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Physicochemical, functional and cooking properties of under explored legumes, *Canavalia* of the southwest coast of India

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Abstract

Nutritionally potential under explored wild legumes viz., *Canavalia cathartica* and *Canavalia maritima* are widely distributed in mangroves and sand dunes, respectively, in Southwest coast of India. Physicochemical, functional and cooking properties of dried seeds of these legumes have been evaluated. Seeds and cotyledons of *C. cathartica* are larger and possessing higher hydration and swelling capacity than that of *C. maritima* indicating higher permeability and softness. The crude protein of *C. maritima* and *C. cathartica* were found to be higher than common pulses. The pH vs. protein solubility profile was almost similar with minimum solubility at pH 4 (27.8–28.1%). *C. maritima* showed higher oil absorption capacity (1.53 ml/g) as well as water absorption (0.1 M) capacity. The gelation capacity was minimal at 0.1 M NaCl and pH 4 for both the seed flours. Addition of carbohydrates (starch, lactose, maltose and sucrose) reduced the lowest gelling capacity of *C. maritima* except for maltose in *C. cathartica*. Emulsifying activity (EA) and emulsifying stability (ES) diminished with increasing concentration of flours. Minimum EA and ES were attained at pH 4 and maximum at pH 10 in both seed flours. Maximum EA for *C. cathartica* and *C. maritima* (62% vs. 72.6%) was attained at 0.4 M NaCl. The ES vs. flour concentration, pH and ionic strength profiles did not differ much between *C. maritima* and *C. cathartica*. Peak foam capacity (FC) and stability (FS) were achieved at 6% (w/v) of *C. maritima* flour, while the same was attained at 8% (w/v) of *C. cathartica*. The FC and FS of the seed flours improved with increasing pH (pH 2–10). *C. maritima* flour exhibited the better FC (27.7%), while *C. cathartica* exhibited better FS (44.42%) at pH 10. Although highest FC was attained at 0.4 M NaCl in both flours, *C. maritima* was found to be superior (30.5% vs. 28.5%). The flour of *C. maritima* attained the highest FS at 0.2 M NaCl than *C. cathartica* (0.4 M NaCl). The minimum cooking time for cotyledons of *C. cathartica* was more and higher gruel solid loss was reported due to its high L/B ratio. The Pearson correlation coefficients revealed that functional properties of seed flours vary due to their chemical composition.

Keywords: *Canavalia*; Seeds; Physical properties; Cooking properties; Functional properties; Sand dunes; Mangroves

1. Introduction

Due to inadequate supply of protein diets, malnutrition in children and lactating women is evident in developing countries, which can be compensated by wild legumes (Pelletier, 1994; Siddhuraju, Vijayakumari, & Janardhanan, 1992; Vadivel & Janardhanan, 2001a). Exploration of economically viable wild legumes as an alternative source of food may expand the protein sources for nutrition. *Canavalia cathartica* are common in the mangrove habitats of southwest coast of India as wild legumes. *C. cathartica* as well as *Canavalia maritima* are the wild landraces widely distributed (frequency: 22.2–44.4%; abundance: 6.1–19.2%) on the coastal sand dunes of southwest coast of India (12°52′N, 70°49′E–14°51′N, 74°7′E) contributing to dune stability (Arun, Beena, Raviraja, & Sridhar,

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1999). They also have potential use in agriculture as cover crops, green manures and mulch as they fix atmospheric nitrogen. Attempts are yet to be extended to exploit such benefits through domestication of this gene pool. These legumes produce considerable pods and seeds and are occasionally consumed by fisher folk during acute food shortage (Arun, Sridhar, Raviraja, Schmidt, & Jung, 2003; Seena, Sridhar, & Jung, 2005a). Similarly, seeds of *C. maritima* are consumed by humans and livestock, which form an important source of dietary protein in West Africa and Nigeria (Abbey & Ibeh, 1987). The use of these edible beans as a food deserves intensive study and promotion. It is necessary to investigate the chemical composition and functional properties of legume flours in view of optimal utilization and consumer acceptance. The functional properties that affect the sensory features of food play a very important role in physical qualities and ingredients of food during preparation, processing and storage. Several food industries are in search for the desirable functional qualities of legume flours in order to meet their requirements.

