Quick-cooking beans (*Phaseolus vulgaris* L.): I. Investigations on quality†

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Abstract. Soaking three beans cultivars (*Phaseolus vulgaris* L.: Great Northern, kidney, and pinto) in mixed salt solution (sodium chloride 2.5% + sodium bicarbonate 1.5% + sodium tripolyphosphate 1.0% + sodium carbonate 0.5%) resulted in 80%–85% reduction in cooking time over corresponding controls. Irradiation (γ-rays) at 500 krad of soaked and dehydrated beans caused a reduction of nearly 50% in cooking time. Water uptake and leaching losses for each treatment during soaking at 22°, 37°, and 45°C were investigated. High temperature (37° and 45°C) and pH (9.0) caused greater water imbibition and total solid loss than at room temperature (22°C). Organoleptic evaluation revealed that quick-cooking Great Northern beans appear to be more acceptable than kidney and pinto beans. Quick-cooking cooked beans had better in vitro protein digestibility than conventionally cooked beans. Phenolic content was found to be inversely related to in vitro digestibility.

**Introduction**

Grain legumes are economical sources of protein, calories, B-complex vitamins, and minerals. Nevertheless, they are considered secondary proteins, animal protein sources being utilized more extensively at a large cost differential. Low utilization of dry beans for food has been attributed to: (a) inconvenience due to prolonged preparation and cooking, (b) low protein quality associated with less than optimal proportions of sulfur-containing amino acids (particularly methionine), and (c) bloat, flatulence, and general gastrointestinal distress experienced after ingesting legume products. Quick-cooking bean products, developed by Rockland et al. [14, 17, 19], represent the first major change in the processing and utilization of dry beans since the introduction of canning more than 100 years ago.

Quality characteristics of cultivars of several California dry beans have been reported previously [13, 14]. The present study includes investigations on the effects of processing on physicochemical changes, cookability, organoleptic properties, and in vitro digestibility of quick-cooking Great Northern, red kidney, and pinto beans.

**Material and Methods**

Lot sizes of 25 lbs of beans (*Phaseolus vulgaris* L.), namely, Great Northern, dark red kidney, and pinto, were obtained from Bean Growers' Warehouse, Filer, Idaho, and stored at 4°C.

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Production of quick-cooking beans

Beans were blanched in boiling distilled water for 5 min to facilitate hydration and to loosen the seed coats. The blanched beans were soaked for 0–24 h in different soak solutions. The soak solutions contained 2.5% sodium chloride, 1% sodium tripolyphosphate, 1.5% sodium bicarbonate, and 0.5% sodium carbonate in 100 ml distilled water (all percentages wt/vol), and a combination of the above salt solutions hereafter abbreviated as MSS (mixed salt solution) (each at same corresponding concentrations), at temperatures of 22°, 37°, and 45°C, at pH 7.0 and 9.0. Food acidulants (citric, malic, and tartaric), each at concentrations of 0.1%, 0.5%, and 1.0% in 100 ml distilled water (wt/vol), were employed. Throughout, the bean–soak solution ratio was 1:3 (wt/vol). The soaked beans were rinsed with distilled water and portions were employed for direct cooking [in distilled water at 100°C, bean:water::1:5 (wt/vol)], freeze dehydration, and dehydration in conventional tray driers.

Soaked beans were dehydrated in conventional tray driers to a final moisture content of 10%–12%. An air velocity of 14 m/min and a temperature not greater than 55°C were maintained during drying. The soaked, dehydrated beans were subjected to γ-irradiation (137Cs). Beans were irradiated at room temperature (22°C), employing doses of 0, 100, 250, and 500 krads at the rate of 12 krads/h.

Physicochemical analyses

Moisture content of the samples was estimated by the AOAC method [2]. Amount of water imbibed during soaking was determined at intervals of 6, 12, 18, and 24 h by weight gain. Total solids leached during soaking were determined by drying aliquots of soak solution to constant weight. Hunter Color and Color Difference Meter was used to measure the changes in color of seed coats after processing. Tenderness or ‘doneness’ of beans was determined using a Warner Bratzler shear press, and the observations were expressed as average lb force/bean.

Tannins. A total of 200 mg bean meal (60 mesh) was extracted with 25 ml of absolute methanol for 24 h at room temperature (22°C) and centrifuged at 5000 g for 15 min. Aliquots of supernatants were assayed for total phenolic content according to the method of Burns [3], and expressed as phloroglucinol equivalents.

In vitro protein digestibility. The procedure followed was a modification of that of Romero and Ryan [2]. Sequential enzymatic hydrolysis of the bean proteins (bean flour) was carried out with pepsin followed by trypsin + chymotrypsin, at 37°C. The enzyme–substrate ratio in each case was 1:10 (wt/wt). The duration of each enzyme digestion was 4 h. The slurry was then