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PROXIMATE COMPOSITION, MINERAL CONTENT, AND FATTY ACIDS PROFILE OF TWO VARIETIES OF LENTIL SEEDS CULTIVATED IN IRAN

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The objective of this research was to investigation the varietal effect on chemical composition, mineral content, energy value, and fatty acid profile of lentil seeds (*Lens culinaris* Medik., family Fabaceae) grown in Iran.

Several chemical compositions, mineral contents, and energy values of the two different lentil seed varieties are presented in Table 1. As can be seen in Table 1, the lentil seeds are a good source of carbohydrate (59.01–61.5%) and are rich in protein (25.90–27.30%). The amounts of protein and carbohydrate present in green lentils were higher than in red lentils ($p < 0.05$). In general, protein and carbohydrate contents of lentil seeds vary due to differences in species and environmental factors such as climate, geographical origin, harvest year, and methods of cultivation [1]. The differences in the dry matter, crude fat, and acid detergent fiber (ADF) contents of the two varieties were not significant. However, the amounts of these components were 92.22–93.72%, 2.5–2.7%, and 5.6–5.7%, respectively. Moreover, there were also significant differences in neutral detergent fiber (NDF) and ash values of the two lentil varieties ($p < 0.05$). These amounts for both lentil seeds were found to be 8.2–8.7% and 3.41–3.62%, respectively.

Also, the mineral contents of the two lentil seed varieties, expressed as mg/100 g dry matter, is indicated in Table 1. The data presented show that the lentil seeds contain many dietary essential minerals, such as sodium (65–81 mg/100 g), potassium (978–1024 mg/100 g), calcium (168–170 mg/100 g), magnesium (4.62–5.20 mg/100 g), phosphorus (301–341 mg/100 g), iron (6.6–7.3 mg/100 g), zinc (4.2–4.3 mg/100 g), copper (4.62–6.12 mg/100 g), and manganese (1.40–1.62 mg/100 g). There were differences in some mineral contents of the two lentil seed varieties, at different significance levels ($p < 0.05$ and $p < 0.01$). The Mn, Fe, Ca, and Cu contents of samples were not significant ($p > 0.05$). The presence of the various mineral nutrients such as K, Ca, Mg, P, Fe, Zn, Mn, and Cu is of biochemical importance to the physiology of the seeds. In addition, they are an essential part of many important enzymes and they play roles as catalysts and antioxidants. For example, iron and copper are essential in blood formation and copper is involved in normal carbohydrate and lipid metabolism [2]. The difference in caloric value was significant between the varieties analyzed ($p < 0.05$). The means of the obtained energy values for red and green lentil seeds are 363.9 and 377.7 kcal/100 g, respectively. These findings are supported by the literature [3] for different genotypes of lentil. However, higher amounts of energy value have been reported in the literature [4], with the mean being 406.1 kcal/100 g. Moreover, the variation observed in the metabolizable energy value for both young chicks and adult birds between the two varieties of lentil was remarkable ($p < 0.05$). These values for young chicks varied from 364.5 to 377.9 kcal/100 g, and for adult birds from 374.3 to 387.8 kcal/100 g. Interestingly, the amounts of metabolizable energy for young chicks were very near the food energy values of lentil varieties.

Mean values and standard deviations of the fatty acid composition are presented in Table 2. As illustrated in Table 2, the major fatty acids found in lentil oil are linoleic (46.81–49.11%), oleic (21.3–23.27%), palmitic (14.41–18.10%), and linolenic (8.20–11.25%) acids. The ratios of these fatty acids are considered important for their nutritional value.

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TABLE 1. Proximate Composition, Mineral Content, and Energy Values of Two Varieties of Lentil Seed (*Lens culinaris* Medik.)