Our research efforts have been channeled to assess the proximate composition, mineral contents, amino acid profile and fatty acid composition of seeds of *Canavalia* spp. found in southwest coast of India (Arun et al., 2003; Seena et al., 2005a, Seena, Sridhar, & Bhagya, 2005b). Interesting proximal characteristics (e.g., protein and essential amino acids) of seeds of *C. cathartica* and *C. maritima* of west coast of India (Arun et al., 2003; Seena et al., 2005a, 2005b) warranted us to explore their nutritional importance. The major aim of this study is to extend the investigation of these underutilized legumes towards their physicochemical, functional and cooking properties for effective utilization as food and food based applications.

2. Materials and methods

2.1. Seed materials

Dried seeds of *C. cathartica* Thouars [synonyms: *Canavalia microcarpa* (DC.) Piper; *Canavalia turgida* Graham ex A. Gray; *Canavalia virosa* (Roxb.) Wight et Arn.; *Dolichos virosus* Roxb.; *Lablab microcarpus* DC.] and *C. maritima* Thouars [synonyms: *Canavalia lineata* (Thunb.) DC.; *Canavalia obtusifolia* (Lam.) DC.; *Canavalia rosea* (Sw.) DC.; *Dolichos maritimus* Aublet; *Dolichos obtusifolius* Lam.; *Dolichos roseus* Sw.] were collected from the Nethravathi mangroves (13°17′50″N, 74°44′32″E 12°50′N, 74°50′E) and coastal sand dunes of Kaup (13°14′00″N, 74°44′30″E), respectively, during February–March 2004. Shrunken, discoloured and insect infested seeds were eliminated, sun dried and divided into three sets. The first set constitutes intact seeds, the second set was longitudinally and transversely dissected to obtain four pieces per seed and the third set was dehulled, ground (30 mesh, Wiley mill) and stored in airtight glass containers until use.

2.2. Physical properties

Seed, cotyledon and seed coat weight: Seed, cotyledon, seed coat weight of randomly selected 100 seeds were determined in triplicates.

Seed length, width, thickness and hilum length: Hilum length, length, width and thickness of 20 randomly selected seeds were recorded using dial calipers.

Length–breadth ratio: The length–breadth ratio (L/B) of 20 randomly selected intact seeds as well cotyledons (each cotyledon was cut into two pieces) were determined by dividing the length by breadth.

Bulk density: Twenty-five grams of seeds and cotyledons in triplicate were poured into a measuring jar from a fixed height (30 cm). The volume occupied by the sample was determined and the ratio was calculated in g/ml (Singh, Kaur, Sodhi, & Sekhon, 2005).

Hydration capacity: One hundred grams of seeds or cotyledons in triplicate were enumerated and transferred to a measuring jar containing 100 ml distilled water and it was left for 24 h at room temperature (28 ± 2 °C). Later the water was drained, seeds/cotyledons were blotted to remove adhered water and weighed (Adebowale, Adeyemi, & Oshodi, 2005)

$$\text{Hydration capacity (g/seed or cotyledon)} = \frac{W_2 - W_1}{N},$$

where W_1 = weight of seeds/cotyledons before soaking; W_2 = weight of soaked seeds/cotyledons; N = number of seeds/cotyledons

$$\text{Hydration index} = \frac{\text{Hydration capacity per seed/cotyledon}}{\text{Weight of one seed or cotyledon}}.$$

Swelling capacity: One hundred grams of seeds or cotyledon were enumerated in triplicate, its volume was determined and soaked overnight in distilled water. Volume of the soaked seeds or cotyledon was noted in a graduated cylinder (Adebowale et al., 2005)

$$\text{Swelling capacity (ml/seed or cotyledon)} = \frac{V_2 - V_1}{N},$$

where V_1 = volume of seeds/cotyledons before soaking; V_2 = volume of soaked seeds/cotyledons; N = number of seeds/cotyledons

$$\text{Swelling index} = \frac{\text{Swelling capacity of seed/cotyledon}}{\text{Volume of one seed or cotyledon}}.$$