Physico-chemical characters and nutrient composition of lentils grown in Pakistan

M. Akmal Khan, Iftikhar A. Rana, Ihsan Ullah, and Saeeda Jaffery
Nutrition and Food Quality Laboratories, National Agricultural Research Centre, Park Road, Islamabad, PAKISTAN

Abstract

Physical characters, cookability and nutritional quality of four improved lentil lines were determined. The hydration coefficient ranged from 175.0 to 189.7%. The cooking time of dry seed (23.0-26.4 min) significantly reduced (6.3-8.0 min) when the seeds were soaked overnight in water. Lentils contained an average of 24.1% protein, 4.3% fat, 55.0% carbohydrate, 4.7% crude fibre, 2.7% ash, 1.03% tannin, and 355 Kcal/100 g. The average contents of Ca, P, Fe, Zn, Mn, Cu, Ni, and phytate were 190.1, 282.9, 9.6, 6.1, 3.4, 2.3, 0.3, and 164.2 mg/100 g, respectively. The major amino acids were glutamic acid, proline, aspartic acid, leucine, lysine, and arginine. Methionine was present in relatively lower concentration.

Introduction

The food legumes are major sources of protein and other nutrients in the diets of the majority of population in developing countries. Their role, however, is limited by several factors including low protein digestibility, antinutritional factors, and flatulence and poor cooking qualities (Elias and Bressani 1974; Khan and Ghafoor 1978; Weder *et al.* 1985).

Legumes contain twice as much protein as cereal grains. This protein is a rich source of lysine although low in sulphur containing amino acids (Khan *et al.* 1978). The proteins of cereal grains and food legumes supplement each other nutritionally because each is comparatively rich in amino acids in which the other is deficient (Khan *et al.* 1976; Khan *et al.* 1977; Khan and Eggum 1978; Khan and Eggum 1979). The highest protein quality was obtained when 50% of the protein of the diet was derived from each of wheat and lentils (Khan *et al.* 1979).

In spite of their nutritional importance, plant breeders have given less attention to food legumes than cereal grains. Consequently, legume yields remain at a low yield level and legume production is either stagnant or dropping. The challenge to the legume breeders is to develop varieties which are both more productive and more nutritious. The present paper deals with the physico-chemical characters and nutrient composition of some improved lentil lines evolved in Pakistan.

Materials and Methods

Lentil samples: Four improved lentil (*Lens culinaris*) lines, grown at the National Agricultural Research Centre, Islamabad were used in the study.

Physico-chemical measurements: Parameters including seed size (weight), hydration coefficient, and cooking time were studied. All tests were carried out in duplicate.

Seed size was recorded as the mean weight of 100 seeds. Hydration coefficient was calculated by measuring water uptake by 10 g of lentil soaked in 25 ml of distilled water for 8 hr at room temperature (Hulse *et al.* 1977). Cooking time of dry and soaked seed (soaked overnight in distilled water) was derived from a boiling and thumb pressing method according to Williams *et al.* (1983).

Chemical analysis: Seeds were ground in cyclotec mill to pass a 1.0 mm ∅ screen. Moisture content was determined by drying a 2 g sample of ground lentils at 130°C for 70 minutes, then cooling, and weighing. Protein (Nx5.7), fat, crude fibre, ash, and major elements were determined by the official methods (Horwitz W. 1980). Carbohydrate contents were calculated by difference. Gross energy value was calculated by multiplying protein, fat, and carbohydrate contents with factors of 4,9, and 4, respectively. Trace elements were determined by using atomic absorption spectrometer, model 4000 (Perkin-Elmer). Tannin content was estimated as described by Eggum and Christensen (1975). Phytate content was measured according to Haug and Lantzsch (1983). The amino acids were determined with Beckman 6300 amino acid analyzer (Khan *et al.* 1978).

Table 1. Seed yield and physico-chemical parameters of lentils.

Line	Seed yield (kg/ha)	100-seed weight (g)	Hydration coefficient (%)	Cooking time (min) Dry	Soaked
18-10	550	1.9	184.6	26.4	6.3
9-6	750	1.9	178.3	24.3	7.5
18-12	550	2.0	189.7	24.5	8.0
Vm-25	550	2.0	175.0	23.0	7.0
Mean	600	2.0	181.9	24.6	7.2
S.E. +/-	10.0	0.06	6.55	11.44	0.65
C.V.	16.67	3.08	3.60	5.85	8.97

S.E.: Standard error

C.V.: Coefficient of variation

Results and Discussion

The yield and physico-chemical parameters of improved lentil lines are given in Table 1.

