POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES

www.pan.olsztyn.pl/journal/
e-mail: joan@pan.olsztyn.pl

Pol. J. Food Nutr. Sci.
2009, Vol. 59, No. 1, pp. 25-27

CHARACTERISTICS OF STARCH FROM RICE BEAN (*VIGNA UMBELLATA* L.) SEEDS – A SHORT REPORT

Uttam D. Chavan[1], Ajim Momin[1], Jayshing K. Chavan[1], Ryszard Amarowicz[2]

Department of Food Science and Technology, Mahatma Phule Agricultural University, Rahuri, India; [2]Institute of Animal Reproduction and Food Research of the Polish Academy of Sciences, Division of Food Science, Olsztyn, Poland

Key words: starch, rice bean, chemical composition, physicochemical properties

Starch was extracted from rice bean (*Vigna umbellata* L.) using 0.5% (w/v) NaOH solution for 24 h at 60°C. The separated starch was characterised for the content of moisture, ash, nitrogen, lipids, amylose, starch damage, enzymatic (α-amylase) and acid (2.2 mol/L HCl) hydrolysis, swelling factor, amylose leaching, water and fat absorption, and gelatinization temperature. The gross chemical composition of rice bean starch did not differ significantly from other edible legumes, for example, amylose content was 32.8%. The rice bean starch was found to absorb 83.2% of water, 77.6% fat and exhibit a gelatinization temperature of 66±2°C.

INTRODUCTION

Legumes constitute an important source of carbohydrates for a large part of human population, mainly in the developing world. India is the largest producer and consumer of legumes in the world [Singh *et al.,* 2008]. Rice bean (*Vigna umbellata* (thumb) Ohwi and Ohashi) is one of the unexploited and underutilized pulse crop widely grown in rice fields after the harvesting of paddy on residual soil moisture. This plant is grown in India chiefly by the natives of the eastern and northeaster region [Arora *et al.,* 1980] and has some good qualities over greengram, blackgram and cowpea such as resistance to drought, pests and diseases during growth period, synchronising habit of pod maturity, resistance to attack of storage pests and a high percentage of seed viability [Mukherjee & Sarkar, 1999]. It is less preferred for direct consumption due to its disagreeable taste or flavour. The seeds contain about 24% protein and 60% starch. It can however be processed into value added products like protein concentrate and food-grade starch.

The information on starch extraction from rice bean seeds and its physicochemical properties is quite limited. This study describes a chemical composition and some properties of starch from rice bean seeds and its properties.

MATERIALS AND METHODS

Plant material

Seeds of rice bean were obtained from Plant Breeder (Mahatma Phule Krishi Vidyapeeth, Rahuri, India).

Chemical, biochemical, and physicochemical methods.

Total starch content in rice beans was determined according to McCready *et al*. [1950]. For starch extraction, the seeds were soaked separately in 0.5% (w/v) NaOH solution for 24 h at 60°C [Hoover & Sosulski, 1985]. Then starch was separated from the soaked seeds as described earlier by Chavan *et al*. [1999]. The separated starch was characterised for the content of moisture, ash, nitrogen [AACC, 1984], lipids [Vasanthan & Hoover, 1992], amylose [Chrastil, 1987], as well as for starch damage, enzymatic (α-amalase) and acid (2.2 mol/L HCl) hydrolysis, swelling factor (SF), amylose leaching (AML), water and fat absorption and gelatinization temperature as described earlier [Chavan *et al*., 1999].

RESULTS AND DISCUSSION

The dry rice bean seeds contained 56.58% of starch and the yield of extraction was 36.5%. The yield of isolated starch was relatively low as compared to other common legumes such as pea (40%), black gram (45%), red bean (46%) [Hoover & Sosulski, 1991]. This may be due to compact association of starch granules with other biomolecules in rice bean seeds.

