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Nutritional Components and Amino Acids in Lentil Varieties

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ABSRACT

Lentil is one of the world's healthiest foods due to excellent nutritional profile. Protein quality in lentil seeds is strongly influenced by composition of amino acids. In the present research, content of protein and amino acids were determined to identify a total of six lentil varieties (Altintoprak, Cagil, Meyveci, Seyran, Sultan, Yerli kirmizi) which are widely preferred in Turkey. All of the lentil varieties showed statistically significant differences ($p<0.01$) for the investigated parameters except for phenylalanine and tryptophan. Content ranges of the following basic parameters (%) were: 22.79 (Sultan) – 29.73 (Seyran) for protein; 0.92 (Yerli kirmizi) – 1.49 (Cagil) for methionine and 0.56 (Seyran) – 1.37 (Altintoprak) for tryptophan among genotypes. Consequently, tryptophan was found as limiting amino acid. Results indicated that lentil varieties Cagil and Altintoprak should be considered as promising genotypes due to their high content of essential amino acids. Results of the present study can be used for the future researches which are focused on the desired quality characteristics in lentils.

1. Introduction

Legumes are a valuable source of protein, minerals, vitamins etc. essential components of human health in poorer areas of the world (Norton et al. 1985). Lentil, a member of legume family has a big importance for today's world due to has advantages for concerns such as food security, poorness, drought stress, sustainability etc. problems in a changing climatic conditions and lentil is one of the most tolerant legumes to high salinity (Chattopadhyay et al. 2011; Kahraman and Ozkan 2015). Digestibility is high, protein rich seeds, providing several dietary nutrients, high energy (primarily due to starch), containing most essential minerals and several vitamins, nitrogen fixing by symbiotic living with Rhizobium bacteria, carbon sequestration ability, tolerance for different soil types and low fertilization, efficient water usage, essential complement for cereal based food menu are main advantages of lentils. Additionally, consumption of lentil with wheat or rice provides a balance in essential amino acids for human nutrition because of its high lysine and tryptophan content (Erskine et al. 1990; Urbano et al. 2007). Additionally, nutritional value of lentil is highly regarded in vegetarian diets welded by high content of protein, minerals and vitamins.

Lentil (*Lens culinaris* Medik.) is one of the first domesticated plant species and, as old as those of barley and pea. It has been cultivated for 10,000 years in the most difficult agricultural environments (Harlan 1992; Sandhu and Singh 2007). According to the FAO statistical databases, lentil is grown on 4.344.671 ha area by 4.951.720 tons of production, 114 kg da-1 yield, 1.918.223 tons of import ($1.650.961) and 1.963.981 tons of export ($1.548.557) over the world, while those values are 281.178 ha area by 417.000 tons of production, 148 kg da-1 yield, 309.561 tons of import and 212.596 tons of export in Turkey.

Cereal grains have lower levels of total protein, deficient in lysine, although having sufficient value of the sulphur based amino acids. Otherwise, pulses have two times more protein compared with cereals. Therefore, a diet consisted from pulses and cereals is a good combination for optimum protein quality. Previous studies have highlighted that a combination of pulses and cereals is quite superior than consumption individually

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(Bressani et al. 1962; Bressani and Elias 1974; Khan et al. 1977).

Nutritional characteristics of the foods are essential parameters in plant breeding programs. Lentil has high adaptation ability to different environment conditions over the world and also an important source of food. Present work was conducted to determination of protein and amino acid content in lentil genotypes.