The overall mean for seed yield was 600 kg/ha. The lines yielded 550 kg/ha - 750 kg/ha. The average seed weight was 2.0 g/100 seeds. The hydration coefficient varied from 175.0 to 189.7%. Rapid water uptake is a desirable attribute of legume grain used for food. In the present study, the value for hydration coefficient was highest in line 18-12. Cooking time is one of the important parameters in evaluating the quality of legumes. The cooking process makes hard seed soft by improving the plasticity of the cell wall and gelatinization of the starch. The mean time for cooking of dry seeds was 24.6 min. Seeds of Vm-25 were the quickest to cook (23.0 min.), whereas seeds of line 18-10 took an average of 26.4 min. to cook. However, cooking time significantly reduced when seeds were soaked overnight in water. A range of 6.3-8.0 min in cooking time was observed. Seeds of line 18-10 with highest content of phytate (Table 2) has the shortest cooking time (6.3 min). There was no relationship between the hydration coefficient and cooking time of seeds in the present study. The cooking quality of lentil has been reported to be dependent on the seed coat, phytic acid and pectin contents of seed coat, Ca + Mg/P ratio, and amylose content (Bhatty 1984).

Chemical composition of improved lentil lines is given in Table 2.

The protein content (Nx5.7) ranged from 22.8% in line 18-10 to 25.0% in Vm-25. The overall mean was 24.1% giving a protein yield of 141 kg/ha. Bhatty *et al.* (1976) reported protein content of six lentil genotypes ranging from 27.7 - 31.3%. The protein content of world lentil collection has been reported to be 23.4 - 36.4% (Hawtin *et al.* 1977). The protein content of lentil is comparable with that of faba bean, higher than chickpea, and more than double that of

Table 2. Chemical composition (dry basis) of some improved lentil lines.

Line	Protein (Nx5.7) (%)	Fat (%)	Carbohydrate (%)	Crude fibre (%)	Ash (%)	Energy (Kcal/100 g)	mg/100 g Ca	P	Fe	Zn	Mn	Cu	Ni	Phytate	Tannin (%)
18-10	22.8	4.9	57.4	4.3	2.7	365	173.9	260.6	9.6	5.2	3.3	2.0	0.3	181.6	1.09
9-6	24.6	3.6	56.4	4.8	2.5	356	171.2	264.5	9.6	5.4	2.6	2.0	0.3	154.2	1.08
18-12	23.9	3.6	56.3	5.0	2.7	353	284.4	276.4	9.0	4.8	3.7	2.5	0.2	154.8	1.00
Vm-25	25.0	4.9	50.0	4.8	2.7	344	130.9	330.6	10.1	8.9	3.9	2.6	0.3	166.8	0.98
Mean	24.1	4.3	55.0	4.7	2.7	355	190.1	282.9	9.6	6.1	3.4	2.3	0.3	164.2	1.03
S.E.	0.96	0.75	3.39	0.30	0.10	8.66	65.87	50.87	0.45	1.90	0.57	0.32	0.05	12.6	0.06
C.V.	3.99	17.65	6.14	6.35	3.77	2.44	34.49	18.85	0.70	11.28	16.89	14.06	18.18	7.68	5.78

S.E.: Standard error

C.V.: Coefficient of variation

wheat (Abu-Shakra and Tannous 1981). The fat content varied from 3.6 to 4.9%. The carbohydrate was highest (57.4%) in line 18-10 and lowest (50.0%) in Vm-25. The fibre content ranged from 4.3 to 5.0%. The ash content was uniform in all the lines. Calcium content was highest (284.4 mg/100 g) in line 18-12, whereas phosphorus was highest (330.6 mg/100 g) in Vm-25. The concentration of iron ranged from 9.0 to 10.1 mg/100 g. The highest content (8.9 mg/100 g) of zinc was found in Vm-25. The concentration of manganese, copper, and nickel ranged from 2.6 to 3.9, from 2.0 to 2.6, and from 0.2 to 0.3 mg/100 g, respectively. The phytate content ranged from 154.2 mg/100 g in line 9-6 to 181.0 mg/100 g in line 18-10. It is evident that lentil is rich in iron and other minerals. The levels of various mineral elements in lentil seed were found to be influenced by the availability of plant nutrients in the soil media during plant growth and seed development (Wassimi *et al.* 1978). The tannin content varied between 0.98 and 1.09%. The gross energy ranged from 344 Kcal/100 g in Vm-25 to 365 Kcal/100 g in genotype 18-10.

