water at varying flour to water ratios of 1/3, 1/7, 1/10, 1/12 and 1/15. The pH of each suspension was adjusted to pH 9, based on the solubility profile of protein in peanut flour, using 1.0 N NaOH and 1.0 N HCl, and stirred for 1 h at room temperature (Fig. 1). Suspensions were centrifuged and protein concentration in each supernatant was determined by Kjadhal Nitrogen Analyzer using 6.25 as conversion factor. The optimum peanut protein recovery was achieved at flour/water ratio of 1/10 and a solubilization pH of 9. These conditions were used in subsequent production of peanut protein isolates (PPI). To produce PPI for experimental analysis, defatted peanut flour (cold pressed and heat pressed) were mixed with water in the ratio of 1/10 (w/v), and pH of the mixture was adjusted to 9.0 with 1.0 N NaOH. The PPI obtained from the cold pressed and heat treated methods are referred to in this work as CPI and HPI, respectively. Particle size determination of CPI and HPI was carried out by using laser light scattering and Quanta-200 for scanning electron microscope. Thermal characteristics of protein samples (CPI and HPI) were determined with a Perkin-Elmer differential scanning calorimeter (DSC).The solubility of both CPI and HPI were estimated at varying pH levels by using a modified form of the method described by Wu *et al.* (1998). Water absorption properties (WAP) were determined using the method outlined by Tang (2007), with some modifications. Oil absorption property was determined using the method of Chakraborty (1986). Emulsifying activity and stability indices were determined using the method of Neto *et al*. (2001). Molecular weight distributions of HPI and CPI were determined by gel permeation chromatography (GPC) using a Size-Exclusion High-Performance Liquid Chromatography (SE-HPLC) system (waters 600, USA).

The Scanning Electron Micrographs show that oil extraction method contributed to differences in particle sizes of CPI and HPI. Isolates obtained from heat treated method had relatively larger particle sizes compared to those obtained from the cold-pressed method. This difference may have occurred to due to protein denaturation and/or the formation of a protein-polysaccharide conjugate during heat treatment.Table 1 shows that HPI demonstrated an early onset temperature compared to CPI. This indicates that HPI started undergoing denaturation earlier than CPI. The ΔH value calculated from the area under the transition peak is more favorable for CPI than CPH as the former recorded significantly ($P \leq 0.05$) lower ΔH value (0.36±0.02 J/g) than the latter. The difference in ΔH value may have been influenced by the different oil extraction methods.At all pH levels CPI was slightly more soluble than HPI. This

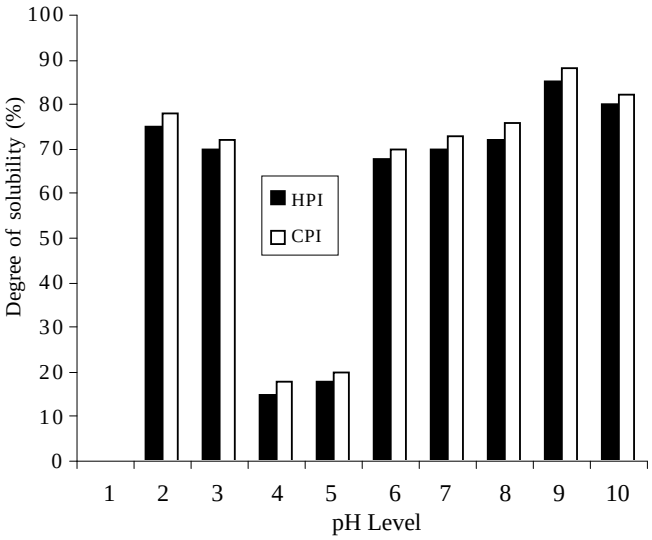

Fig. 1 : Protein solubility of CPI and HPI at different pH levels

Table 1: Protein denaturation profile with differential scanning calorimetry (DSC)

Samples	Phase transition parameters[a]			
	T_0 (°C)	T_P (°C)	T_C (°C)	ΔH (J/g)
CPI	72.71±0.13^A	78.42±0.10^A	81.76±0.12^A	0.36±0.02^A
HPI	61.00±0.07^B	71.65±0.13^B	82.91±0.15^B	4.15±0.11^B

[a] Onset temperature (To), transition temperature peak (Tp), conclusion temperature (Tc);
Data are the means ±SD, n = 3. Samples means with different superscript letters in the same column are significantly different at $P \leq 0.05$.

is in agreement with findingsof other researcher who reported that heating full fat peanut seed in water at 100–120° C for 15 min decreased protein solubility. This decrease can be attributed to the effect of heating which resulted in an increase in surface hydrophobicity of protein due to unfolding of molecules upon the application of heat and molecular size through hydrophobic interactions and disulfide formation. CPI demonstrated better emulsifying properties (both EAI and ESI) than HPI. The emulsifying properties of HPI and the commercial soy protein isolate were not significantly different ($P \leq 0.05$). Emulsifying properties of CPI and HPI reflected their solubility patterns. CPI demonstrated better whipping properties than HPI. However, in terms of foam leakage no significant difference ($P \leq 0.05$) was observed between CPI and HPI. Data obtained in this study show that heat pressed oil extraction method reduced both water and oil absorption properties of HPI. The decreased water and oil absorption properties of HPI could be due to irreversible denaturation caused by heating which might have destroyed both hydrophilic and hydrophobic groups of peanut protein, thus reducing both water and oil absorption properties. Results show that HPI had a higher molecular weight distribution than CPI. Heat treatment breaks intermolecular disulfide bonds in proteins and allows the proteins to unfold. Then the unfolded bonds interact and form intermolecular disulfide and hydrophobic bonds. This may polymerize the protein thereby resulting in the formation of high molecular weight aggregates. CPI recorded higher protein (≈90%) and carbohydrate (≈5%) values than HPI. No significant differences were recorded for the fat contents of CPI and HPI ($P \leq 0.05$). This further indicates that oil extraction method, to some extent, can contribute to different in the biochemical components of the by-product (peanut cake).

Peanut protein isolates extracted from the two oil extraction methods demonstrated relatively good solubility potentials in both acidic and alkaline pH regions, which can serve as important characteristics for food formulations. CPI showed better functional properties (such as EAI, ESI, FAP, WAP, solubility, etc.) than HPI. On the whole, protein isolates extracted from peanut cakes, an inexpensive by-product of peanut oil industries, can serve as an economic advantage to peanut oil industries, as they have the potential of adding value to the peanut industries by providing food processors with affordable source of plant proteins with unique flavour and functional characteristics.

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