Vol. XVII (3-4) 1980

NUTRITIONAL EVALUATION OF COOKED BENGAL GRAM

M. Akmal Khan*

The nutritional quality of some new lines of Bengal gram (*Cicer arietinum*) evolved at the University of Agriculture, Faisalabad, was measured chemically and biologically in N-balance experiments with growing rats. The protein, fat, available carbohydrate and crude fibre contents of different cooked varieties ranged from 21.4–29.4, 4.8–6.3, 33.5–39.8 and 11.5–14.3%, respectively. Calcium, phosphorus, sulphur and iron contents (mg per 100 g) were 250–320, 230–370, 44.1–58.1 and 7.3–14.0 respectively. Lysine tryptophan and total sulphur amino acids were lowered in variety with a higher content of protein. The true protein digestibility (TD), biological value (BV) and net protein utilisation (NPU) of different varieties varied between 85–89, 62–69 and 55–60% respectively. The TD of protein was the highest in Bengal gram 6560 having a higher protein content (29.4%) while its BV was the lowest (62%) as compared to the other varieties. Tannin content does not seem to affect the TD of these varieties.

INTRODUCTION

The pulses are important and economical sources of protein and calories as well as of certain vitamins and minerals essential in human nutrition. However, the significant role they play in the diets of many developing countries appears to be limited by their scarcity caused in great part by their present low yields, their consequent cost and certain antinutritional factors affecting their qualities. Compared to cereal grains, pulses are relatively rich in protein most containing from 21 to 29 per cent. However, the quality of the proteins is only fair because they are deficient in the sulphur-containing amino acids,

* Department of Nutrition, University of Agriculture, Faisalabad.

methionine and cystine (Khan *et al.*, 1979). Supplementation of pulses with cereal proteins improves their protein quality (Khan *et al.*, 1976; Khan *et al.*, 1977; Khan and Eggum, 1978; Khan and Eggum, 1979; Khan *et al.*, 1979). Raw pulses may contain a wide variety of toxic substances but most of these are destroyed by the heat of ordinary cooking. Excessive cooking, on the other hand, reduces the biological value of the protein (Almas, 1979).

Bengal gram is mainly produced in the Punjab and is commonly consumed all over the country. The average consumption of Bengal gram has been calculated to be 15 g per person per day. Recently some new lines with encouraging yields of Bengal gram have been evolved at the University of Agriculture, Faisalabad. The present paper deals with the nutritive value of these varieties as measured by chemical analysis and N-balance experiments with rats.

MATERIALS AND METHODS

Experimental Animals and Diets. The experimental procedure has been described by Eggum (1973). Groups of five Wistar male rats each weighing approximately 75 g were used. The preliminary period lasted for 4 days and the balance period for 5 days. The rats were weighed at the beginning of the experiment and divided into groups of five such that the average weights of the groups differed by no more than ± 0.5 g. Weighing was repeated at the end of the preliminary and balance periods: access to feed and water was prevented 3 hours before weighing. Each animal received 150 mg N and 10 g dry matter daily throughout the preliminary and balance periods. The N content of the diet was adjusted using a basal diet consisting of an N-free mixture. The rats were housed in individual metabolic cages. During the balance period, urine and faeces were collected in separate flasks containing 5 per cent H_2SO_4. At the end of the experiment the animals were weighed and killed with chloroform. Any feed left in the feed container was also weighed. A 5-day sample of urine and faeces was collected from each of the rats. Faeces were homogenised in a blender. Urine and faeces were diluted to volume with distilled water and nitrogen was determined by the kjeldahl method.

Processing methods. Different varieties of Bengal gram viz. C 727, 6227, 6501, 6560 and 6576 were obtained from the University of Agriculture, Faisalabad. All the varieties were soaked in water for 12 hours and were cooked for 20 minutes at 121°C. All the samples were freeze-dried, ground and incorporated into the N-free mixture at the expense of autoclaved potato starch, to be measured in the N-balance experiments with rats.

Analytical Methods. The chemical composition of the samples was measured according to AOAC methods. The estimations of available carbohydrate, tannin and amino acids have been described (Khan and Eggum, 1979). All the assays were performed in duplicate.

RESULTS AND DISCUSSION

Chemical composition. The average values for the chemical composition of different lines of Bengal gram are given in Table 1.

Table 1. *Chemical composition (dry basis) of cooked Bengal gram.*

		g per 100 g						mg per 100 g			
		Protein (Nx5.7)	Fat	Available carbohydrate	Crude fibre	Ash	Tannin	Ca	P	S	Fe
Bengal	C727	22.9	5.4	39.8	13.8	2.4	0.85	260	310	46.3	13.0
gram	6227	23.1	5.2	37.2	11.5	2.6	0.67	300	250	44.1	12.0
	6501	22.3	4.8	37.8	12.8	2.6	0.51	320	280	50.7	14.0
	6560	29.4	6.3	33.5	13.7	2.8	0.61	250	370	58.1	7.3
	6576	21.4	5.7	38.8	14.3	2.3	0.75	280	230	45.1	13.0

