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Review

Pulse proteins: Processing, characterization, functional properties and applications in food and feed

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ABSTRACT

Pulses (pea, chickpea, lentil, bean) are an important source of food proteins. They contain high amounts of lysine, leucine, aspartic acid, glutamic acid and arginine and provide well balanced essential amino acid profiles when consumed with cereals and other foods rich in sulphur-containing amino acids and tryptophan. The protein content of most pulse legumes fall within the range of 17–30% (d.w.b.). Apart from their nutritional properties, pulse proteins also possess functional properties that play an important role in food formulation and processing. Examples of such functional properties include solubility, water and fat binding capacity and foaming. Various research studies indicate that some functional properties of pulse proteins may be comparable to those of other frequently used proteins such as soy and whey. The functional properties of pulse proteins have been exploited in the preparation and development of products such as bakery products, soups, extruded products and ready to eat snacks. The growing body of research on the health benefits associated with the consumption of pulses has increased interest in developing innovative technologies to expand the use of pulses in food products. At the same time, there are growing global food security challenges and protein malnutrition continues to be a problem in many countries around the world. Pulses, especially when blended with cereal proteins, may offer a promising alternative source for nutritional and functional proteins. This review provides an overview of the characteristics of pulse proteins, current and emerging techniques for their fractionation, their major functional properties and opportunities for their use in various applications.

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1. Introduction

Pulses constitute an important source of dietary protein for large segments of the world's population particularly in those countries in which the consumption of animal protein is limited by nonavailability or is self-imposed because of religious or cultural habits (Liener, 1962). Pulses provide energy, dietary fibre, protein, minerals and vitamins required for human health. Recent research studies suggest that consumption of pulses may have potential health benefits including reduced risk of cardiovascular disease, cancer, diabetes, osteoporosis, hypertension, gastrointestinal disorders, adrenal disease and reduction of LDL cholesterol (Hu, 2003; Jacobs & Gallaher, 2004; Philanto & Korhonen, 2003; Tharanathan & Mahadevamma, 2003). Such studies have contributed significantly to a growing awareness of the usefulness of including pulses in the diet and a steady rise in interest in using pulses and ingredients derived from them in the development of novel food products, especially in North America. From the nutritional perspective, pulses are of particular interest because they contain high amounts of protein (18–32%). In addition to providing a source of essential amino acids and bioactive peptides, pulse proteins possess functional properties such as water holding, fat binding, foaming and gelation which could expand their potential use in the development of a wide variety of food products.

World protein requirements continue to be a global issue with heightened concerns about food security and protein malnutrition. In 1997 the Food and Agriculture Organization of the United Nations (FAO) estimated that over 800 million people in the developing world were undernourished (Blandford & Viatte, 1997). Today the figure is higher. The World Bank estimates there are currently 967 million malnourished people in the world (http://www.reliefweb.int/rw/rwb.nsf/db900SID/MCOI-7KGM87?OpenDocument). Moreover, an estimated 149.6 million children younger than 5 years are malnourished in terms of weight for age. In south central Asia and eastern Africa, about half the children have growth retardation due to protein–energy–malnutrition (PEM), a syndrome resulting from inadequate supplies of protein and other macro and micronutrients (http://emedicine.medscape.com/article/1104623-overview). Programs such as the World Food Program, the Millennium Hunger Task Force and the New Partnership for Africa's Development (NEPAD)-Hunger Taskforce are undertaking School Feeding Programs aimed at providing adequate nutrition to children and malnourished communities globally. Most hungry and undernourished people live on a mono carbohydrate diet (e.g., maize or rice) and lack the required protein, fat, vitamin A, iodine, zinc and iron. The potential for blending pulses such as pea, chickpea, lentil and beans with other locally grown grains to meet some of the protein malnutrition problem worldwide is, therefore, of tremendous interest.

This paper will attempt to provide a review of the nutritional and functional properties and the current and potential applications of proteins from pulses. The paper will focus specifically on pea, chickpea, lentil and bean. A brief summary of the protein quality of pulse legumes is provided along with the processing technologies available for their fractionation and processing into protein flours, concentrates and isolates. The paper will also briefly address the possible use of pulses as an alternative to priority allergens such as soybean, gluten, dairy, eggs and nuts. As reports in the literature have shown that pulse proteins may themselves be allergenic, a short summary of the body of knowledge on the allergenic properties of pulse proteins is also presented.

2. Composition, molecular characteristics and nutritional quality of pulse proteins

The proximate composition of different pulses is presented in Table 1. Pea, chickpea, bean and lentil contain 17–30% protein with varying concentrations of essential amino acids (Sathe, Deshpande, & Salunkhe, 1984). The major proteins found in pulses are globulins and albumins. Albumins are water soluble and comprise enzymatic proteins, protease inhibitors, amylase inhibitors and lectins and have molecular masses (MM) ranging between 5000 and 80,000 Da. Globulins on the other hand are salt soluble. The major globulins found in pulse legumes are legumin (11S) and vicilin (7S). The 11S and 7S storage proteins of pulses are built of polymorphic subunits encoded by multigene families (Schwenke, 2001 and references within). 11S legumins have hexameric quaternary structures with acidic (MM of ~40,000 Da) and basic (MM of ~20,000 Da) subunits. The 7S vicilins have a trimeric structure with MMs of 175,000–180,000.