The values of moisture, ash, nitrogen, lipids and amylose in rice bean starch (Table 1) are comparable to the literature values for other legumes such as moth bean, horse gram, navy bean, beach pea and pinto bean [Gujska *et al*., 1994; Hoover & Manuel, 1996; Chavan *et al*., 1999]. Apparent amylose content of field pea, kidney bean, chickpea, blackgram and pigeon pea, mung bean starch, and bean was 37.9%, 36.0%,

Author's address for correspondence: Uttam D. Chavan, Department of Food Science and Technology, Mahatma Phule Agricultural University, Rahuri-413722, India; tel: +91 246 243253; fax: +91 246 243253; e-mail: uttamch2002@yahoo.co.in

TABLE 1. Characteristics of rice bean starch – proximate chemical composition (%) and percent of damage.

Compounds	Mean ± SD
Moisture	10.1 ± 0.2
Ash	0.21 ± 0.01
Nitrogen	0.04 ± 0.01
Lipids	0.16 ± 0.02
Amylose	32.8 ± 0.8
Starch damage	3.01 ± 0.5

34.4-35.5%, 32.9-35.6%, 31.8%, 38.0%-41.5%, and 31.7--33.8%, respectively [Nishinari, 2008; Kim *et al*., 2007; Chung *et al*., 2008]. In the study of Sandhu & Lim [2008] amylose content in six legume seeds ranged from 28.4% (pigeon pea) to 33.1% (field pea).

Starch damage of rice bean (3.01%) was compared with that reported before for beach pea (4.9%), green pea (1.9%), grass pea (1.7%) [Chavan *et al*., 1999], green arrow pea (2.4%), and lentil (1.8%) [Hoover & Manuel, 1996]. Much lower results for starch damage for black bean, pinto bean, and field bean (0.2-0.7%) were found by Hoover & Manuel [1996].

The rice bean starch was found to absorb 83.2% of water and 77.6% of fat (Table 2), which is in accordance with literature data [Hoover & Sosulski, 1985]. Starch obtained from rice bean exhibited a gelatinization temperature of 66±2°C. Starches separated from pigeon pea, chickpea, field pea, kidney bean and blackgram were characterised by gelatinization temperature from 68.3 to 69.3°C [Sandhu & Lim, 2008]. The same parameter for black bean, pinto bean, field bean, and lentil was of 82.0, 82.0, 69.0, 69.0°C, respectively [Hoover & Manuel, 1996].

The hydrolysis of rice bean starch by 2.2 mol/L HCl and porcine pancreatic α-amylase is presented in Figure 1. At the end of the 20th day, 37.1% of starch hydrolysis was observed. In the study of Chavan *et al.* [1999] at the same condition beach pea, grass pea, and green pea starches were hydrolysed to the extents of 49, 41, and 37%, respectively. The results are also comparable with those of Hoover & Manuel [1995; 1996] and Hoover *et al*. [1992]. After 24 h of α-amylase treatment 45.7% hydrolysis of rice bean starch was achieved. In the study of Chavan *et al*. [1999] the corresponding values for beach pea, grass pea, and green pea starches were 35, 22, and 16%, respectively. Application of pancreatin and amyloglucosidase resulted in approximately 75% of bean starch hydrolysis [Chung *et al.,* 2008].

Swelling factor and amylose leaching were investigated over the temperature range of 50-95°C (SF), and 70-95°C (AML). The results are presented in Figure 2. The SF and AML were within the range reported for other legume starch. Starches of beach bean, green pea, and grass pea were char-

TABLE 2. Physicochemical properties of rice bean seeds starch.

