

Physicochemical Characters and Nutrient Composition of Some Improved Lines of Lentils Grown in Pakistan

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Physical characters, cookability, and nutritional quality of four improved lines of lentils were determined. The hydration coefficient ranged from 175.0 to 189.7%. The cooking time of dry seed (23.0–26.4 min) was 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 fiber, 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 concentrations. © 1987 Academic Press, Inc.

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, appears to be limited by several factors, including low protein digestibility, antinutritional factors, 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. The proteins are 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 the amino acids in which the other is deficient (Khan *et al.*, 1976, 1977; Khan and Eggum, 1978, 1979). The highest protein quality was obtained when 50% of the protein in the diet was derived from wheat and 50% from lentils (Khan *et al.*, 1979).

Despite their nutritional importance, food legumes have until recently received much less attention by plant breeders than the cereal grains. Consequently, legume yields have remained at a low yield level and legume production either has been stagnant or has dropped. The challenge to the legume breeders is to develop varieties which are both more productive and more nutritious. The present paper deals with the physicochemical characters and nutrient composition of several improved lines of lentils developed in Pakistan.

MATERIALS AND METHODS

Lentil samples. Four improved lines of lentils (*Lens culinaris*), 18-10, 9-6, 18-12 and Vm-25, grown under similar production environments at the National Agricultural Research Centre, Islamabad, were used in the study.

TABLE I
SEED YIELD AND PHYSICOCHEMICAL PARAMETERS OF LENTILS

Improved lentil line	Seed yield (kg/ha)	Seed weight (g/100 seeds)	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
SE	10.0	0.06	6.55	11.44	0.65
CV	16.67	3.08	3.60	5.85	8.97

Note. SE, standard error; CV, coefficient of variability.

Physicochemical 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 lentils soaked in 25 ml of distilled water for 8 h at room temperature (Hulse *et al.*, 1977). Cooking time of dry and soaked seeds (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 a 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 min, cooling, and weighing. Protein ($N \times 5.7$), fat, crude fiber, ash, and major elements were determined by the official methods (AOAC, 1980). Carbohydrate content was 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 a Model 4000 Perkin-Elmer atomic absorption spectrometer. Tannin content was estimated as described by Eggum and Christensen (1975). Phytate content was measured according to Haug and Lantzsch (1983). After hydrolysis of proteins (Mattern *et al.*, 1968), the amino acids were determined with Beckman 6300 amino acid analyzer (Khan *et al.*, 1978). All the assays were performed in duplicate.

RESULTS AND DISCUSSION

The yield and physicochemical parameters of improved lines of lentils are given in Table 1. The overall mean for seed yield was 600 kg/ha. The lines yielded from a minimum of 550 kg/ha to a maximum of 750 kg/ha. The average seed weight was 2.0 g/100. All varieties introduced into South Asia have been small seeded (Sohl and Erskine, 1984), as are the improved lines in this study. By comparison, average weights of 5.8 and 8.0 g/100 seeds for Chilean commercial and Laird lentil varieties grown in Canada have been reported (Slinkard and Bhatti, 1979). The hydration coefficient varied from 175.0 to 189.7%. Rapid uptake of water 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 evalu-

ating 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 seed of line 18-10 took an average of 26.4 min to cook. However, cooking time was reduced significantly when seeds were soaked overnight in water. A range of 6.3–8.0 min in cooking time was observed. Seeds of the 18-10 line, with the highest content of phytate (Table 2) had the shortest cooking time (6.3 min). There was no relationship between the hydration coefficient and the cooking time of seeds in the present study. The cooking quality of lentils has been reported to be dependent on the seed coat, the phytic acid and pectin contents of the seed coat, the Ca^+ , Mg/P ratio, and the amylose content (Bhatty, 1984).

Table 2 shows the chemical composition of improved lines of lentils. The protein content ($\text{N} \times 5.7$) 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 the protein content of six genotypes of lentils ranging from 27.7 to 31.3%. The protein content of the world collection of lentils has been reported to be 23.4–36.4% (Hawtin *et al.*, 1977). The protein content of the lentil is comparable with that of the faba bean, higher than the chickpea, and more than double that of wheat (Abu-Shakra and Tannous, 1981). The lipid 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 fiber content ranged from 4.3 to 5.0%. The ash content was uniform in all the lines. The 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 concentrations of manganese, copper, and nickel were 2.6–3.9, 2.0–2.6, and 0.2–0.3 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 the lentil is rich in iron and other minerals. The levels of various mineral elements in the 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 overall level of protein in lentil seeds, the amino acid content of the protein is very important in determining nutritional quality. The amino acid contents of the four improved lines of lentils are given in Table 3.

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

CONCLUSION

The breeding program of lentils is very young (about 5 years old) in Pakistan. The improved lines tested in the present study were the selection of land races, based on

TABLE 2
CHEMICAL COMPOSITION (DRY BASIS) OF SOME IMPROVED LINES OF LENTILS

Improved lentil line	Protein (N × 5.7, %)	Fat (%)	Carbohydrates (%)	Crude fiber (%)	Ash (%)	Energy (kcal/100 g)	mg/100 g								Tannin (%)
							Ca	P	Fe	Zn	Mn	Cu	Ni	Phytate	
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
SE	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
CV	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

Note. SE, standard error; CV, coefficient of variability.

TABLE 3
AMINO ACID CONTENTS (mg/g N) OF SOME IMPROVED LINES OF LENTILS

Amino acid	Improved lentil 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

yield per unit area, early maturity, and disease resistance. One of the advance lines (9-6) tested in the present study has recently been approved as a commercial variety (Masoor-85) and is the only commercial variety available in the country. Thus it was not possible to compare the present data with the local commercial varieties. The present study was the first of its kind conducted comprehensively on the quality evaluation of Pakistani improved lines of lentils.

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

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