Research Article

Effect of Soaking on Polyphenol Content and Cooking Time of Kidney Beans (*Phaseolus Vulgaris* L)

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Abstract

Kidney beans (*Phaseolus vulgaris* L) are good source of important nutrients with good amount of protein, mineral matter, crude fiber, and carbohydrates. However, anti-nutritional factors reduce the quality as they interfere in biological utilization of the nutrients in legumes. In the present study the effect of soaking on cooking time and total phenol, tannin concentration of two types of kidney beans was studied. It was observed that quality improvement of kidney beans can be done through the application of soaking. It was observed that soaking reduced the concentration of total phenols and tannins by 9.31 % and 56 % respectively for small red kidney beans while reduction of total phenols and tannins content observed in local cultivar after soaking was 2.9% and 37.65 % respectively. Statistically significant difference ($p<0.05$) has been observed between the values of total phenols and tannins in both the kidney beans. Soaking also reduced the cooking time of both the kidney beans by 50-66 percent. Physical characteristics like size and color also seen to have an impact on the anti-nutritional content and cooking time of both the kidney beans.

Keywords: kidney beans, soaking, cooking time, tannins, and polyphenols

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Introduction

Legumes are important local food crops as an essential source of protein in the diets of the world's poorest countries. In farming systems, legumes are valuable for their biological fixation of nitrogen. In Africa, Latin-America and Asian countries, Beans play an important role in human diet as they improve the nutritional status of many low income populations [1]. In the western hemisphere, kidney beans are used in salads, soups and other food products [2]. India being the world's largest producer and importer of pulses—is experiencing massive price hikes in pulses therefore raising awareness about these important crops can help increase production, encourage new research and development, and ultimately ensure that pulses are widely available for consumption throughout the world [3].

Factors like plant genetics, soil composition and growing conditions, state of maturity and post-harvest conditions affects the quantity and quality of polyphenols present in plant foods [4]. Polyphenols have the potential to bind positively charged proteins, amino acids and/or multivalent cations or minerals such as iron, zinc and calcium in foods [5].They thus reduce the bioavailability of essential minerals and a reduction in their content may result in improved absorption of these nutrients. Tannins are higher-molecular-weight (molecular weights P500), water-soluble polymeric phenolics that precipitate proteins due to their ability to interact with proteins and render them unavailable for absorption by the human body [6, 7]. The highly reactive nature of polyphenols and tannins in foods, which may affect their anti-oxidant activity and the nutritional value of foods can be altered by various processing techniques [8]. Raw pulses are subjected to a variety of processing techniques prior to consumption, including milling, dehulling, soaking, germination, fermentation and cooking. These processing techniques save time, energy and fuel and yield edible products having a higher nutritional value and lower levels of anti-nutritional compounds such as polyphenols and tannins. Soaking before cooking bean facilitates physical and chemical changes due the denaturation of proteins, gelatinization of starch and destruction of toxic factors [9]. In the present study, comparative evaluation of the effect of domestic processing technique (soaking) on concentrations of total polyphenols and tannins in two different kidney beans was done.

Beans could be soaked in water or other solutions prior to cooking in order to reduce cooking time [10, 11]. Cooking time is considerable in determining the cooking quality of pulses. Cooking time is the time required for beans to reach the acceptable cooked texture which varies among varieties [12, 13]. A reduction in cooking time is advantageous because it requires less energy and fuel. Consumers prefer beans that cook fast (e.g. less than 1 hour) to

those that are long cooking because it saves them on energy costs and time for preparation of meals. Thus the comparison of cooking time of two different commonly consumed kidney beans (on the basis of their size and color) was also studied.

Materials and Methods

Procurement of Sample

Two types of Sample was procured for the comparison one of small red kidney beans purchased from local market of Haldwani (Nainital) while another was large red kidney beans (local cultivar) purchased from local market of Pantnagar.

Processing of Sample

The samples were cleaned by hand to remove dirt, grit and broken grains and then packed in airtight plastic containers. Both the samples were well mixed separately and four lots of each were drawn by the quartering method [14]. One lot of both the samples was used for determination of cooking time, total phenols and tannin content of the raw samples while Second lot of both the samples were used to study the effect of soaking on cooking time and concentration of total phenols, tannins. From each lot, samples were drawn in triplicate for analysis. The main focus of the present study was to investigate processing technique (soaking) which was representative of those practiced in Indian households. Thus, the total phenol and tannin contents of kidney beans, which are usually soaked before pressure-cooking, were determined in raw, soaked only.

