Effect of Soaking on Functional Properties of Rice Bean-A Review

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Abstract: *Vigna umbellata* (Thunb.) Ohwi and Ohashi, previously *Phaseolus calcaratus*, is a warm-season legume, commonly called as rice bean and it is a mixed crop with maize, sorghum and cowpea. In this paper proximate composition of rice bean flour and its functional properties and effect of soaking on proximate composition, anti-nutritional factors, functional properties, cooking quality and PCMP number (protein phytate, calcium, magnesium and pectin content of the pulses) are reviewed.

Keywords: Rice bean, soaking, phytic acids, polyphenols, legume flours

1. Introduction

*Vigna umbellata* (Thunb.) Ohwi and Ohashi, pre viously *Phaseolus calcaratus*, is a warm-season legume with yellow and sm all ed ible. It is commonly calle d *rice bean*. It is re garded as a minor a nd fodder crop in *Vigna umbellata* (Thunb.) Ohwi and Ohashi, previously Phaseolus calcaratus, is a warm-season legume, commonly called as rice bean and it is a mixed crop with maize, sorghum and cowpea. In this paper proximate composition of rice bean flour and its functional properties and effect of soaking on proximate composition, anti-nutritional factors, functional properties, cooking quality and PCMP number (protein phytate, calcium, magnesium and pectin content of the pulses) are reviewed.

1. Introduction

1.1. Domestication

*Vigna umbellata* (Thunb.) Ohwi and Ohashi, previously *Phaseolus calcaratus*, is a warm-season legume, commonly called as rice bean and it is a mixed crop with maize, sorghum and cowpea. In this paper proximate composition of rice bean flour and its functional properties and effect of soaking on proximate composition, anti-nutritional factors, functional properties, cooking quality and PCMP number (protein phytate, calcium, magnesium and pectin content of the pulses) are reviewed.
combination of salts), and alkali and the soak water may or may not be discarded prior to cooking depending on regional preferences. Such practices may influence the nutritive quality of beans. Soaking and cooking of legumes result in significant red uction in n p hy tic ac d and t annin co ntents. Maximum red uction of phytic ac d (78.05%) a nd t annin (65.81 %) was fo und for sod ium b icarbonate soaking followed by cooking. These treatments also result in a slight reduction in n n utrients suc h as pt otein, m inerals a nd d i t otal sugars. It has been known si nce the t hird century BC that certain c ha nges oc c ur i n n leg um e s e eds d uring e xtended storage, es pecially at hi gh t emperatures a nd humidi ty, making t hem di fficult t o c oo k. Th e s har d t o o c ok phenomen o n is a res ul t of s everal hypothesi sed changes at the m olecular lev el. Th e p ectin-cation-phytate theory suggests that during storage e an int racellular enzy me me, phytase, hydrolyzes p hytins, res ul ting i n t he rel ease of divalent cations. Once cooking begins, monovalent cations from the pectin located in the cell wall ex change with those divalent cations to form insoluble pectin, become extremely strong and make long stored legumes difficult to cook. This phenomenon i s ex pressed th rou gh a t erm call ed “PC MP number” which determines the hardness of the bean. Certain water soluble, nutritionally important minerals and vitamins may al so b e lo st t o soa k w ater, i f di scarded, al ong wi th undesir able com ponents suc h as f l atulenc e ca using oligosaccharides, phytates and polyphenols. Ka dam et a l. (1981) reported that soaking of horse gram in a salt so lution of 1.5% NaHCO3, 0.5% Na2SO3 and 0.75% citric acid for 12hr caused reduction in cooking time from 145 m in to 27 min. They also observed 69 to 73% improvement in protein digestibility a nd 35% less p olyphenols in co oked ho rse min. They also reported that fat content of t he bean ranged b etween 0.44g a nd 0.56g per 100g of d i t otal f i ve d i fferent v arieties. Mohan an d Ja nardhanan (1994) reported t hat Ca a nd Mg co ntent of the bean a s 2 64 mg a nd 73 mg respectively per 100g of rice bean. Saikia et al. (1999) found 0.46-0.52% c rude fat s (f atty ac d is a nd fat s ubl e constituents) in uncooked rice bean.

