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Nutritional and antinutritional evaluation of raw and processed seeds of a wild legume, *Canavalia cathartica* of coastal sand dunes of India

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Abstract

Seeds of a wild legume, *Canavalia cathartica* collected from coastal sand dunes of the southwest coast of India were processed (roasted and cooked) and analyzed for proximate composition, mineral constituents, protein fractions, amino acid profiles, fatty acids and some antinutritional factors. Raw, roasted and cooked seeds contained 35.5%, 30.5% and 29.2% crude protein; 52.8%, 65.3% and 65.4% crude carbohydrates; 1.3%, 1.4% and 1.4% crude lipids; 1.7%, 1.6% and 1% crude fibre and 3.1%, 3% and 3.1% ash, respectively. Among the minerals, potassium was the highest (895, 821 and 190 mg/100 g), followed by phosphorus (137, 112 and 99 mg/100 g) and calcium (84, 70 and 44 mg/100 g). Among the true protein fractions of raw seeds, globulins (18.3 g/100 g) and albumins (7.3 g/100 g) were the major seed proteins. Essential amino acids, threonine, valine, methionine + cystine, isoleucine, leucine, phenylalanine + tyrosine and lysine, were above the FAO/WHO pattern in raw seeds. In roasted and cooked seeds, essential amino acid score ranged between 54 (threonine) and 224 (methionine). Essential amino acids, leucine, phenylalanine and lysine, in raw seeds were more than those of whole egg protein, soybean and rice. Total phenolics slightly declined in cooked seeds. Seeds did not possess tannins and trypsin inhibitors. Proteins of raw seeds possessed strong hemagglutination activity, which was lowered in processed seeds. The current study demonstrated that seeds of *C. cathartica* were high in protein, essential amino acids and low in saturated fatty acids and anti-nutritional factors.

Keywords: *Canavalia cathartica*; Sand dunes; Wild legume; Nutritive value; Proteins; Amino acids; Saturated fatty acids; Roasting; Cooking

1. Introduction

Malnutrition in children and lactating women in developing countries is common, due to inadequate supply of protein diets, and this is of great concern to scientists and governments (Coulter et al., 1988; Olsen, 1975; Pelletier, 1994). Such protein requirements, where animal protein is inadequate, can be compensated using wild legumes adapted to adverse conditions (Amubode & Fetuga, 1983; Rao, 1994; Siddhuraju, Vijayakumari, & Janardhanan, 1992; USNAS, 1975; Vadivel & Janardhanan, 2001). Even though many wild legume plant species have been identified, their utilization is limited due to lack of nutritional information (Viano et al., 1995; Vijayakumari, Siddhuraju, & Janardhanan, 1994). Investigations on economically viable wild legumes as alternative foods broaden the protein sources for human nutrition. Adaptation to adverse environmental conditions, resistance to pests and adequate nutritional qualities are the major advantages of wild legumes (Maikhuri, Nautiyal, & Khali, 1991). Attempts

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have been made to explore the nutritional status of wild legumes in India (Janardhanan & Nalini, 1991; Maikhuri et al., 1991; Mohan & Janardhanan, 1995; Pandey & Srivastava, 1990; Rajaram & Janardhanan, 1991; Siddhuraju, Vijayakumari, & Janardhanan, 1995).

Canavalia cathartica was the most common wild legume on the Coastal Sand Dunes (CSDs) of the southwest coast of India (Arun, Beena, Raviraja, & Sridhar, 1999). Coastal fisher folk occasionally utilize tender pods under conditions of severe shortage of food. There are insufficient data on the nutrient status of *C. cathartica* although some species of *Canavalia* have been evaluated (Bressani, Brenes, Gracia, & Elias, 1987; Ekanayake, Jansz, & Nair, 1999, 2000; Rajaram & Janardhanan, 1992a). Besides distribution of *C. cathartica* on the CSDs, it is also widely distributed in plantations adjacent to CSDs as well as in mangrove habitats. Due to lack of information on the nutritional potential of *C. cathartica* of coastal sand dunes, the current study emphasizes the proximate composition, mineral constituents, proteins, amino acids, fatty acids and antinutritional qualities of raw and processed seeds. Seed processing followed includes, household roasting and cooking in view of convenience, saving cooking fuel and enhancement of nutritive value for coastal dwellers of developing countries.

