



ORIGINAL ARTICLE

Effect of Traditional processing Methods on Nutritional Quality of Field Bean

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ABSTRACT

Legumes are important sources of protein, carbohydrates, dietary fibre and minerals consumed worldwide. They are well adapted to a wide range of environmental conditions. However, only few have been promoted and extensively used. The Dolichos lablab bean is one of the lesser known legumes of arid and semi-arid regions. Nonetheless, it has been classified as a potential source of protein and might be of great importance in developing countries requiring indigenous food sources of high energy and good protein quality. A better understanding of the effect of different traditional processing methods; soaking (6, 12, 18 h), germination (40, 60 h), cooking (soaked, unsoaked), autoclaving (soaked, unsoaked) and roasting on the nutritive value and antinutritional factors, may lead to a wider use of this legume. Germination increases the moisture and protein content. Crude lipid and ash contents were reduced under the various processing methods followed. There was an increase in the carbohydrate content under all methods of processing except upon germination. Phytic acid content was significantly lowered, while tannins increased upon processing. A reduction in carbohydrate and lipid content in germinated Field bean is beneficial for people suffering from diabetes mellitus, cardiovascular disease and hypercholesterolemia. Germinated food products can be used in flour, beverages and weaning food.

Keywords: cooking, germination, nutrients, phytic acid, tannins

Received 16/06/2013; Accepted 20/07/2013

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INTRODUCTION

The importance of Field bean as a food crop has been documented in archeo-botanical finds in India prior to 1500 BC [1]. Its world-wide popularity can be demonstrated by more than 150 documented local names [2]. It has been grown substantially in tropical areas either as a sole crop or in mixed production systems. In spite of its many attributes, potential uses and stress adaptation, it has been classed under the 'underutilized' crops [3]. Within India, Field bean is mostly confined to the peninsular region and cultivated to a larger extent in Karnataka, Tamil Nadu, Andhra Pradesh and Maharashtra.

Legumes are important sources of proteins, carbohydrates, dietary fibre and minerals. Only a few of the known legume species are extensively promoted and used. Field bean is a marginally known legume having the potential of reducing protein deficiency in developing poorer nations. The young pods and unripe seeds of this plant are used as vegetables and the ripe seeds are used as pulse. It is a good source of protein, carbohydrate, dietary fibre and energy [4,5,6]. The young pods and dried seeds of Field bean contain 4.5 and 25 % protein respectively. In spite of their good nutritional qualities, legume consumption is declining worldwide. According to Iyer et al., [7] the necessity of extensive preparation and cooking time, and the occurrence of gastro-intestinal distress after ingestion are contributing to the abstention of the use of legumes. In addition, antinutritional factors interfere with protein and carbohydrate digestibility by forming complexes with proteins and minerals [8].

Untreated Field bean has been reported to possess high levels of anti-nutritional factors; such as trypsin inhibitors [6,9], tannins [6,10] and phytic acid [6,11]. High trypsin inhibitor activity in Field bean prevents protein metabolism while phytate phosphorous compromises mineral absorption [12]. In order to utilize the bean effectively as human food, it is essential to inactivate or remove these anti-nutritional factors. A better understanding of the effect of different traditional processing methods on the nutritive value and anti-nutritional factors, may lead to wider use of this legume in the food industry. The purpose of this study was to investigate the effect of soaking, cooking, roasting, autoclaving and germination on the nutritive value and anti-nutritional factors on Field bean.

MATERIALS AND METHODS

The seeds of *Dolichos lablab* (cv HA-4) were purchased from National Seed Project, University of Agricultural Science, GKVK, Bengaluru, India.

Processing and cooking methods

Soaking: Seeds were soaked in tap water at ratio 1:10 (w/v) at room temperature (25 ± 2 °C) for 6, 12 and 18h. The soaked seeds were washed twice with ordinary water followed by rinsing with distilled water and then dried in an oven at 60 °C to a constant weight [13]. Dried samples were ground, stored in an airtight plastic container for further analysis.

Cooking: The soaked seeds (12h in tap water) were cooked in beakers with a seed to water ratio of 1:5 and 1:6 (w/v) for soaked and unsoaked seeds, respectively. The water was allowed to boil before the addition of seeds. The seeds were cooked until soft as felt between fingers (about 10 min for soaked and 15 min for unsoaked seeds). The cooked samples were then mashed and dried in a hot air oven maintained at 60 °C and then ground to a fine powder and stored [13].

Autoclaving: The seeds soaked for 12h and unsoaked seeds were autoclaved for 15 min at 121 °C under 15lb/in. The ratio of seed to water was 1:5 (w/v) for unsoaked seeds and 1:4 (w/v) for soaked seeds. The autoclaved seeds were then mashed, dried at 60 °C, finely ground and stored [13].

