Sarhad J. Agric. Vol.27, No.2, 2011

EFFECT OF HOME COOKING ON THE RETENTION OF VARIOUS NUTRIENTS IN COMMONLY CONSUMED PULSES IN PAKISTAN

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ABSTRACT

Four different types of pulses viz. chickpea (Cicer areitinum L.), lentil (Lens culinaris L.), mungbean (Vigna radiata L.) and mashbean (Phaseolus aureus L.) were analyzed both in raw and cooked forms for proximate composition and mineral elements (Na, K, Ca, Mg, Fe, Cu, Zn and Mn) in order to study the retention of each nutrient. In all four pulses, retention of protein, lipid and crude fiber ranged from 82.94-93.89, 78.94-114.20, 86.11-123.90%, respectively. The retention of ash content ranged from 67.17 to 76.19% while that of Nitrogen Free Extract (NFE) ranged from 76.82-86.30% in all four pulses. Amongst the mineral elements, the percent retention was 73.17-104.90, 58.17-107.90, 78.70-238.20, 65.87-72.73, 65.50-117.81, 61.11-91.33, 67.23-129.7, and 76.40-103.10 for Na, K, Ca, Mg, Fe, Cu, Zn and Mn, respectively. Maximum retention value (238.20%) was observed for Ca in chickpea and minimum (58.17%) for K in mungbean. On the average, the retention values of Na, K, Mg, Cu, Zn and Mn were lower but the losses were nutritionally negligible.

Key Words: **Chikpea, lentil, mungbean, retention of protein, lipid and crude**

Citation: Shah, H.U., U.L. Khan, S. Alam, A.A. Shad, Z. Iqbal and S. Parveen. 2011. Effect of home cooking on the retention of various nutrients in commonly consumed pulses in Pakistan. Sarhad J. Agric. 27(2): 279-284

INTRODUCTION

As rich sources of protein, calories, certain minerals and vitamins, legumes play an important role in human nutrition (Deshpande, 1992). In Afro-Asian diets, legumes are the major contributors of protein and calories for economic and cultural reasons (Amjad, 2003). They are mainly grown for their edible seeds, and thus also named as grain legumes. The decorticated or dehulled seeds of legumes are known as pulses. In Pakistan, food legumes covered an area of about 1.5 million ha with a total production of about 1.09 million tons (Anonymous, 2004-2005).

Chickpea, also called Bengal gram or chana (*Cicer areitinum L*.) is an important grain legume. It is used as pulse (dhal) with cereals, grown in both tropical and temperate regions of the world especially in the Southeast Asian countries, including Pakistan. Chickpea is a good source of protein (Hulse, 1991) and improves the nutritive value of cereal-based diets (Singh *et al.* 1988). Chickpea protein is rich in lysine and arginine but most deficient in the sulphur containing amino acids, such as methionine and cystine (Boulter *et al.* 1976). In addition to carbohydrates and vitamins, chickpea is also a good source of micro and macro mineral such as phosphorus, potassium, magnesium, iron and zinc**.**

Lentil (*Lens culinaris L.)* plays a significant role in human nutrition. Its seeds are a good source of dietary protein and calories. Its high nutritive value, digestibility, shorter cooking time and low price make it an attractive item in food menu. Lentil is thus often considered as the poor-man dish. (Khalil and Jan, 2002). The lentil seeds are usually boiled with water and salt. The resulting mixture or paste, called 'Dhal' is eaten with cereal bread, or boiled rice. Lentil seeds are also cooked to make soup and porridge, or fried and seasoned as a snack food. The seeds can also be utilized as poultry feed. Lentil seeds contain about 24 % protein, 58 % carbohydrates and 2% each of fat and fiber. It provides 3460 Cal. kg^{-1} in human diet (Khalil and Jan, 2002).

Mungbean (*Vigna Radiata L*.), also called green gram, is a tropical legume, widely grown in Asia. Mungbean seeds are primarily used for food purposes. They are rich source of protein and lysine, and thus can supplement cereal-based human diets. The whole or split seed is usually cooked as dhal or boiled with rice. The seed may be milled and ground into flour for making noodles, breads and soups. The spiced roasted seeds of mungbean are sometimes eaten as snake food. In rural areas, the immature green pods are also used as vegetable. Dry seeds of mungbean contain about 10 moisture, 22 crude protein, 60 carbohydrates and 3.5% ash. They contribute 3400 Cal. kg^{-1} dry seeds (Khalil and Jan, 2002).