2. Materials and methods

2.1. Seed samples and processing

Dried seeds of *C. cathartica* Thouars were obtained from coastal sand dunes of Thalapady (12°45′ N, 74°45′ E), west coast of India, during the summer (February–March, 2002). The seeds were sun-dried for three days. Mean weights and dimensions of seeds were determined. Seeds were divided into three parts. The first set of the seeds was cut and dehulled, milled (30 mesh) and stored in air-tight glass containers and designated as raw seed samples. The second set was roasted on a sand bath at 180 °C for 20 min. After attaining room temperature, roasted seeds were cut, dehulled, milled and stored. A third set of seeds was cut and dehulled. The cotyledons were soaked in freshwater for 1 h and subsequently cooked in a pressure cooker for 30 min with 1:3 (v/v) freshwater. Cooked cotyledons were sun-dried, milled and stored.

2.2. Proximate composition

Moisture content of seed powders was determined after attaining constant weight at 100 °C. Total nitrogen and the crude protein content ($N \times 6.25$) were determined by the microKjeldahl method (Humphries, 1956). Crude lipid (Soxhlet extraction), crude fibre and ash contents (gravimetric) were determined by on employing AOAC methods (AOAC, 1990). Total crude carbohydrate was calculated as outlined by Müller & Tobin (1980) [100 − (crude protein + crude lipid + crude fibre + ash)]. Gross energy (kJ) was estimated by multiplying the percentages of crude protein, lipid and carbohydrates by the factors 16.7, 37.7 and 16.7, respectively.

2.3. Mineral constituents

Seed flour was digested with concentrated nitric acid, sulfuric acid and perchloric acid (10:0.5:2, v/v) and mineral constituents (sodium, potassium, calcium, magnesium, iron, copper, zinc and manganese) were determined by atomic absorption spectrophotometry (GPC 902, Australia) by the method outlined in AOAC (1990). Total phosphorus (as orthophosphate) was determined by the ascorbic acid method after acid digestion and neutralization by phenolphthalein indicator and combined reagent (APHA, 1995). Absorbance was read at 880 nm (Bausch and Lomb Spectronic 21) with KH_2PO_4 as standard.

2.4. Protein isolates

Total protein of raw seed flour was extracted, based on the method outlined by Basha, Cherry, & Young (1976); to save the prolamine, ethanol treatment was omitted. Proteins were purified by precipitation with 20% TCA and estimated according to Lowry, Rosebrough, Farr, & Randall (1951). The albumin and globulin fractions were separated, based on Murray (1979). The rest of the pellet was treated with 80% ethanol (1:10 w/v) overnight and centrifuged (20,000*g*, 20 min); the prolamine-containing supernatant was air-dried, dissolved in 0.1 N NaOH (1:10 w/v), centrifuged (20,000*g*, 20 min) and the supernatant thus obtained was designated as glutelin. The protein fractions obtained were precipitated with TCA and redissolved in 0.2 N NaOH and protein content was determined (Lowry et al., 1951).

2.5. Proteins separation

Proteins (100 μg) were dissolved (100 μl) in buffer consisting of 60 mM tris–HCl, pH 6.8, 10% (w/v) glycerol, 2% (w/v) SDS and 10% (v/v) mercaptoethanol. Samples were boiled for 2 min at 100 °C, cooled and 2 μl 50% (w/v) bromophenol blue solution were added (Miersch, Kullertz, & Henning, 1998). Soluble protein separation was carried out using one-dimensional SDS–PAGE prepared in a 5% (w/v) stacking gel and 13.5% (w/v) separating gel (Laemmli, 1970) using a BROVIGA Mini Vertical Slab Gel Electrophoresis unit (Balaji Scientific Services, Chennai, India). Identical