Roasting: The seeds were roasted on trays at 160°C for 30 min according to Yanez [14].

Germination: The seeds were germinated in an incubator at 30 °C for 40 and 60h in trays lined with wet filter paper. The sprouted samples were dried in a hot air oven at 60 °C, ground and stored in glass bottles under refrigeration for further analysis [13].

Proximate composition analysis

The raw and processed samples were analyzed for the moisture, ash, fat, protein contents and total carbohydrate contents. Moisture content, total ash, crude fat and protein were determined according to the method described by the AOAC [15]. All determinations were done in triplicate and the results were expressed as the mean value. Total carbohydrate content of the sample was determined as total carbohydrate by difference, that is by subtracting the measured protein, fat, ash and moisture from 100 [16].

Determination of antinutritional components

Phytic acid: The determination of phytic acid was applied according to the method described by Wheeler and Ferrel [17]. Phytic acid was extracted from 3 g seed flour with 50 ml of 3% TCA by shaking at room temperatures followed by high speed centrifugation. The phytic acid in the supernatant was precipitated as ferric phytate by adding excess ferric chloride and centrifuged. The ferric phytate was converted to ferric hydroxide with a few ml of water and 3 ml of 1.5N NaOH, and then the iron content in the sample was estimated. The phytate phosphorous was calculated from the iron results assuming a 4:6 iron:phosphorous molecular ratio. The phytic acid was estimated by multiplying the amount of phytate phosphorous by the factor 3.55 based on the empirical formula $C_6P_6O_{24}H_{18}$.

Tannins: The modified vanillin-HCl method was followed with minor modification [18]. The amount of condensed tannins contents were calculated as catechin equivalent from the calibration curve of standard catechin (50-350 µg/ml). This was transferred to two sets of tubes and the volume in each of the tubes was made up to 1ml with methanol and then incubated at 30 °C in a water bath. 5 ml of vanillin-HCl reagent was added at an interval of 1min to one set of the tubes and 5 ml of 4% HCl was added to the other set at intervals of 1.0 min. The absorbance was recorded at 500 nm after incubation in a water bath 30 °C for 20 min. A difference of one minute was maintained as the color continues to develop when left for long time. The absorbance of the blank was subtracted from that of the sample containing vanillin-HCl reagent.

Statistical analysis

The experiment was performed using a randomized design. All data are expressed as means of triplicate experiments unless mentioned otherwise. Comparisons of means were performed using GraphPad Prism version 3.02. Data were subjected to a one-way analysis of variance (ANOVA), and the mean differences were compared by least standard deviations (LSD) test. Comparisons with $P \leq 0.05$ were considered significantly different.

RESULTS AND DISCUSSION

The gross chemical composition of nutrients and anti-nutritional factors of raw and treated Field bean are presented in Table 1. The moisture content significantly increased in soaked and germinated beans, whereas roasting drastically decreased the moisture content. This finding is similar to the results reported in green gram and Bengal gram [19]. With the progress of germination, legumes rapidly take up water from the surroundings to commence the metabolic processes. The increase in water uptake with

time is due to the increasing number of cells within the seed becoming hydrated [20]. Cooking and autoclaving did not have much effect on the moisture content.

Table 1: Effect of different processing methods on the chemical composition of Field bean

	Moisture	Ash	Protein	Lipid	Carbohydrates	Phytic acid	Tannins
Raw (Control)	5.23±0.01	3.00±0.02	22.41±0.12	1.92±0.02	67.44±1.21	501.33±5.0	0.51±0.01
Soaking							
6h	6.41±0.06	2.98±0.08	21.32±0.38	1.54±0.11	69.75±1.13	402.14±6.4	0.57±0.02
12h	6.64±0.05	2.79±0.07	21.00±0.37	1.47±0.04	70.54±0.82	387.54±4.1	0.61±0.04
18h	6.75±0.03	2.66±0.05	20.14±0.42	1.41±0.2	71.54±2.32	354.08±2.5	0.78±0.03
Germination							
40h	10.84±1.0	2.83±0.04	27.14±0.44	0.98±0.07	58.17±2.45	288.24±7.3	1.34±0.21
60h	11.35±0.98	2.59±0.07	27.29±0.71	0.93±0.04	55.75±1.88	217.28±3.9	1.41±0.09
Cooking							
unsoaked	5.00±0.02	2.11±0.03	22.00±0.35	1.05±0.08	70.04±0.34	318.34±4.9	0.98±0.08
soaked	5.13±0.04	2.05±0.06	20.59±0.64	0.97±0.02	70.26±1.98	287.24±3.9	0.95±0.04
Autoclaving							
unsoaked	5.17±0.08	2.72±0.07	21.12±0.47	0.98±0.03	70.54±2.39	312.42±5.2	0.87±0.03
soaked	5.15±0.11	2.67±0.08	20.87±0.33	0.89±0.01	71.22±2.56	319.50±6.1	0.82±0.05
Roasting	1.93±0.12	2.84±0.09	21.86±0.23	1.32±0.06	71.33±3.59	298.47±4.1	0.74±0.11