Mashbean (*Phaseolus aureus L.)*, also called "black gram" is a related species of mungbean. Like mungbean, mashbean is also a rich source of protein in human diet and livestock feed. It is used in the same way as mungbean. The seed composition of black gram is similar to that of green gram, containing 22 to 24% protein and 60 to 64% carbohydrate on dry weight basis. It contributes 2400 to 2500 Cal. Kg^{-1} of dry seed (Khalil and Jan, 2002).

In Pakistan, legume grains are processed and cooked in a variety of methods based on tradition and taste preferences. Various processing and cooking methods affect the levels of nutritional and anti-nutritional factors (Jood *et al.* 1987; Kakker 1992; Wang *et al.* 1997) of legume grains.

Information is needed on the content and variability of these nutrients in these pulses in both raw and cooked form. Thus, a study was undertaken to investigate the effect of ordinary cooking methods on the nutrients retention of commonly consumed legumes in Pakistan.

MATERIALS AND METHODS

Seed samples (2 Kg of each) of four different commonly consumed legumes namely chick pea, lentil, mashbean and mungbean were collected from local markets of five main cities (Karachi, Lahore, Peshawar, Islamabad and Quetta) of Pakistan in the months of March-April, 2007. Seeds were cleaned and freed from broken seeds, dust and other foreign materials. All the samples were packed in polypropylene bags and kept at 4ºC for further analysis.

Preparation and Cooking Methods

Samples Preparation

All the samples were washed with tap water to remove dust and then with de-ionized water. The samples were dried to original dryness (Rehman *et al.* 1988). Half of the seed from each lot was kept for cooking experiments. The remaining was ground in a laboratory micro-mill to pass a 1 mm sieve and stored at room temperature for further chemical analysis.

Cooking

Approximately 500 gm seeds of each legume were cooked in round mouthed beakers fitted with condensers using a seed to water ration of 1:5 W/V (Rani *et al.* 1996) at 95-100ºC for 60 min. The seeds were boiled till they became tender and there was no hard material left (Khalil *et al.* 2007). The cooked samples were strained and their weights were recorded. The cooking water was collected in conical flasks and stored at 4ºC for further analysis. After determining the moisture content, the cooked seeds were oven dried at 55ºC and ground in a cyclone sample mill using 1mm sieve and stored at room temperature in plastic containers at room temperature until required for further analysis.

Chemical Analysis

Proximate Composition

Proximate chemical composition analysis of the raw and cooked seeds and cooking water including moisture, total ash; crude protein, crude fiber, crude fat and lipid content were performed according to AOAC (2000) official methods 925.09, 923.03, 979.09, 962.09, 4.5.01 and 923.05, respectively. Total carbohydrates excluding crude fiber were calculated by difference. Crude protein, crude lipid and crude fiber were analysed using Kjeldahl block digestion and steam distillation (2200 Kjeltec Auto distillation, Foss Tecator, Sweden), Sox Tec service unit 1046 and Fibertec I and M systems (Foss Tecator, Sweden), respectively.

Mineral Analysis

Mineral contents in the samples of both raw and cooked pulses as well as in cooking water were determined by the standard methods of AOAC (2000). The dried samples were wet acid digested using a nitric acid and perchloric acid mixture (HNO_3: $HClO_4$, 5:1 w/v). Na and K were determined by flame photometer (Genway PFP 7, England) while Ca, Mg, Cu, Zn, Fe and Mn were determined by atomic absorption spectrophotometer (Perkin Elmer, England) (Lindsey and Norwell 1969, Alam *et al.* 2007). The cooking water was filtered through wattman No. 2 filter paper and analyzed for the above mentioned elements.

Nutrient Retention

The % true retention (TR) of nutrients was calculated by the following the formula of Murphy *et al.* (1975)

$$\%TR = \left\{ \frac{\text{Nutrient content/g of cooked seed x g of seed after cooking}}{\text{Nutrient content/g of raw seed x g of seed before cooking}} \right\} \text{x } 100$$

Statistical Analysis

The data recoded on various parameters was statistically analyzed using Completely Randomized Design (CRD) with GLM procedure of Statistical Analysis System (SAS, 2002). Each mean was the average of three observations. Means were separated by Least Significant Difference (LSD) test at 5.0% level of significance (SAS, 2002).