Soaking

A 500 g sample from the second lot of both the procured sample was soaked overnight for 12 h in tap water (1:5 w/v) at room temperature. The soaked samples were then drained and washed in running water and further divided into two equal parts.one part was used for estimation cooking time after soaking while another part was dried in oven at 50^0C for 6 hrs. The fully dried grains were subjected to grinding. The ground material was stored in air tight containers to study the effect of soaking on total phenol and tannin content. All chemicals and reagents used were of analytical grade.

Estimation of polyphenols

Total phenols

Total phenol content was estimated according to the method in which phenols react with phosphomolybdic acid in Folin-Ciocalteau reagent in alkaline medium and produce blue coloured complex (molybdenum blue) [15, 16]. 1.0 g of the sample was weighed and grinded with a pestle and mortar in 10 time volume of 80% ethanol. The homogenate was centrifuged at 10,000 rpm for 20 minutes and the supernatant was collected. The residue was Re-extracted with five times the volume of 80% ethanol, centrifuged and the supernatant was pooled. The supernatant was evaporated to dryness than the residue was dissolved in known volume of distill water (5ml). Different aliquots (0.2-2ml) were taken into test tubes. The volume was made up in each tube to 3 ml with water. 0.5 ml of Folin-Ciocalteau reagent was added. After 3 minute, 2ml of 20% sodium carbonate solution was added to each tube and Mixed thoroughly. The tubes were placed in boiling water for exactly one minute, cooled and the absorbance was measured at 650 nm against a reagent blank. A standard curve was prepared using different concentrations of Gallic acid.

Tannins

Tannins like compounds reduce phosphotungstomolybdic acid in alkali solution to produce a blue colored solution, the intensity of which is proportional to the amount of tannins. Tannic acid was estimated by colorimetric method (Folin-Denis method) [16]. Powdered sample (1 g) was transferred to a 250 ml conical flask and 75 ml water was added. Flask was heated gently and boiled for 30 min. It was centrifuged at 2000 rpm for 20 minutes and the supernatant was collected in 100 ml volumetric flask and made up the volume. 1 ml of sample was transferred to 100 ml volumetric flask containing 75 ml of water. A 5 ml of Folin – Denis reagent was added followed by addition of 10 ml of sodium carbonate solution and diluted to 100 ml with water. Solution was shaken well and absorbance was read at 700 nm after 30 minutes. A blank was prepared with distilled water instead of sample.

Estimation of Cooking Time

Cooking time of kidney beans before and after soaking was determined as per the method given by [17] with slight modification.

Cooking time before soaking

Hundred seeds of each sample with 300 ml water were put in a pressure cooker (Hawkins). The samples were cooked for 20, 30, 40, 50 minutes at 10 pounds per square inch (psi) pressure. Just after steam started coming out from the vent, times were recorded. Cooking time is generally assessed by the softness of the cooked seeds by applying pressure of the fingers [17] and percentage of cooked grains was counted.

Cooking time after soaking

Soaked beans were than cooked in the same way as given above for four different timings for 5,10,15,20 minutes. Cooking time was assessed in the same way as given above and the number of cooked grains was counted and was reported as percentage.

Statistical procedure

Data on the polyphenols content was calculated for their mean value and independent sample *t*-test and paired *t*-test was used for comparison of means and significance was accepted at 0.05 level of probability ($p < 0.05$) [18].

Results and Discussion

Total polyphenol and tannin contents of samples before and after soaking

In the present study, the total phenol content of the raw and soaked kidney beans has been estimated as mg/100g Gallic acid equivalents. The results on total phenol content of both the kidney beans have been given in **Table 1**. The data shows that the total phenol content in raw small red kidney bean was 2.23 mg/100g while the total phenol content of raw local cultivar was found to be 2.02 mg/100g. After soaking the total phenol content was significantly reduced to 2.04mg/100g with 9.31 percent reduction and 1.96mg/100g with 2.9 percent reduction for small red kidney bean and local cultivar respectively. Percent reduction in small red kidney beans after soaking was found to be higher than local cultivar. Statistically significant difference ($p<0.05$) has been observed between the values of total phenols in both the kidney beans.

