Pak. J. Sci. Ind. Res. 2003 ***46****(5) 358 - 362*

Effect of Cooking Method and Length of Cooking Time on Nutritive Value of Various Bean Broths

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(Received April 9, 2001; accepted March 27, 2002)

Nutritive value of various bean broths was evaluated. Black grams, chick-peas, lentil, red and white kidney beans were subjected to different cooking methods for different time periods. Cooked broth was analyzed for total solids, °Brix, protein, minerals and total soluble sugars to assess the nutritive value. Variable amounts of these nutrients were obtained in these broths depending upon the cooking method and cooking time. These nutrients in broth showed a significant increase with cooking time. Total solids and °Brix, in these bean broths varied from 8.10 - 30.00 and 5.40 - 20.00 g/l, whereas the amount of protein, minerals and soluble sugars ranged from 4.10 - 17.00, 2.20 - 5.80 and 1.20 - 4.80 g/l, respectively. However, maximum amount of nutrients in broth was obtained by pressure cooking of beans.

Key words**:** Beans, Nutritive value, Cooking method.

Introduction

Beans, widely cultivated and consumed through out the world, are excellent sources of protein (20-25%) and carbohydrates (50-60%) and are fairly good sources of minerals and vitamins (Aykroyd and Doughty 1977). They are used as a substitute of relatively expensive animal protein in human diet. However, their wide acceptability is adversely affected by the presence of tannins, saponins and other anti-nutritional substances (Hentges *et al* 1991; Morrow 1991; Stanley 1992). They are usually cooked after soaking in water (De-Leon *et al* 1992; Wah *et al* 1997). Most of the macro and micronutrients are lost during cooking of beans (Rincon *et al* 1993; Addy *et al* 1995). Losses in proteins have also been ascribed to different cooking processes of beans (Phirke *et al* 1982). During bean preparation for consumption, the broth is often discarded. Chicken and vegetable soups are commonly used in many parts of the world including Pakistan due to their high nutritional value, whereas the use of bean broth as soup is not well-known. Broth obtained from various beans can also be used as soup as they may also be rich in various nutrients. Therefore, it is pertinent to ascertain the nutritive value of various bean broths. Further, these broths can also be sweetened with sugar and served as a dessert (Barroga *et al* 1985). Thus, present work was undertaken to investigate the effect of common bean variety, cooking method and cooking duration on the nutritional qualities of bean broth in order to make use of broth for nutritional purpose.

Materials and Methods

Black grams (*Vigna mungo*), chick-peas (*Cicer arietinum*), lentils (*Lens culinaris*), red kidney beans (*Vicia faba*) and white kidney beans (*Vigna sinensis*) were obtained from Ayub Agricultural Research Institute, Faisalabad (Pakistan). The beans were cleaned to remove broken seeds, dust and other foreign materials and cooked by three different methods after soaking in water (5 g/l) for 4 h.

Ordinary cooking. Presoaked beans were put in a round bottom flask fitted with a condenser. Tap water (5 g/l) was added and the samples were cooked on a hot plate for different time periods.

Pressure cooking. Presoaked beans were placed in one litre beakers containing tap water (5 g/l). Tops of beakers were covered with aluminum foil and then cooked in a pressure cooker at 15 lbs/inch^2 for different time periods.

Microwave cooking. Presoaked beans were placed in one litre beakers containing tap water (5 g/l). Tops of beakers were covered and then cooked in a domestic microwave oven for different time periods.

Chemical analysis. After cooking, excess water (broth) in each case was collected and then subjected to chemical analysis to evaluate their nutritive value.

Total solids of broth were determined by oven drying at 100°C for 24 h. Total minerals (ash) were estimated after ignition of dried material at 550 ± 5°C in a muffle furnace for a period of 4 h, while protein contents of the broth were estimated after digestion with concentrated sulphuric acid according to micro Kjeldahl method (AOAC 1984). Brix of the broth was determined by using a hand refractrometer, whereas total soluble

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Table 1
Total solids and °Brix of various bean broths (g/l)*