RESULTS AND DISCUSSION

Proximate Composition

(Table I) represent the proximate composition of the raw, cooked and cooking water of pulses. Moisture content was found to be 9.51, 9.22, 6.94 and 6.94% in raw samples of chickpea, lentil, mungbean and mashbean, respectively. Maximum percent increase (1304 %) of moisture content over control was observed in mungbean cooking water. The moisture content of the cooked pulses was higher than the raw pulses due to absorption of water during cooking which had a dilution effect on all other nutrients (Rehman and Khalil, 1988). The protein content in the raw chickpea, lentil, mungbean and mash bean was investigated to be 22.10, 23.18, 22.06 and 22.59%, respectively. Traditional cooking had a negative impact on protein content and maximum decrease was observed in mungbean (-58% over control) in cooked samples. Analysis of cooking water of all samples showed appreciable quantities of proteins showing the solubility of proteins in water. Other workers also observed effect of processing on protein contents of legumes (Akinyele, 1989). Heat processing increased the protein digestibility most likely by destroying heat labile protease inhibitors and by denaturing other protein globulins highly resistant to proteases in the native state (Rani *et al.* 1996). The lipid content in raw chickpea, lentil, mungbean and mashbean was found to be 3.54, 3.60, 2.92 and 3.01%, respectively. Lipid content was progressively decreased in both cooked and cooking water in all samples except in the samples of cooked chick pea where an increase (+6%) occurred in cooked samples. In the present study, the effect of cooking treatments had significant influence on fat contents as has already been substantiated by other researchers (Akinyele, 1989; Jood, 1998).

Table-I ***Effect of processing methods on proximate composition of pulses***

Pulse	Treatment	Moisture (%)	Proteins (%)	Lipid (%)	Fiber (%)	Ash (%)	NFE (%)
Chick Pea	Raw	9.51c	22.10a	3.540a	4.70a	2.70a	58.70a
	Cooked	48.90b (+414)	12.28b (-44)	3.77a (+6)	3.59b (-24)	1.35b (-50)	29.88b (-49)
	Cooking water	95.88a (+908)	0.44c (-98)	0.08b (-98)	0.22c (-95)	0.65b (-76)	2.70c (-95)
	LSD ($P \leq 0.05$)	2.71	4.37	1.12	0.75	0.92	2.67
Lentil	Raw	9.22 c	23.18a	3.60a	4.96a	3.38a	57.16a
	Cooked	64.88b (+604)	13.06b (-44)	1.34b (-63)	2.23b (-55)	2.08b (-38)	16.54b (-71)
	Cooking water	98.12a (+964)	0.29c (-99)	0.03c (-99)	0.18c (-96)	0.28c (-92)	1.36c (-98)
	LSD ($P \leq 0.05$)	0.76	0.54	1.25	1.04	0.80	0.84
Mung Bean	Raw	6.94c	22.06a	2.920a	3.77a	3.05a	63.25a
	Cooked	65.26b (+840)	9.307b (-58)	0.690b (-76)	1.03b (-73)	2.66a (-13)	20.89b (-67)
	Cooking water	96.36a (+1288)	0.580c (-97)	0.120c (-96)	0.20c (-95)	0.34b (-89)	2.260c (-96)
	LSD ($P \leq 0.05$)	2.81	2.06	0.46	0.38	0.40	6.37
Mash Bean	Raw	6.94c	22.59a	3.007a	3.17a	3.41a	52.84a
	Cooked	62.00b (+793)	10.58b (-53)	1.090b (-64)	1.70b (-46)	1.49b (-56)	22.63b (-57)
	Cooking water	97.42a (+1304)	1.070c (-95)	0.030c (-99)	0.290c (-91)	0.25c (-93)	1.113c (-98)
	LSD ($P \leq 0.05$)	7.37	5.10	0.82	0.44	0.25	2.68

Figures in each column followed by same letters are not significantly different at $P \leq 0.05$
Figures in parentheses indicate percent increase (+) and decrease (-) over the control (raw) values

Crude fiber was in the range of 3.17-4.96% in the raw samples of all the four selected pulses. Cooking significantly decreased the crude fiber content and the maximum decrease (-96 % over control) was observed in the cooking water of Mungbean. The ash content was found to be 2.70, 3.38, 3.05 and 3.41% in the raw samples of chickpea, lentil, mungbean and mashbean, respectively. A significant effect of cooking was observed on ash content of the pulses (Table I). The substantial reduction of ash content in the processed seeds might be due to the leaching of both micro and macro elements into the water through the mechanically broken and enhanced permeability of seed coats when compared to the unprocessed seed sample. Similar results have also been reported in soya bean (*Glycine max*) and lima bean (*Phaseolus lunatus*), when samples were subjected to the autoclaving process (Aletor and Ojo, 1989). Nitrogen free extract (NFE), calculated by difference, was observed to be 58.70, 57.16, 63.25 and 52.84% in the raw samples of chickpea, lentil, mungbean and mashbean, respectively. Both the cooked and cooking water had a significantly lower amount of NFE than the raw forms. In fact, reduction in the levels of available carbohydrates with these treatments occurred mainly because of their solubility in water as has already been observed by earlier workers in other beans (Silva and Braga, 1982; Sudesh *et al.* 1986, Rehman *et al.* 2001).