2. Proximate Composition of Rice Bean Flour

The raw protein content of rice bean cultivars appears to be lower th an o f m ost o ther pu ls es, al though th e re is co nsiderable variation in t he f i gures presen ted i n th e literature.

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<th>Author Percentage</th>
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<tr>
<td>Malhotra et al. (1988)</td>
<td>17.5 - 23.1</td>
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<td>Mohan and Janardhan (1994)</td>
<td>21.9 - 26.1</td>
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<td>Saikia et al. (1999)</td>
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<td>Rodriguez and Mendoza (1991)</td>
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<td>Saharan et al. (2002)</td>
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<td>Duke (1981)</td>
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<td>FAO (1982)</td>
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<td>Chandel et al. (1978) 14.0-24.0</td>
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<td>Kaur and Kapoor (1992)</td>
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<td>Overall range</td>
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Duke (1981) gave the following figures for mineral content per 100 g of rice bean: 200 mg Ca, 390 mg P, and 10.9 mg Fe. Analyses of the rice bean revealed a n ash c ontent of 4.03%. M allhota et al. (1988) re ported that carbohydrate content of the bean ranges from 58.15-71.99%. Ka ur a nd Kapoor (1992) rep ort ed that to tal s luble fu ts, non -reducing sugars, starch and total available carbohydrates of five h i gh g yielding ri ce beans v aried e ven fr om 5.0g to 5.6g, 4.4g to 8.3g, 52.4g to 61.1g/100g, respectively. In the case of starh b and to tal a vailable carbohy drates there were no significant varietal differences; whereas some significant varietal variations were ob served in respect to total soluble sugars, reducing sugars a nd on-reducing sugars. The mineral content of 5 d i fferent v arieties of ri ce beans a nd the concentrations of calcium, phosphorus and iron of rice bean varieties varied from 287mg to 327mg, 234mg to 249mg and 6.3mg to 7.7mg per 100gm respectively. In rice bean the extractability of cal ci um m ay b e hi ghest (ab out 88%) a nd ph osphorus wa s the lowest (33%). The concentrations of the other minerals were com parable in all the legumes studied. Th ey al s o re ported that fat content of t he bean ranged b etween 0.44g a nd 0.56g per 100g of rice bean. Mohan and Janardhanan (1994) reported that Ca a nd Mg co ntent of the bean as 2 64 mg a nd 73 mg respectively per 100g of rice bean. Saikia et al. (1999) found 0.46-0.52% crude fat (fatty acids and fat soluble constituents) in uncooked rice bean.

3. Effect of soaking on proximate composition of legume flours

Egb e an d A Kinyele (1990) reported that decrease in crude protein content of five high yielding rice bean varieties. Phytic acid has been known to be the major storage form of phosphorus, and in dry legumes it has been reported to vary from 0.44 to 1.46%. It is known to be involved in undesirable processes including t hose h ard co ok phenomenon. This adverse attribute increases cooking times and is important in the processing of legumes. Mobarak (2005) reported decrease in fat and ash during soaking treatment of mung bean might be attributed due to leaching or the heir diffusion into the soaking water. M agadi (2007) reported a significant increase in moisture content during soaking and cooking which might be attributed due to the leaching of soluble proteins and minerals.

3.1 Antinutritional factors

a) Phytic acid

Kaur and Kapoor (1992) found between 1875 and 2270 mg phytic acid in their analysis on five high yielding rice bean varieties. Phytic acid has been known to be the major storage form of phosphorus, and in dry legumes it has been reported to vary from 0.44 to 1.46%. It is known to be involved in undesirable processes including those leading to hard-cook phenomenon. This adverse attribute increases cooking times and is important in the processing of legumes. Mobarak (2005) found from 1998 to 2170 mg phytic acid/100 g uncooked rice bean, but substantial reduction after presoaking or boiling. Saharan et al. (2002) measured 2018 ± 5.9 mg/100 g. Rice bean has a fairly high content of phytic acid and its content among cultivars varied significantly. He further reported that the high content of phytate is of nutritional significance as not only is the phytate phosphorus unavailable to the human, but it also lowers the availability of many other essential minerals.
b) Polyphenols