Proximate composition, %	Variety		Proximate composition, %	Variety	
	Red lentil	Green lentil		Red lentil	Green lentil
Dry matter (ns)	93.72 ± 0.20	92.22 ± 0.44	Potassium*	1024 ± 0.44[a]	978 ± 10.43[b]
Ash*	3.62 ± 0.44[a]	3.41 ± 0.06[b]	Magnesium*	4.62 ± 0.66[b]	5.20 ± 0.38[a]
Crude protein (N × 6.25)*	25.90 ± 0.14[b]	27.30 ± 0.75[a]	Phosphorus**	11.46[a] ± 341	301 ± 10.75[b]
Fat (ns)	2.7 ± 0.31	2.5 ± 0.73	Zinc (ns)	4.2 ± 0.11	4.3 ± 0.35
Carbohydrate*	59.01 ± 2.01[b]	61.5 ± 1.22[a]	Copper*	4.62 ± 0.23[b]	6.12 ± 0.44[a]
ADF[c] (ns)	5.6 ± 0.45	5.7 ± 0.12	Manganese (ns)	1.62 ± 0.21	1.40 ± 0.16
NDF[c]*	8.2 ± 0.30[b]	8.7 ± 0.18[a]	Energy values, kcal/100 g		
Minerals, mg/100 g			Food energy*	363.9 ± 1.41[a]	377.7 ± 2.13[b]
Calcium (ns)	8.2 ± 170	6.3 ± 168	Metabolizable energy		
Iron (ns)	6.6 ± 0.35	7.3 ± 0.37	Young chicks*	364.5 ± 1.78[b]	377.9 ± 2.11[a]
Sodium*	65 ± 0.44[b]	81 ± 4.06[a]	Adult birds*	374.3 ± 2.25[b]	387.8 ± 1.63[a]

All data represent the mean of three replications. *,**Significant levels at 5%, 1%, respectively. ns: not significant. [a,b]Letters indicate the statistical difference in rows. [c]ADF = acid detergent fiber, and NDF = neutral detergent fiber.

TABLE 2. Fatty Acid Composition of Two Varieties of Lentil Seed

Fatty acids	Red lentil, %	Green lentil, %	Fatty acids	Red lentil, %	Green lentil, %
16:0**	14.41 ± 1.20[b]	18.1 ± 2.20[a]	20:1*	0.66 ± 0.03[a]	0.43 ± 0.05[b]
16:1 (ns)	0.08 ± 0.01	0.15 ± 0.05	22:1 (ns)	0.16 ± 0.01	0.15 ± 0.02
18:0 (ns)	1.14 ± 0.04	1.16 ± 0.05	P (ns)	58.06 ± 0.34	57.31 ± 0.21
18:1*	23.27 ± 1.05[a]	21.3 ± 0.22[b]	U (ns)	80.23 ± 0.74	79.34 ± 0.74
18:2*	46.81 ± 0.09[b]	49.11 ± 1.02[a]	S*	15.94 ± 1.22[b]	19.81 ± 1.22[a]
18:3*	11.25 ± 0.82[a]	8.2 ± 2.01[b]	P/S*	3.64 ± 0.09[a]	2.89 ± 0.14[b]
20:0 (ns)	0.39 ± 0.02	0.55 ± 0.08	U/S*	5.03 ± 0.17[a]	4.00 ± 0.11[b]

All data represent the mean of three replications. *,**Significant levels at 5%, 1%, respectively. ns: not significant. [a,b]Letters indicate the statistical difference in rows.
S – saturated fatty acids; P – polyunsaturated fatty acids; U – unsaturated fatty acids.

Other fatty acids detected in the samples were stearic, gadoleic, arachidic, erucic, and palmitooleic acids at 1.14–1.16, 0.43–0.66, 0.39–0.55, 0.15–0.16, and 0.08–0.15% respectively (Table 2). Statistical analysis also showed significant differences between varieties for palmitic, oleic, linoleic, linolenic, and gadoleic fatty acids. However, the amounts of palmitooleic, stearic, arachidic, and erucic fatty acids were found to be statistically insignificant ($p > 0.05$).

Fatty acid analysis allowed the estimation of the different nutritional fractions: saturated fatty acids (SFAs) and polyunsaturated fatty acids (PUFAs). PUFAs, due to the high content of linoleic acid, were the main component of total fat extracted from the studied lentil varieties, representing values higher than 57.31–58.06% of total fat. The SFA contents were the minor group, with lower than 20% for both lentil seeds (Table 2). The amounts of fatty acids in the investigated lentils found in this study were similar to values reported in the literature [5].

Sample Preparation. Two lentil seed verities (red and green) were used for all the experiments in this study. The seeds were obtained from the local market during June–July, 2008 in Karaj (located west of the capital Tehran) and were kept in cooled bags during transportation to the laboratory. The seeds were cleaned in an air screen cleaner to remove all foreign matter such as dust, dirt, and chaff, as well as immature and damaged seeds.