In addition to the level of protein in lentil seeds, the amino acid content of the protein is very important in its nutritional quality. The amino acid contents of four improved lentil lines are given in Table 3.

Table 3. Amino acid contents (mg/gN) of some improved lentil lines.

Amino acid	Line			
	18-10	9-6	18-12	Vm-25
Aspartic acid	665.6	426.5	588.8	471.6
Threonin	275.2	173.9	281.3	166.3
Serine	400.4	252.7	345.7	248.3
Glutamic acid	1298.6	822.9	858.2	820.1
Proline	445.4	289.8	445.8	371.3
Glycine	270.2	190.1	257.5	143.5
Alanine	167.6	134.4	176.4	109.4
Valine	315.3	224.8	302.8	211.9
Methionine	65.1	41.7	64.4	22.8
Isoleucine	267.7	199.4	257.5	193.6
Leucine	540.5	390.9	483.9	353.1
Tyrosine	185.2	115.9	219.3	104.8
Phenylalanine	357.8	238.8	338.5	293.9
Lysine	510.4	421.9	381.4	375.9
Histidine	167.6	148.4	176.4	129.9
Arginine	390.3	350.0	357.6	312.1

The lysine content ranged from 375.9 mg/gN in Vm-25 to 510.4 mg/gN in line 18-10. The concentration of methionine, the first limiting amino acid in legumes varied between 22.8 and 65.1 mg/gN. The major amino acids of lentil were glutamic acid, proline, aspartic acid, leucine, lysine, and arginine. Methionine was present in relatively lower concentration. The amino acid composition of these lines was similar to kidney beans, cowpeas, and chickpeas as reported by Tannous and Ullah (1969). The contents of lysine, leucine, isoleucine, and histidine of lentils in the present study were comparable with the essential amino acids of egg protein as reported by Sheffner (1967).

There is an urgent need to increase the yield, improve the quantity and quality of protein, and to eliminate antinutritional factors. Also the breeder should introduce varieties with larger seed size as the decortication loss has been related to seed size.

References

Abu-Shakra, S. and Tannous, R.I. 1981. Nutritional value and quality of lentils. Pages 191-202 in Lentils (Webb, C. and Hawtin, G., eds.). ICARDA/CAB, CAB, Slough, England.

Bhatty, R.S. 1984. Relationship between physical and chemical characters and cooking quality in lentil. Journal of Agricultural and Food Chemistry 32(5): 1161-1166.

Bhatty, R.S., Slinkard, A.E. and Sosulski, F.W. 1976. Chemical composition and protein characteristics of lentils. Canadian Journal of Plant Science 56: 787-794.

Eggum, B.O. and Christensen, K.D. 1975. Breeding for seed protein improvement using nuclear techniques. International [illegible] Energy Egency, Vienna, Austria.

Elias, L.G. and Bressani, R. 1974. Nutritional factors affecting the consumption of leguminous seeds. Archivo Latinoamericanos de Nutricion 24: 365-378.

Haug, W. and Lontzsch, H.J. 1983. Sensitive method for the rapid determination of phytate in cereal products. Journal of Science of Food and Agriculture 34: 1422-1426.

Hawtin, G.C., Rachie, K.O. and Green, J.M. 1977. Breeding strategy for the nutritional improvement of pulses. Pages 43-51 in Nutritional Standards and methods of evaluation for feed legume breeders, IDRC-TS 7e (Hulse, J.H., Rachie, K.O. and Billingsley, L.W., eds.). IDRC, Ottawa, Canada.

Horwitz, W. (ed.) 1980. Official methods of analysis. 13th ed. AOAC (Association of Official Analytical Chemists), Washington DC, USA.

Hulse, J.H., Rachie, K.O. and Billingsley, L.W. (eds.). 1977. Nutritional Standards and Methods of Evaluation for Food Legume breeders, IDRC-TS 7e. IDRC, Ottawa, Canada. 100pp.

Khan, M.A., Almas, K., Abid, A.R. and Yaqoob, M. 1976. The effect of gram flour on the quality of wheat protein. [illegible] Journal of Agricultural Sciences 13: 167-172.

Khan, M.A. and Eggum, B.O. 1978. The nutritive value of some Pakistani diets. Journal of the Science of Food and Agriculture 29: 1023-1029.

Khan, M.A. and Eggum, B.O. 1979. Effect of home and industrial processing on the quality of baby foods and breakfast cereals. Journal of the Science of Food and Agriculture 30: 369-376.