Mosely and Griths (1979) reported that polyphenols are responsible for affecting the digestibility of dietary protein and, to a lesser extent, that of available carbohydrate and lipid. He further reported that tannin ins form complexes with proteins, carbohydrates and other polymers in food as well as with certain metal ions such as iron under suitable conditions and an appropriate pH. Deshpande and C. Herryan (1983) observed soaking at a rice bean variety havi ng a dark color seed coat had a higher concentration of polyphenols than that having a light color. The concentration of tannins in the seed of the legumes thus may be a function of the color of the seed coat. Sun Lunkhe et al. (1982) reported that polyphenols in legumes are present as an intrinsic factor, due to mainly to the effects of tannins, which reduce protein digestibility and the inhibitory effect of these compounds on the activities of digestive enzymes like trypsin, lipase and amylase reduce the digestibility of the protein an d carbohydrates and the availability of vitamins and minerals. Malhotra et al. (1988) reported polyphenols to be 900 mg/100 g in rice bean lower than that in other 'sta ndard crops such as soybeans, green beans, and pinto bean'. Kapoor (1992) found between 1279 and 1587 mg polyphenols per 100 g in five varieties. Anton et al. (2008) reported that polyphenols in legumes with progressive increase in tannin quan tities will affect ph enolic content.

Pastor Corrales (2005) reported that only 1 and 2% of the polyphenolic compounds were found in the water used for soaking bean and pinto beans. However, higher flavonoids levels were observed in the bean and pinto beans compared with light color (white kidney beans and white grams). He further reported that soaking and cooking of legumes resulted in significant reduction in phytic acid and tannin contents. M. Alex red uction of p hytic acid to 70.5% a nd tannin in cow pea a red uction of 82.1% in defatted kaulili chickpea which is milled and compared with light color (white kidney beans and white grams). He further reported that soaking and cooking of legumes resulted in significant reduction in phytic acid and tannin contents. Morphological and chemical analysis of dry cowpea have revealed that soaking and cooking of legumes resulted in significant reduction in phytic acid and tannin contents.

3.2 Effect of Soaking on Phytic Acid and Polyphenolic Content of Legume Flours

Sathe and Salunkhe (1981) and observed a marked decrease in tannin and equivalent of winged bean and yellow pea. A successive and significant reduction in polyphenols content was found in all the p umps with progressive increase in content of the hull such as soaking and cooking. In contrast, research shows that a significant reduction in total phytic content occurs during a process that combines soaking and cooking. Nergiz and Gok goz (2007) reported that water absorption of phytic acid after cooking beans that had been soaked 12 hr prior to cooking. Bosheng et al. (2008) also observed as slight decrease in total phytic acid content and there is no difference in soaked kidney and pinto beans. However, higher flavonoids levels were observed in the bean and pinto beans compared with light color (white kidney beans and white grams). He further reported that soaking and cooking of legumes resulted in significant reduction in phytic acid and tannin contents.

3.3 Effect of S oaking on Fu nctional Prop erties of Legume Flours

Hsu et al. (1982) reported that the lowest solubility of t he protein of yellow pea, lentils and faba bean were at pH 4.5-5.0. On either side of pH 5 the protein solubility started to increase and reached its maximum value at pH 12 (88%). Bencini and Caracea (1986) studied the functional properties of legumes and found an emulsification activity and emulsification stability of 57-58% and a nd tannin (65.81 %) was foun d for s oaked b eans. They also observed that cooking and emulsification of legumes resulted in a slight reduction in nutrients such as protein, minerals and total sugars.

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reported that red kidney bean when soaked dried and passed through Hammer mill possesses’ water ab sorption capacity of 2.25 g per gram of sample.