Table 1 Total phenols and tannin content of small red kidney bean and local cultivar

Kidney beans	Total phenols (mgGAE/100g)	Percent reduction	*t*cal	Tannins (mgTAE/100g)	Percent reduction	*t*cal
Small raw	2.23±0.01	9.31	10.41*	6.66±0.75	56	5.13*
Small soaked	2.04±0.02			2.91±0.62		
Local raw	2.02±0.005	2.9	17.00*	4.78±0.62	37.65	2.72
Local soaked	1.96±0.005			2.98±0.63		

All values are the mean of triplicate observations ±SD,
t stat at 2*df* and 0.05 significance level – 4.30
*Significant at 0.05 level ($p<0.05$)

The tannin content of the raw and soaked kidney beans has been estimated as mg/100g tannic acid equivalents. As shown in Table 1, the tannin content of raw small red kidney bean was found to be 6.66 mg/100g which was reduced to 2.91 mg/100g with 56 percent reduction after soaking while the tannin content of raw local cultivar was found to be 4.78 mg/100g which was reduced to 2.98 mg/100g with 37.65 per cent reduction after soaking. Statistically no significant difference was observed between the values of tannins in both the raw kidney beans and between the tannin content of raw and soaked local cultivar but significant difference was found for tannin content values of raw and soaked small red kidney beans with higher percent reduction of tannins (56%) after soaking.

One author reported that the polyphenol content in unprocessed red kidney bean were significantly ($P<0.001$) decreased 13 percent after soaking in water [19]. Black or dark pigmented beans are reported to have higher amounts

of polyphenols [20] and the colour of red kidney beans is associated with the presence of condensed tannins (procyanidins) [21]. Since small red kidney beans were dark red in colour, the higher amount of total polyphenol content in these beans confer with the reports stating that the dark coloured beans normally contain higher concentration of total polyphenols [10, 22].

Tannin content in small red kidney beans was found to be higher due to the seed colour as tannins are positively correlated with seed coat colour [23]. In one study it was observed that the leaching losses during soaking of beans were highest for tannins among the anti-nutritional factor [24].

Cooking time

Cooking time for kidney beans was determined by cooking the grains in pressure cooker before and after soaking. These grains were subjected to different cooking time and it was observed that with the increase in time the percentage of cooked grains also increased. The general seed size, varietal differences in terms of external and internal composition, length and temperature of storage, bring about different water absorption and cooking characteristics of dry bean [25].

Cooking time before soaking

Cooking time of both the kidney beans was determined before soaking which is presented in **Table 2** and **Figure 1**. It is clear from the data that local cultivar took longer time to cook than the small red kidney bean. It took 30 minutes for small red kidney bean to be cooked to 80 percent. When cooked for 20 minutes small red kidney bean showed least cooking. At 50 minutes 100 percent of small red kidney bean was cooked. Local cultivar took 40 minutes to be cooked to 80 percent. At 30 minutes of cooking local kidney beans showed the least amount of cooked grains. At 50 minutes the highest percentage of cooked grains were observed in local cultivar. Time at which 80 percent bean seeds were cooked was taken as cooking time so that 30 minute was taken as the cooking time of small red kidney bean while 40 minute was estimated as the cooking time of local cultivar.

Table 2 Cooking time and Percent cooking of small red kidney beans and local cultivar cooked in pressure cooker before soaking

Cooking time (minutes)	Small red Percent cooking (raw)	Local percent cooking (raw)
20	38	32
30	82	68
40	90	84
50	100	97

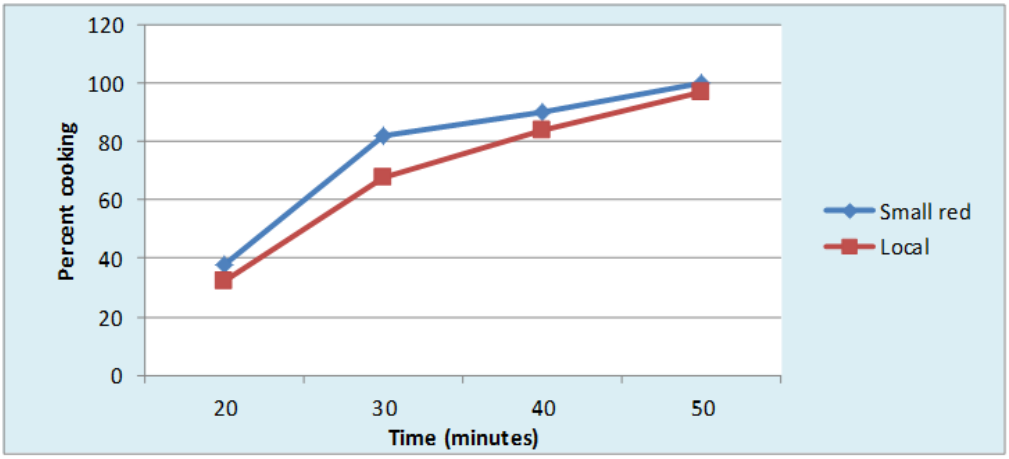

Figure 1 Percent cooking of small red kidney beans and local cultivar when cooked in pressure cooker without soaking