Type of cooking	Cooking time (min)	Total Solids					°Brix				
		Black gram	Chick-peas	Lentils	Red kidney beans	White kidney beans	Black gram	Chick-peas	Lentils	Red kidney beans	White kidney beans
Ordinary cooking	30	13.00 ± 0.73	12.30 ± 0.37	8.10 ± 0.44	21.30 ± 1.73	21.70 ± 1.34	6.00 ± 0.46	6.30 ± 0.41	6.90 ± 0.36	16.00 ± 0.77	16.30 ± 0.44
	60	16.40 ± 0.59	15.50 ± 0.56	10.03 ± 0.42	24.70 ± 1.63	25.70 ± 1.36	7.20 ± 0.73	7.70 ± 0.32	8.00 ± 0.40	17.50 ± 0.88	17.90 ± 0.73
	90	19.70 ± 0.73	18.80 ± 0.67	12.20 ± 0.39	27.50 ± 1.39	28.20 ± 1.44	9.30 ± 0.80	9.60 ± 0.28	9.80 ± 0.29	19.00 ± 0.90	19.10 ± 0.77
Pressure cooking	5	15.10 ± 0.82	14.60 ± 0.73	14.90 ± 1.00	24.40 ± 1.11	23.90 ± 1.74	6.40 ± 0.44	6.80 ± 0.22	7.20 ± 10.37	16.40 ± 0.67	16.80 ± 0.94
	10	18.60 ± 0.93	18.40 ± 0.82	16.00 ± 1.26	27.30 ± 1.84	27.60 ± 1.39	7.70 ± 0.60	8.40 ± 0.34	9.00 ± 0.44	17.70 ± 0.42	18.60 ± 0.46
	15	22.50 ± 1.20	20.70 ± 1.00	18.10 ± 0.83	30.00 ± 2.06	29.00 ± 1.09	9.80 ± 0.93	9.90 ± 0.33	10.70 ± 0.73	19.80 ± 0.49	20.00 ± 0.59
Microwave cooking	2	11.20 ± 1.11	10.70 ± 0.39	11.60 ± 0.33	20.70 ± 2.01	20.00 ± 2.22	5.70 ± 0.33	5.40 ± 0.81	6.00 ± 0.26	15.70 ± 0.53	16.00 ± 0.55
	4	14.10 ± 0.82	14.20 ± 1.02	14.90 ± 0.46	23.00 ± 1.77	23.90 ± 1.77	6.90 ± 0.40	7.00 ± 0.84	7.20 ± 0.22	16.70 ± 0.55	17.20 ± 0.77
	6	17.20 ± 1.02	17.20 ± 1.02	16.50 ± 0.49	25.90 ± 1.53	26.10 ± 1.40	8.60 ± 0.42	9.00 ± 0.49	8.80 ± 0.71	18.30 ± 0.85	18.80 ± 0.61

* Mean ± S.D. of Triplicate determinations.

sugar of the broth was determined by following the method as described by Yemm and Willis (1954). Total polyphenols in broth were determined by Vaillin-sulphuric acid method on spectrophotometer at 500 nm as described by Wilson and Blunden (1983). All determinations were carried out in triplicate and standard deviations (S.D.) were calculated according to the method of Steel and Torrie (1980). Duncan's multiple range test was applied to determine significant difference ($P < 0.05$).

Results and Discussion

Variable amounts of nutrients including protein, minerals and soluble sugars were present in the broth of black grams, chick-peas, lentils, red and white kidney beans. However, significant variation in total solids amongst varieties, cooking methods and cooking times was observed. Total solids in broth of red and white kidney beans ranged 20.70 - 30.00 and 20.00 - 29.00 g/l, whereas 8.10 - 18.10,11.20 - 22.50 and 10.70 - 20.70 g/l total solids were present in broths of lentils, black grams and chick-peas, respectively (Table 1). These results are in agreement with the observations of other workers who found significant variation in total solids of broth from bean seeds of three varieties (Gupta and Wagle 1987). Different cooking methods extracted total solids in broth to various extents. However, amount of total solids in broth was significantly ($P < 0.05$) higher after pressure - cooking compared to ordinary and microwave cooking. In fact, pressure - cooking caused greater destruction to tissue cells of beans, which consequently leached out greater amount of solids from bean seeds. It was also observed that total solids in broth also increased with increase in cooking time, suggesting that there was an increase in dispersion of solids from the beans with cooking time. The results for the °Brix are also reported in Table 1. There was a significant difference in soluble solids between varieties, cooking method and cooking time. °Brix in broth was also distinctly higher on cooking beans in a pressure cooker (6.40 - 20.00 g/l) compared to other cooking methods (5.40 - 19.10 g/l). On cooking in a domestic microwave oven least amount of °Brix (5.40 - 18.80 g/l) was obtained in broth. However, total soluble solids of the bean broth from these beans increased with increase in cooking time. It is apparent that longer the beans are cooked, the higher is the dispersion of solids and other soluble nutrients into the cooking medium. Similar observations had been made by Narasimha and Desikacher (1978) during cooking of split red beans.