Property	Mean ± SD
Water absorption capacity (%)	83.2 ± 2.2
Oil absorption capacity (%)	77.4 ± 1.8
Gelatinization temperature (°C)	66 ± 2

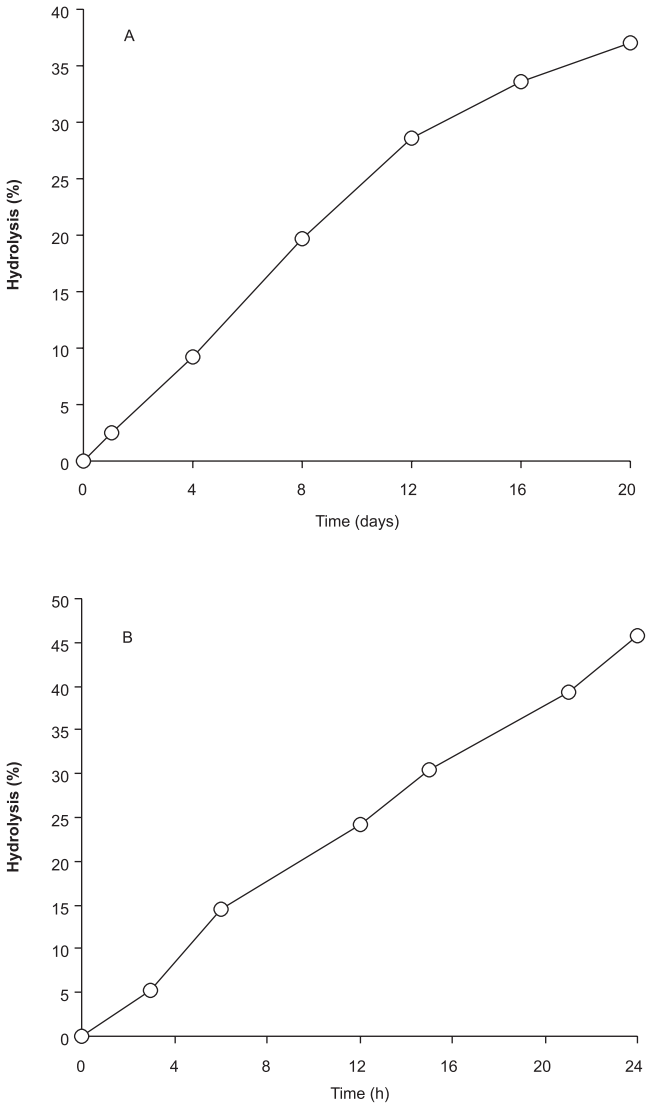

FIGURE 1. Acid (A) and enzymatic (B) hydrolysis of rice bean starch.

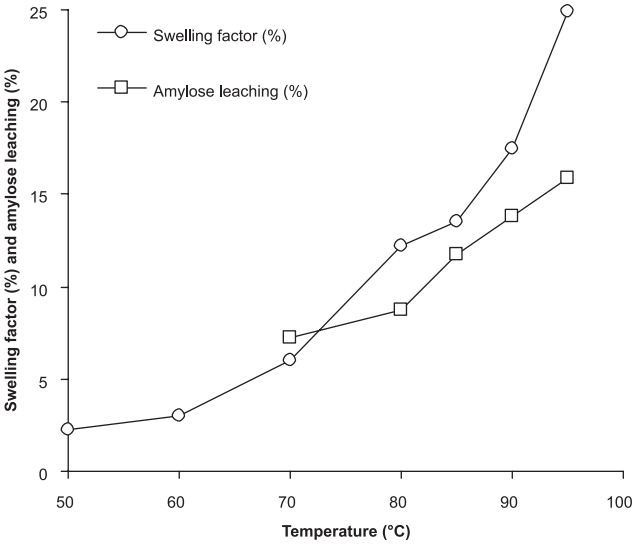

FIGURE 2. Influence of temperature on swelling factor and amylose leaching of rice bean starch.

acterised at 95°C by a swelling factor of 30.7, 34.1, and 26.0% [Chavan *et al*., 1999]. At the same temperature leached amylose achieved the values of 12.9, 17.1, and 19.1%, respectively [Chavan *et al*., 1999]. Starch granule swelling is known to begin in the bulk relatively mobile amorphous fraction and in the more restrained amorphous regions immediately adjacent to the crystalline region [Donovan, 1979]. Furthermore, amylose-lipid complexes have been shown to inhibit granule swelling [Hoover & Manuel, 1996].