The results on cooking time of the beans in present study are consistent with [26] and [27] they found that small seeds hydrated even more than large seeds during soaking, a negative correlation was reported between seed size and hydration rate and the authors attributed it to the effect of a large surface area per unit mass of small seeds.

Cooking time after soaking

It was observed that after soaking the cooking time was reduced to 50-66 percent. Cooking times of both the kidney beans after soaking are presented in **Table 3** and **Figure 2**. Local cultivar took longer time to cook than the small red kidney bean. The least percentage of cooking was observed at 5 minutes for both the kidney beans. Cooking time was found to be 10 minute and 20 minute for small red kidney beans and local cultivar respectively as 80 percent seeds of both the kidney beans were cooked.

Table 3 Cooking time and Percent cooking of small red kidney beans and local cultivar cooked in pressure cooker after soaking

Cooking time (minutes)	Small red Percent cooking (soaked)	Local percent cooking (soaked)
5	62	56
10	89	70
15	100	79
20	100	88

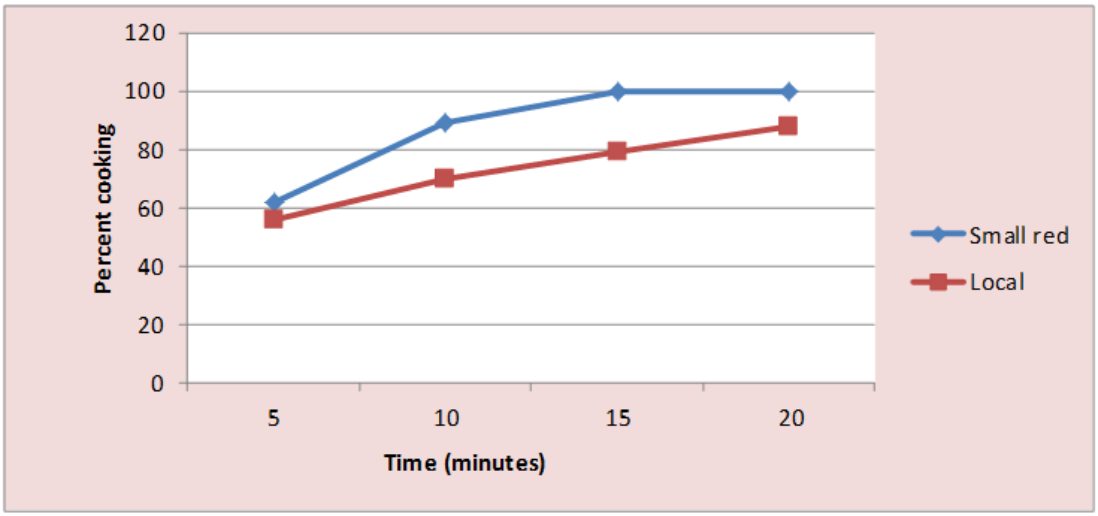

Figure 2 Percent cooking of small red kidney beans and local cultivar when cooked in pressure cooker after 12 hours soaking

Small red kidney beans Large red kidney beans (Local cultivar)

Small red kidney beans soaking

Large red kidney beans after soaking

Small red kidney beans after cooking

Large red kidney beans after cooking

Conclusion

Soaking assists in uniform expansion of the seed coat and cotyledon and is also essential for uniform cooking and tenderness. Total phenols and tannins were found in higher amounts in both the kidney beans and were significantly ($p<0.05$) reduced after soaking. Soaking of beans was found to reduce cooking time. The least percentage of cooking was observed at 5 minutes for both the kidney beans. Cooking time was found to be 10 minute and 20 minute for soaked small red kidney beans and soaked local cultivar respectively as 80 percent seeds of both the kidney beans were cooked. Raw and soaked local cultivar took longer time to cook than the small red kidney bean. Therefore soaking of legumes is necessary before consumption to ensure quality and safety. Small red kidney beans was found to be superior in terms of cooking time than the local cultivar.

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