Table 2 contains the protein contents in bean broth. Significant difference ($P < 0.05$) was observed between the varieties, cooking methods and cooking times. Highest protein content in broth was obtained from red kidney beans (8.10 - 17.00 g/l) and the lowest from lentils (4.10 - 9.20 g/l). Protein contents in broth were again comparatively higher in case of pressure-cooking compared to other cooking methods. Cooking time was also positively related to protein content in all the varieties of beans, probably as cooking continues, more bean seed

Table 2
Protein contents of various bean broths (g/l)*

Type of cooking	Cooking time (min)	Protein contents: Black gram	Chick-peas	Lentils	Red kidney beans	White kidney beans
Ordinary cooking	30	8.20 ± 0.44	16.00 ± 0.22	4.20 ± 0.21	9.00 ± 0.19	8.00 ± 0.26
	60	9.00 ± 0.56	7.00 ± 0.26	6.00 ± 10.19	12.02 ± 0.11	11.70 ± 0.43
	90	10.30 ± 10.63	9.00 ± 10.27	8.50 ± 0.28	14.00 ± 0.11	12.70 ± 0.44
Pressure cooking	5	9.00 ± 0.29	7.30 ± 0.29	6.00 ± 0.1	12.50 ± 0.21	12.00 ± 10.39
	10	12.00 ± 0.36	8.80 ± 0.22	7.80 ± 0.24	12.50 ± 0.36	14.60 ± 0.33
	15	14.00 ± 10.40	10.60 ± 3.33	9.20 ± 0.24	17.00 ± 0.16	16.60 ± 0.31
Microwave	2	6.00 ± 0.22	5.20 ± 0.21	4.10 ± 0.20	8.10 ± 0.19	7.40 ± 0.30
	4	8.80 ± 0.29	6.40 ± 0.20	5.50 ± 0.25	11.00 ± 0.26	10.60 ± 10.26
	6	10.20 ± 0.33	7.70 ± 0.19	8.00 ± 0.36	12.00 ± 0.32	12.00 ± 0.22

* Mean ± S.D. of Triplicate determinations.

materials disperse into the cooking medium carrying with them protein content, as reported by Ekpenyong and Borcheres (1980). Variation in protein content of bean broth with bean variety observed in this study is in agreement with findings of earlier workers (Okezie and Martin 1980; Kailasapathy and Nagalingam 1987). Protein contents in broth could be attributed to partial removal of certain essential as well as non-essential amino acids along with other nitrogenous compounds from the bean seeds during cooking process. Total soluble sugars of the bean broth from different varieties of beans are reported in Table 3. Significant variations in total soluble sugars between the varieties, cooking methods and cooking times were observed. Different cooking methods extracted total soluble sugars to various extents. However, maximum amount of total soluble sugars was present in broth, cooking in a pressure cooker. Cooking time was observed to be positively related to total soluble sugars. These observations are in agreement with Rao and Belavady (1978) who reported that cooking resulted in a distinct increase in soluble sugars. In fact, increase in the level of soluble sugars occurred mainly because of their increased solubility in water on cooking as it has already been reported by earlier workers (Sudesh *et al* 1986).

The results for total minerals in broth are also shown in Table 4. Maximum amount of minerals was present in broth, obtained after cooking beans in pressure cooker. This suggests that cooking under pressure extracted maximum amount of nutrients due to greater destruction of the tissue cells of beans. It is apparent that longer the bean seeds are cooked, higher is the dispersion of solids and other soluble nutrients including minerals into the cooking medium. This observation suggests that cooking was positively related to mineral contents. The findings of Kon (1979) also revealed that cooking caused some of the bean cells to separate rather than to break as a result of which cell contents including protein, sugars and minerals were released to the cooking medium and consequently, increased nutrients in bean broth.

Variable amounts of total polyphenols were present in broth of different beans (Table 5). General observation revealed that the amount of total polyphenols was comparatively higher in broth of coloured beans compared with white beans. Amount