Mineral Composition

Sodium, potassium, calcium, magnesium, iron, copper, zinc and manganese contents of raw chickpea were 129.01, 1258.01, 155.20, 200.40, 5.20, 2.52, 3.62 and 1.60 mg $100g^{-1}$, respectively (Table II) and (Table III). Cooking had a significant effect on the mineral contents of chickpea ($P \leq 0.01$). A significant amount of iron in cooking water of chickpea showed its solubility in hot water. Sodium contents of the raw and cooked pulses were significantly higher than the values reported by Khalil and Khan (1994) and Meiners *et al.* (1976). The reason for higher values of sodium in the pulses is not clearly known; however, the difference may be due to genetic, soil and environmental factors or some contamination. A similar trend was observed for the mineral contents of lentil, mungbean and mashbean. On cooking all the eight minerals were significantly reduced in all pulses. However an increased amount of Fe was observed in cooking water of all pulses. The increase of iron in cooking water was found be 178, 33, 162 and 149% in chickpea, lentil, mungbean and mashbean respectively. The loss in minerals on cooking may be attributed to leaching out of these minerals into the cooking water (Grewal and Jood, 2006).

Ordinary cooking treatments proved to be beneficial for effective utilization and for improvement of acceptability of food grains. In the present study the effect of cooking treatments had a significant influence on mineral contents. A significant improvement in availability of Fe was also observed on cooking treatments compared to the unprocessed treatment, which may be due to leaching out of antinutrients (Kakker 1992). Phytate, the major phosphorus-bearing compound in cereals and pulses, chelates divalent and trivalent cations, like Ca, Fe and Zn, forming insoluble complexes and thereby decreasing the availability of minerals in humans (Vohra *et al.* 1965). The decrease in phytic acid content, possibly through its destruction by heat treatments, may result in the divalent and trivalent cations being freed from the phytate mineral complexes thus accounting for the improved availability of minerals in processed seeds. Reduction in Fe availability by the presence of phytate has also been reported in red gram, Bengal gram and green gram (Murthy *et al.* 1985; Hazel1 and Johnson 1987; Khalil *et al.* 2007).

Table-II ***Effect of cooking methods on mineral content (mg/100gm) of pulses***

Pulse	Treatment	Na	K	Ca	Mg
Chick Pea	Raw	129.01a	1258.01a	155.20a	200.40a
	Cooked	70.40b (-45)	390.50b (-69)	75.40b (-51)	33.13b (-83)
	Cooking water	28.40c (-78)	55.73c (-96)	29.20c (-81)	31.20b (-84)
	LSD (P≤0.05)	5.38	11.2	11.17	11.27
Lentil	Raw	121.80a	1144a	126.60a	207.20a
	Cooked	50.50b (-59)	274.90b (-76)	65.13b (-49)	34.90b (-83)
	Cooking water	22.87c (-81)	50.73c (-96)	28.73c (-77)	29.60b (-86)
	LSD (P≤0.05)	4.341	11.98	10.19	16.75
Mung Bean	Raw	140.3a	1160.10a	139.90a	121.60a
	Cooked	38.13b (-73)	232.20b (-80)	65.20b (-53)	33.00b (-73)
	Cooking water	14.47c (-90)	54.37c (-95)	26.50c (-81)	26.60c (-78)
	LSD(P≤0.05)	11.27	9.37	5.05	2.17
Mash Bean	Raw	140.90a	1160.00a	139.80a	121.60a
	Cooked	39.07b (-72)	232.20b (-80)	65.17b (-53)	32.87b (-73)
	Cooking water	16.47c (-88)	54.47c (-95)	26.60c (-81)	30.53b (-75)
	LSD (P≤0.05)	5.15	9.52	4.53	5.69

Figures in each column followed by same letters are not significantly different at P≤0.05
Figures in parentheses indicate percent increase (+) and decrease (-) over the control (raw) values

Table-III ***Effect of cooking methods on mineral content (mg/100gm) of pulses***