The protein content (N × 5.7) in Bengal gram ranged from 21.4 to 29.4% with a mean of 23.8. The fat content appears to lie between 4.8 and 6.3%. The highest contents of protein (29.4%) and fat (6.3%) and the lowest content of available carbohydrate (33.5%) were found in variety 6560. The fibre content ranged from 11.5 to 14.3% and the highest level was observed in variety 6576. The ash content was almost uniform in all the varieties. The tannin content varies from 0.51 to 0.85%. The calcium content was the highest (320 mg/100 g) in variety 6501 and was low (250 mg/100 g) in variety 6560. Phosphorus was found in largest (370 mg/100 g) and smallest (230 mg/100 g) amounts in varieties 6560 and 6576 respectively. The sulphur content (mg/100 g) was the highest (58.1) in 6560 and was low (44.1) in 6227. All the varieties were found to be good source of iron (7.3–14.0 mg/100 g). The amino acid composition of all the varieties is shown in Table 2.

Table 2. *Amino acid composition of cooked Bengal gram.*
(mg/g protein)

	C727	6227	6501	6560	6576	WHO*
Isoleucine	46	45	45	46	46	40
Leucine	76	75	77	72	76	70
Lysine	61	60	63	58	61	55
Methionine	17	17	17	15	17	35
Cystine	16	15	14	12	15	
Phenylalanine	55	53	56	54	54	60
Tyrosine	28	27	29	25	29	
Threonine	34	33	35	31	35	40
Tryptophan	12	12	12	8	11	10
Valine	43	43	44	41	43	50
Histidine	24	23	25	23	25	—

*WHO (1973)

Among all the varieties, the lowest levels of lysine, methionine+cystine and tryptophan were found in variety 6560 which had the highest protein content. The amino acids of these varieties were compared with the reference amino acids pattern, recommended by the World Health Organization (Table 2). It appears that all the new varieties lack methionine+cystine, threonine and valine in their proteins.

Biological Efficiency. The true protein digestibility (TD), biological value (BV) and net protein utilisation (NPU) of different varieties of Bengal gram are presented in Table 3.

Table 3. *Biological efficiency of cooked Bengal gram*

		True digestibility %	Biological value %	Net protein utilisation %
Bengal Gram	C727	87.0	69.0	60.0
	6227	86.0	67.0	58.0
	6501	86.0	65.0	56.0
	6560	89.0	62.0	55.0
	6576	85.0	66.0	56.0

The TD of Bengal gram 6560 was the highest (89 %) and was slightly better than all the other varieties. The BV of 6560 was significant ($P<0.001$) lower than all the varieties of Bengal gram. The NPU, a derived factor, ranged from 55 to 60 %.

It is evident from the results that the TD of protein was highest in Bengal gram 6560 having a higher protein content (29.4 %) while its BV was lowest (62 %) as compared to the other varieties, indicating that methionine and cystine are the first limiting amino acids. These results agree with the findings of Khan *et al.* (1979) who showed a significant correlation ($r=0.97$) between BV and the total sulphur containing amino acids. According to Bressani and Elias (1977) the protein quality of grain legumes depends on the presence of of anti-physiological substances, tertiary structures, protein complexing substances and is limited by the sulphur containing amino acids.

In summary; Bengal gram represents valuable but considerably underexploited source of edible protein. Attention should be given to its genetic diversity to determine the range of variability related to its biochemical composition. However, breeding for improved nutritional quality should not be undertaken at the expense of all those factors that contribute to improved yield.

LITERATURE CITED

Almas, K. 1979. Effect of heat treatment and storage on the nutritive value of various legumes. Ph.D. thesis, University of London.

A.O.A.C. 1970. Official Methods of Analysis Association of Official Agricultural Chemists. Washington D.C.

Bressani, R. and L.G. Elias. 1977. In Nutritional Standards and Methods of Evaluation for legume Breeders (Hulse, J.H., K.D. Rachie, L.W. Billingley Eds). International Development Research Centre, Ottawa, Canada.

Eggum, B.O. 1973. 460 beretn. Forsogslab, Copenhagen, Denmark.

Khan, M.A. and B.O. Eggum. 1978. The nutritive value of some Pakistani diets. J. Sci. Fd. Agric. 29, 1023.

Khan, M.A. and B.O. Eggum. 1979. Effect of home and industrial processing on protein quality of baby foods and breakfast cereals. J. Sci. Fd. Agric. 30, 369.

Khan, M.A. and B.O. Eggum. 1979. The nutritional quality of some Pakistani wheat varieties. J. Sci. Fd. Agric. 30, 779.

Khan, M.A., I. Jacobsen and B.O. Eggum. 1979. Nutritive value of some improved varieties of legumes. J. Sci. Fd. Agric. 30, 395.

Khan, M.A., K. Almas, A.R. Abid and M. Yaqoob. 1976. The effect of gram flour on the quality of wheat protein. Pakistan J. Agric. Sci. 13, 167.

Khan, M.A., R. Haq, A.R. Abid and M. Yaqoob. 1977. Nutritive value of Mexi-Pak wheat flour supplemented with defatted soyflour. Pakistan J. Agric. Sci. 14, 69.

Khan, M.A., S.F. Yasmin and A.R. Abid. 1979. Nutritional evaluation of lentil (Lens esculenta) as protein supplement for wheat protein. Acta Agri. Scand. 29, 109.