Ash content was significantly decreased in all treated samples with significant decrease found in cooked beans (Table 1), parallel to observations in soy bean [21], green gram, Bengal gram [19] and sesame [22]. The reduction in ash content might be due to the leaching out of both macro and micro elements into the soaking and cooking water.

The significant increase in protein content seen in germinating Field beans is attributed to increased water activity as a result of induction of hydrolytic enzymes [23], hormonal changes [20] or a compositional change following the degradation of other constituents. Similar increase in protein content was reported in African oil bean [24], mungbean [25] and Australian sweet lupin [26] upon germination. The minor decrease in protein content during soaking and cooking might be attributed to the leaching of soluble proteins [27].

Another major chemical component, total lipid content is a source of nutritional components and bioactive compounds such as mono- and polyunsaturated fatty acids, tocopherols and phytosterols. Lipid content was decreased in all processed samples (Table 1) with a significant decrease seen in cooked, germinated and autoclaved beans. Similar results were reported in soyabean [28], mungbean [29] and sesame [22] on germination. The decrease in fat content of seed could be due to total solid loss during soaking prior to these methods [30] or the use of fat as an energy source in sprouting process [22].

The total carbohydrate content was found to decrease in germinated Field bean and increase to a small extent under other methods of processing (Table 1). This reduction can be attributed to the utilization of carbohydrate as a source of energy for embryonic growth during germination [31]. Additionally, β -amylase activity that hydrolyzes the starch into simple carbohydrate was increased in a number of germinated legumes [32]. Starch in cotyledon is broken down into smaller molecules such as glucose and fructose to provide energy for cell division while the seeds mature and grow [31,20].

Fibre rich foods, such as cereals and legumes, contain high levels of phytic acid, the storage form of phosphorus. Phytates form insoluble complexes with zinc, iron, magnesium and calcium at physiological pH. Soaking the grain or legume in water of optimum pH, cooking the soaked seeds and germination of the raw seeds are known to reduce phytate content [33]. All methods of traditional processing of Field bean resulted in lowering of the phytic acid content (Table 1), the most significant reduction seen upon germination. Activation of phytase during germination promoted a significant reduction in phytates levels in wheat, black and white cultivars of beans, lentils, chickpea, peas [34,35,36] and soyabean [37]. Germination or malting has also been shown to improve the availability of iron in malted bajra and ragi [38]. Soaking in acid solution followed by cooking [39] and soaking in bicarbonate solution [40] caused decreased phytic acid content. Soaking prior to cooking or germination are simple and cost effective methods that can be used both in the home and by industries that produce food products for persons with high Ca and P requirements.

In contrast to phytic acid levels, the tannin content was significantly increased by the different treatments (Table 1). Germination and cooking of pre-soaked beans showed the highest increase in tannin followed by autoclaving, soaking and roasting. Similar results were reported in winged bean [41], pigeon pea [42] and sorghum [43]. The increment during germination may be due to solubilisation of insoluble tannins that are then brought to the surface [44]. However, when the seeds were pre-soaked and then treated, the tannin levels were lowered due to leaching during soaking and evaporation during boiling.

The many health benefits associated with the consumption of legumes include the control and prevention of diabetes mellitus and coronary heart diseases [45,46]. The decrease of carbohydrate and crude lipid levels upon germination and other methods of processing respectively are beneficial to patients suffering from diabetes mellitus, cardiovascular disease, hypercholesterolemia and obesity [47]. Germinated legumes can be used as flour [48], in beverages [49] and in weaning food [50].

In conclusion, this study indicated that traditional processing methods alter the biochemical composition of Field bean. The various processes significantly decreased the levels of phytic acid, whereas tannins were found to increase. Soaking, cooking of pre-soaked beans and germination hold good potential for improving the nutritional value of Field bean thereby increasing its utilization in food.

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Citation of This Article

Myrene R. D'souza. Effect of Traditional processing Methods on Nutritional Quality of Field Bean Adv. Biores., Vol4 (3) September 2013:29-33.