Proximate Composition. Moisture content was determined by drying the samples at 105°C to constant weight. In order to determine total ash, samples were kept in an oven at 525°C until they became total ash and then weighed [6]. Total protein was determined by the Kjeldahl method. Protein was calculated using a nitrogen conversion factor of 6.25 [6]. Crude fat was determined by the Soxhlet method. Crude fat was obtained by exhaustively extracting 5.0 g of each sample in a Soxhlet

apparatus using petroleum ether (boiling point range 40–60°C) as the extractant. Total carbohydrates were calculated by difference: 100 – (% moisture + % crude protein + % crude fat + % ash content) [6]. Energy values were calculated from the data on protein, carbohydrates, and fats by means of factors of 4, 4, and 9 kcal/g, respectively. The metabolizable energy (ME) levels for young chicks and adult birds were computed by the formula recommended in the literature [3] as:

$$ME\ (kcal/kg) = 40.81\ (0.87 \times \text{crude protein} + 0.87 \times 2.25 \times \text{oil} + \text{available carbohydrate} + C),$$

where C is equal to 4.9 for adult birds and 2.5 for young chicks.

Also, acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined according to the literature method [7] using the Ankom fibre analyzer.

Mineral Content. Samples were wet digested in a mixture of nitric and perchloric acids HNO_3–$HClO_4$, 4:1. Potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and sodium (Na) concentrations in the digest were determined by using atomic absorption spectrophotometry (Perkin–Elmer Model 2380) [2]. The amounts of minerals were calculated with a standard curve. Phosphorus (P) was measured using an UV visible spectrophotometer (Spectronic Genesys 10, GENEQ Inc., Montreal, Canada) at 430 nm wavelength and comparing the results with the standard curve [2].

Fatty Acid Composition. In order to evaluate the fatty acid composition of lentil oil, a 30 m × 0.22 mm, 0.25 μm film thickness fused-silica capillary column DB-23 was connected to a Varian 3400 gas chromatograph (Palo Alto, California) equipped with a flame ionization detector (FID) and split/splitless injector. Helium was used as the carrier gas at a velocity of 23 cm s^{-1}, and as the make-up gas at a rate of 30 mL min^{-1}. The oven temperature was programmed from 140°C (0 min) at 7°C min^{-1} to 215°C (81.29 min). The fatty acid methyl ester (FAME) dissolved in hexane was injected (1 μL) in a split mode of injection at a split ratio of 40:1. The injector and detector temperatures were 250 and 290°C, respectively [8]. A Varian 4270 integrator was used for recording the peak areas. No response factors were applied in calculating fatty acid composition, since the GC temperature program showed almost equal responses for different FAME standard mixtures.

Statistical Analysis. All chemical experiments were performed in triplicate, and the results represented as a mean of the three values with the standard deviation. The results obtained were subjected to analysis of variance (ANOVA) and Duncan′s test using SPSS 13 (SPSS Inc., USA) software.

REFERENCES

1. F. Ozdemir and I. Akinci, *J. Food Eng.,* **63**, 341 (2004).
2. S. M. T. Gharibzahedi, S. M. Mousavi, S. H. Razavi, and M. Akavan-Borna, in: *Proceedings of the 4th International Conference Rural Development,* Lithuania, 2009, p. 304.
3. S. Solanki, A. C. Kapoor, and U. Singh, *Plant Food Hum. Nutr*., **54**, 79 (1999).
4. K. S. Dhindsa, D. R. Sood, and M. S. Chaudhary, *Ind. J. Nutr. Dietet*., **22**, 186 (1985).
5. E. Ryan, K. Galvin, T. P. O′Connor, A. R. Maguire, and N. M. O′Brien, *Plant Food Hum. Nutr.,* **62**, 85 (2007).
6. AOAC, *Official Methods of Analysis of the Association of Official Analytical Chemists*, Washington D.C., 1990.
7. N. Wang and J. K. Daun, *Food Chem.*, **95**, 493 (2006).
8. T. Pirman and V. Stibilj, *Eur. Food Res. Technol.,* **217**, 498 (2003).