3.4 Effect of soaking on cooking quality and PCMP number of legume flours:

Rockland and Metzler (1967) soaked Lima and other beans in mix ed salt so lution of 1.5% NaHCO₃, 0.5% Na₂CO₃, 2.5% NaCl and 1% so dium phos phate and observed significant effect of this soak so lution in redu cing t he cooking time. The effect of pre soaking of legume seeds in the soak solution of chemicals in reducing the cooking time of peas has been reported. Muller (1967) found that the main factor affecting the cooking quality of seeds of several pea and bean varieties was found to be phytin, Ca, Mg and free pectin. Other factors probably in volved were the thickness of the seed coat, palisade layer and the contents of lignin and alpha-cellulose in the seed coat. Cell contents ha d no detectable ef fect. Bo ngwar and Sr eemisnaa (19 977) developed a process for the production of quick cooking peas from dry commercial peas. It involved dehydrating the precooked peas in a standard tray drier at 55 to 60°C for 2 to 2.5 hr to reduce the moisture pressure and dehydrating the precooked peas in a stand ard tray drier at 55 to 60°C for 2 to 2.5 hr to reduce the moisture content to a bout 8%. Narasimha and Desikachar (1978) tried a ddition of cationic surfactant in the soak solution of peas to improve the cooking quality. They al so observed significant reduction of 50% in the cooking time when soaked in 0.5% Na₂CO₃. However, the coating of the dhal with the chemical in the soak solution of peas to promote bean softening was not achieved. Oekend en et al. (1997) reported loss of phytate in beans is faster at high temperature and relative humidity during storage, c onditions t hat h ave h ead and de fective beans. The water uptake was monitored by soaking 16 g of beans in 100 ml of distilled water at 25°C until a complete soaking was achieved. Neelam khetarpaul et al. (1997) reported that soaking in a salt combination of 0.5% NaHCO₃ and 1% Na₂CO₃ for 12 h reduced the cooking time by 58-98% when soaked in 0.5, 0.75 and 1% solutions of these salts. Pawar (1986) observed that water absorption capacity of moth bean is higher in salt solution than in distilled water for 4 h. Paredes lopez et al. (2005) found that the cooking time of untreated soy dhal was 162 min; it reduced significantly by 58-98% per cent when soaked in 0.5, 0.75 and 1% pe a solutions of soy dhal and Moth bean. In their study they observed that water absorption capacity of moth bean is higher in salt solution than in distilled water for 4 h.
and 82°C for 3 h in 0.07% NaHCO3 solution, and followed by precooking at 110°C for 10 min in a heat best quality. Dehydrated lentils produced by Soaking at 22°C for 2 h and 82°C for 20 min in 0.07% NaHCO3 solution, and followed by precooking at 106°C for 10 min in a heat the best quality. Golam an d Tzen (2010) reported t he coo king t ime of untreated Kalimatar seed was s 187 ± 3.15 min; soaking the seeds in different media for 12hr reduced the cooking time considerably. Sodium carbonate solution (2%) was found as the most suitable soaking medium, particularly followed by roasting the seeds. Soaking an d or rasting did d not ca use pronounced r eduction i n nutrient cont ent of t he same palm. Sasikala and Narasimha (2010) reported the hardness values of green gram and ho rse gram and t heir effect on s oaking. The soaking effects on the texture of whole as well as dehulled split green gram and horse gram were studied using universal texture m achine an d scan ning electron microscopy. The hardness values of ra w whole legumes of green gram (67.5–69.9 N) and horse gram (186.5–245 N), untreated Kalimatar seed was 187 ± 3.15 min; soaking the seeds in different media for 12hr reduced the cooking time considerably. Sodium carbonate solution (2%) was found as the most suitable soaking medium, particularly followed by roasting the seeds. Soaking the seeds in different media for 12hr reduced the cooking time considerably. Sodium carbonate solution (2%) was found as the most suitable soaking medium, particularly followed by roasting the seeds.

4. Conclusion

Application of blanching preceded by soaking of rice bean seeds, thus offers the dual advantage of saving valuable fuels by shortening cooking time, as well as renders the seeds more acceptable to consumers. Soaking of legumes reduces the anti-nutrients; phytic acid and tannins, making them more acceptable to consumers. Soaking of legumes reduces the anti-nutrients; phytic acid and tannins, making them more acceptable to consumers.

References


[31] Magadi A. Osman. (20 07). Eff ects of d ifferent processing m ethods, on nutrient c omposition, antinutritional f actors and in vitro protein digestibility of D olichus lablab bean (Phaseolus aureus) as affected by som e e nvironmen tal processes. Food Compos. and Analys. 89: 489-495.


[54] Narasimha, H. V ., and Desi kachar, H.S.R. (1978). Sample proce dures f or re ducting the c ooking t ime of...
split red gram (Cajanus cajan) J. Food Sci. Technol. 15: 149-152.