Khan, M.A. and Ghafoor, A. 1978. The effect of soaking, germination and cooking on the protein quality of mash bean (Phaseolus mungo). Journal of the Science of Food and Agriculture 29: 461-464.

Khan, M.A., Haq, R., Abid, A.R. and Yaqoob, M. 1977. Nutritive value of Mexi-Pak wheat flour supplemented with defatted soyflour. Pakistan Journal of Agricultural Sciences 14: 69-75.

Khan, M.A., Jacobsen, I. and Eggum, B.O. 1978. Nutritional value of some improved varieties of legumes. Journal of the Science of Food and Agriculture 30: 395-400.

Khan, M.A., Yasmin, S.F. and Abid, A.R. 1979. Nutritional evaluation of lentil (Lens esculenta) as protein supplement for wheat protein. Acta Agriculture Scandinavica 29: 109-111.

Sheffner, A.L. 1967. In vitro protein evaluation. Page 125 in Newer methods of nutritional biochemistry (Albanese, A.A., ed.). Academic Press, New York, N.Y., USA.

Tannous, R.I. and Ullah, M. 1969. Effects of autoclaving on nutritional factors in legume seeds. Tropical Agriculture 46: 123-129.

Wassimi, N., Abu-Shakra, S., Tannous, R. and Hallab, A.H. 1978. Effect of mineral nutrition on cooking quality of lentils. Canadian Journal of Plant Science 58: 165-168.

Weder, J.K.P., Mueller, R., Mato, C.I. and Hegarty, M.P. 1985. Proteinase inhibitor activities and electrophoretic inhibitor patterns of lentils. LENS Newsletter 12(1): 29-32.

Williams, P.C., Nakoul, A. and Singh, K.B. 1983. Relationship between cooking time and some Physical characteristics in chickpeas (Cicer arietinum L.). Journal of the Science of Food and Agriculture 34: 492-496.

Detection of broad bean stain virus in lentil seed groups

K. M. Makkouk and O. I. Azzam
ICARDA,
Aleppo, SYRIA

Abstract

Broad bean stain virus (BBSV) was easily detected in lentil seed groups each of 25 seeds by the enzyme-linked immuno-sorbent assay (ELISA). When seeds were dissected into axes, cotyledons, and seed coats BBSV detection was highest in cotyledons followed by the germinating axes and least in seed coats. Detection in ground intact seeds was less than in germinated seedlings. Testing lentil seed groups provided a practical mean in monitoring seed-borne BBSV in lentil seed lots.

Introduction

The seed-borne broad bean stain virus (BBSV) infects a number of leguminous crops including lentils (*Lens culinaris*) (Bos *et al.* 1986; Boswell and Gibbs 1983). No loss estimates have been reported for lentils infected with BBSV. Nevertheless, symptoms induced in response to infection are very mild and virus incidence is usually low, an indication that losses incurred by BBSV on lentils are most likely minimal. However, since BBSV is beetle-transmissible, infection can spread to susceptible crops such as pea (*Pisum sativum*) and faba bean (*Vicia faba*) in places where the insect vector is prevalent.

Testing for BBSV is, therefore, important in areas where susceptible economically important crops are grown. Because of the low seed infection rate, testing for BBSV in single seeds would be very time consuming and not economical. In this study we investigated the possibility of testing groups of lentil seeds for the presence of BBSV.

Materials and Methods

A lentil seed lot (cv Syrian Local), which contained seed-borne BBSV, was used as the seed source for this study. Seeds for testing was randomly picked and each 25 were grouped together as one sample. Seeds were tested as (i) ground, (ii) intact seedlings, and (iii) dissected seedlings to axes, cotyledon, and seed coat. Seeds were sown in moistened sterile sand in germination boxes and incubated at 22-24°C for one week.

Testing for BBSV was carried out using the enzyme-linked immuno-sorbent assay (ELISA) following the procedure of Clark and Adams (1977) with one exception. The Standard extraction buffer was replaced by 0.2M phosphate buffer, pH 6.0. The antiserum used was produced in the virology laboratory of the Faculty of Agricultural and Food Sciences, American University of Beirut, Beirut against a purified BBSV isolate from faba bean (SV 173-85). ELISA values were taken by a Dynatech micro ELISA minireader (MR 590). In each ELISA plate, eight healthy samples were used to determine the negative threshold value. ELISA sample values higher than the healthy mean plus three standard deviations were considered positive.