CONCLUSIONS

The gross chemical composition of rice bean starch does not differ significantly from other edible legumes. Work is now in progress to study the rheological and retrogradation properties of rice bean starch in order to assess the suitability of this starch for food and non-food related application.

REFERENCES

1. AACC, Approved Methods of the AACC, 8th Edition, 1984, American Association of Cereal Chemists, St. Paul, MN.
2. Arora D., Chandel K.P.S., Joshi B.S., Pent K.C., Rice bean: Tribal pulse of eastern India. Econ. Botany, 1980, 34, 260–263.
3. Chavan U.D., Shahidi F., Hoover R., Parera C., Characterization of beach pea (*Lathyrus maritimus* L.) starch. Food Chem., 1999, 65, 61–70.
4. Chrastil J., Improved colorimetric determination of amylose in starches of flours. Carbohyd. Res., 1987, 159, 154–158.
5. Chung H.-J., Liu Q., Pauls K.P., Fan M.Z., Yada R., *In vitro* starch digestibility, expected glycemic index and some physicochemical properties of starch and flour from common bean (*Phaseolus vulgaris* L.) varieties grown in Canada. Food Res. Int., 2008, 41, 869–875.
6. Donovan J.W., Phase transitions of starch-water system. Biopolymers, 1979, 8, 263–275.
7. Gujska E., Duszkiewicz-Reinhard W., Khan K., Physico-chemical properties of field pea, pinto and navy bean starches. J. Food Sci., 1994, 59, 634–637.
8. Hoover R., Sosulski F.W., Studies on the functional characteristics and digestibility of starches from *Phaseolus vulgaris* biotypes. Stärke, 1985, 37, 181–191.
9. Hoover R., Sosulski F.W., Composition, structure functionality and chemical modification of legume starches – a review. Can. J. Physiol. Pharmacol., 1991, 69,79–92.
10. Hoover R., Swamidas G., Vasanthan T., Studies on the physicochemical properties of native, defatted and heat-moisture treated pigeon pea (*Cajmus caja* L.) starch. Carbohydr. Res., 1992, 19, 285–297.
11. Hoover R., Manuel H., A comparative study of the physicochemical properties of starches from two lentil cultivars. Food Chem., 1995, 53, 275–284.
12. Hoover R., Manuel H., Effect of heat moisture treatment on the structure and physico-chemical properties of legume starches. Food Res. Int., 1996, 29, 731–750.
13. Kim S.-H., Lee B.-H., Baik M.-Y., Joo M.-H., Yoo S.-H., Chemical structure and physical properties of mung bean starches isolated from 5 domestic cultivars. J. Food Sci., 2007, 72, C471––C477.
14. McCready R.M., Guggolz J., Silviera V., Owens H.S., Determination of starch and amylose in vegetables. Anal. Chem., 1950, 22, 1156–1158.
15. Mukherjee A.K., Sarkar A., Rice bean – a new crop for sustaining pulse production in India. Environ. Ecol., 1991, 9, 207–211.
16. Nishinari K., Structure and viscoelastic properties of starches separated from different legumes. Starch/Stärke, 2008, 60, 349––357.
17. Sandhu K.S., Lim S.-T., Digestibility of legume starches as influenced by their physical and structural properties. Carbohydr. Polym., 2008, 71, 245–252.
18. Singh N., Nakaura Y., Inouchi N., Nishinari K., Structural and viscoelastic properties of starches separated from different legumes. Starch/Stärke, 2008, 60, 349–357.
19. Vasanthan T., Hoover R., Comparative study of the composition of lipids associated with starch granules from various botanical sources. Food Chem., 1992, 45, 19–29.

Received, revised and accepted December 2008.