Table 3
Total soluble sugar (g/l)* of various bean broths

Type of cooking	Cooking time (min)	Bean variety: Black gram	Chick-peas	Lentils	Red kidney beans	White kidney beans
Ordinary cooking	30	2.10 ± 0.11	1.70 ± 0.07	1.50 ± 0.06	2.40 ± 0.12	2.00 ± 0.13
	60	2.50 ± 0.14	2.00 ± 0.11	1.80 ± 0.07	3.00 ± 0.19	2.70 ± 0.16
	90	3.60 ± 0.14	3.10 ± 0.12	2.60 ± 0.07	3.70 ± 0.16	3.10 ± 0.18
Pressure cooking	5	3.30 ± 0.09	3.40 ± 0.17	2.70 ± 0.07	3.20 ± 0.17	2.80 ± 0.11
	10	4.00 ± 0.13	3.90 ± 0.11	3.40 ± 0.11	4.00 ± 0.22	3.50 ± 0.15
	15	4.80 ± 0.17	4.60 ± 0.14	4.10 ± 0.15	4.50 ± 0.21	4.00 ± 0.15
Microwave cooking	2	1.80 ± 0.09	1.50 ± 0.07	1.20 ± 0.11	2.00 ± 0.19	1.60 ± 0.19
	4	2.20 ± 0.08	2.00 ± 0.06	1.70 ± 0.12	2.40 ± 0.11	2.10 ± 0.11
	6	3.00 ± 0.06	3.20 ± 0.09	2.20 ± 0.14	3.00 ± 0.15	2.70 ± 0.13

* Mean ± S.D. of Triplicate determinations

Table 4
Total minerals (g/l)* of various bean broths

Type of cooking	Cooking time (min)	Bean variety				
		Black gram	Chick-peas	Lentils	Red kidney beans	White kidney beans
Ordinary cooking	30	2.80±0.16	2.50±0.11	2.70±0.15	2.60±0.14	2.90±0.11
	60	3.90±0.17	3.50±0.16	3.80±0.16	3.90±0.16	3.80±0.11
	90	4.40±0.19	4.00±0.17	4.90±0.11	4.20±0.11	4.00±0.15
Pressure cooking	5	3.30±0.11	3.00±0.13	3.20±0.12	3.60±0.19	3.50±0.16
	10	4.40±0.13	4.10±0.14	4.40±0.15	4.20±0.18	4.60±0.19
	15	5.70±0.17	5.00±0.12	5.70±0.11	5.00±0.16	5.80±0.18
Microwave cooking	2	2.20±0.16	2.20±0.16	2.40±0.17	2.00±0.15	2.40±0.18
	4	3.00±0.17	3.00±0.17	3.10±0.19	3.10±0.13	3.30±0.15
	6	4.00±0.13	3.70±0.16	4.00±0.13	3.60±0.13	4.10±0.16

* Mean ± S.D. of Triplicate determinations

Table 5
Total polyphenols (g/l)* in various bean broths

Type of cooking	Cooking time (min)	Bean variety				
		Black gram	Chick-peas	Lentils	Red kidney beans	White kidney beans
Ordinary cooking	30	0.25±0.05	0.14±0.01	0.18±0.05	0.21±0.04	0.10±0.02
	60	0.27±0.01	0.16±0.03	0.20±0.06	0.25±0.05	0.13±0.01
	90	0.28±0.02	0.19±0.02	0.22±0.02	0.28±0.03	0.16±0.03
Pressure cooking	5	0.28±0.04	0.17±0.03	0.20±0.01	0.36±0.03	0.17±0.04
	10	0.34±0.02	0.20±0.06	0.29±0.02	0.39±0.02	0.19±0.05
	15	0.35±0.03	0.21±0.02	0.24±0.01	0.42±0.01	0.21±0.04
Microwave cooking	2	0.24±0.04	0.11±0.01	0.13±0.04	0.18±0.02	0.12±0.02
	4	0.26±0.04	0.14±0.04	0.16±0.04	0.22±0.02	0.14±0.02
	6	0.29±0.05	0.15±0.04	0.19±0.03	0.24±0.04	0.18±0.01

* Mean ± S.D. of Triplicate determinations

of total polyphenols in black grams and red kidney beans was higher and ranged from 0.24 - 0.35 and 0.18 - 0.42 g/l, respectively. However, least amount of total polyphenols in white kidney beans and chick-peas were observed from 0.10 - 0.21 and 0.11 - 0.21g/l, respectively. These results are in accordance with our previous findings of other workers who found that the amount of polyphenols in red kidney beans was higher than white kidney beans (Rehman and Shah 1996). It is also apparent from these results, that cooking method and cooking time affected the extraction of the anti - nutrients from the beans to various extents. However, amount of the anti - nutrients in broth is so low that it would not adversely affect the nutritional quality of broth. Therefore, bean broth can safely be used for the preparation of soups and desserts for human consumption.

Conclusion

It is apparent from this study that the nutritive value of bean broth varied with cooking method, cooking time and bean varieties. Different cooking methods extracted different nutrients from the beans to various extents. However, pressure-cooking extracted comparatively more nutrients from beans than ordinary and microwave cooking methods. The concentration of proteins, soluble solids, soluble sugars and minerals increased in broth with increase in cooking time. Therefore, it may be concluded that broth of various beans con-

tains considerable amount of valuable nutrients, hence these may be used for soup and dessert preparations.

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