Pulse	Treatment	Fe	Cu	Zn	Mn
Chick Pea	Raw	5.20b	2.52a	3.62a	1.60a
	Cooked	3.12c (-40)	0.68b(-73)	2.05b (-43)	0.58b (-64)
	Cooking water	14.44a (178)	0.40c (-84)	0.90c (-75)	0.27b (-83)
	LSD (P≤0.05)	0.72	0.19	0.11	0.416
Lentil	Raw	10.74b	2.70a	3.17a	2.41a
	Cooked	2.19c (-80)	0.72b (-73)	1.87b (-41)	0.74b (-69)
	Cooking water	14.30a (33)	0.31b (-89)	0.93c (-71)	0.84b (-65)
	LSD (P≤0.05)	2.57	0.44	0.16	0.16
Mung Bean	Raw	6.00b	2.64a	3.25a	2.76a
	Cooked	3.11c (-48)	0.64b (-76)	1.88b (-42)	0.83b (-70)
	Cooking water	15.70a (162)	0.22c (-92)	0.74c (-77)	0.47c (-83)
	LSD(P≤0.05)	2.18	0.11	0.22	0.157
Mash Bean	Raw	6.30b	3.25a	3.25a	2.76a
	Cooked	3.09b (-51)	0.64b (-80)	1.84b (-43)	0.83b (-70)
	Cooking water	15.70a (149)	0.21c (-94)	0.74c (-77)	0.53c (-81)
	LSD (P≤0.05)	3.95	0.11	0.16	0.16

Figures in each column followed by same letters are not significantly different at P≤0.05
Figures in parentheses indicate percent increase (+) and decrease (-) over the control (raw) values

True Retention

Data on the true retention (TR) of nutrients are presented in (Table IV) and (Table V). In the proximate composition, the maximum retention was observed for crude fiber in chickpea (123.9%) and lentil (121.0%) while in mungbean and mashbean maximum retention was noted for lipids (114.20%) and proteins (93.89%), respectively. Amongst the mineral contents, chickpea retained Ca to a maximum extent (238.20%) followed by Zn (129.7%), Fe

(117.81%) and K (107.90%). In samples of lentil maximum retention was observed for Ca (134.91%) followed by Fe, Na, Zn, Mn, K, Cu and Mg. In case of mungbean Mn was highly (98.50%) retained while minimum retention (58.17%) was observed for K. In mashbean the retention of Ca was found highest (147.41%) while minimum retention (59.37%) was observed for K.

Table-IV ***Percent True nutrients retention of pulses commonly consumed in study area***

	Proteins	Lipid	Fiber	Ash	NFE
Chickpea	89.62a	108.00b	123.90a	67.17b	82.63a
Lentil	82.94b	91.82c	121.00a	82.48a	77.42b
Mung bean	93.49a	114.20a	105.81b	58.02c	86.30a
Mash bean	93.89a	78.94d	86.11c	76.19a	76.82b
LSD (P≤0.05)	4.44	4.66	6.71	6.32	4.9

Figures in each column followed by same letters are not significantly different at P≤0.05

Table-V ***Percent True nutrients retention of pulses commonly consumed in study area***

Pulse	Na	K	Ca	Mg	Fe	Cu	Zn	Mn
Chickpea	97.50b	107.90a	238.20a	69.30ab	117.81a	91.33a	129.7a	103.10a
Lentil	80.63c	72.93b	134.91c	65.87b	85.40c	68.07c	79.13c	76.40d
Mung bean	73.17d	58.17c	78.70d	67.20b	65.50d	73.51b	90.40b	98.50b
Mash bean	104.90a	59.37c	147.41b	72.73a	106.01b	61.11d	67.23d	85.70c
LSD (P≤0.05)	4.84	4.85	6.37	3.62	3.43	4.54	3.55	3.14

Figures in each column followed by same letters are not significantly different at P≤0.05

Data on the true retention of nutrients showed that protein, fat, fiber and NFE in all pulses cultivars were retained to a greater extent in the cooking process. Ash content was retained the least. In the mineral elements, the average highest retention value was found for Ca and lowest for Mg in all pulses except mungbean in which highest retention value was found for Mn and lowest for potassium. On the average, all mineral elements were retained considerably and the loss was not significant from nutritional point of view.

CONCLUSION AND RECOMMENDATIONS

Nutritionally pulses are a good source of energy, protein and mineral elements. Since these pulses are consumed in cooked form only, the diet formulation based on the consumption of raw pulses is misleading. The result of the present study revealed that all the lots of all the four pulses have almost equal performance. These results also revealed that pulses could meet the human mineral requirement (recommended dietary allowance, RDA). Since animal proteins are expensive and scare, legumes become more important as a cheap protein source for the low - income groups of the world's population. They have been playing a significant role in elevating the protein energy malnutrition (PEM) problem around the globe especially in the developing countries like Pakistan. It is recommended to enhance the protein content of easily available and accessible plant protein sources (especially legumes) to improve the nutritional status of the low-income groups of the population.

ACKNOWLEDGEMENT

The authors are grateful to Higher Education Commission, Islamabad, Pakistan for financial support.

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