2. Materials and Methods

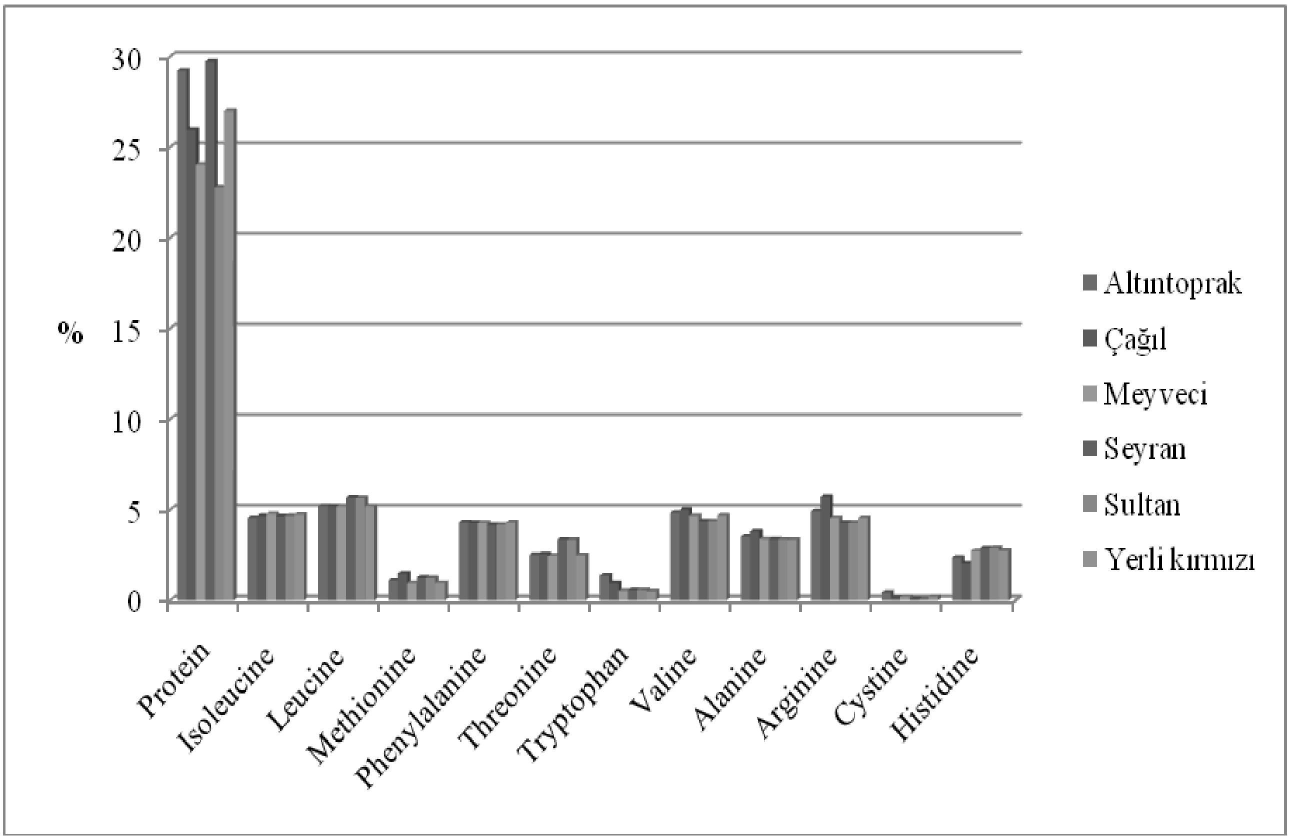
A total of six lentil genotypes (Altintoprak, Cagil, Meyveci, Seyran, Sultan, Yerli kirmizi) were used in this research which was certified in Turkey. The genotypes Meyveci and Sultan are grown as summer crop and have green colored seeds while the rest of lentil genotypes are grown as winter crop and have red colored seeds. Those lentil genotypes were selected due to widely cultivation, having stable yield over the country besides having a big potential by view of quality focused breeding works.

Content (%) of protein (nitrogen ratio*6.25) was determined by LECO device according to the AOAC 992.23 method (Sanchez et al. 1999) and content (%) of amino acids (in total: 11 amino acids) were determined by HPLC-Agilent Varian Vista Model. Amino acids were identified by its peak on comparison with peak of known amino acids (external standard). Analyses for the mentioned parameters were made by two replications. Collected data were analyzed by using “JUMP” computer based program.

3. Results and Discussion

Content of the investigated parameters in the seed of the 6 different lentil varieties which are commonly grown in Turkey were presented in Table 1and, discussion was summarized in the below.

Table 1
Content of the investigated parameters



According to the results of the variance analysis, all of the genotypes showed significant differences on the level of 1% for the investigated parameters except for phenylalanine and tryptophan amino acids. Although the essential amino acid tryptophan was found as non-significant in terms of statistical databases, the used genotype Altintoprak was determined as promising for the enhanced essential amino acid content.

Content of the investigated parameters (%) were ranged between the values that summarized as follows: 22.79 (Sultan) – 29.73 (Seyran) for protein; 4.57 (Altintoprak) – 4.76 (Meyveci) for isoleucine; 5.21 (Altintoprak) – 5.68 (Seyran) for leucine; 0.92 (Yerli kirmizi) – 1.49 (Cagil) for methionine; 3.85 (Seyran) – 4.30 (Altintoprak) for phenylalanine; 2.47 (Meyveci) – 3.37 (Seyran) for threonine; 0.56 (Seyran) – 1.37 (Altintoprak) for tryptophan; 4.35 (Sultan) – 5.01 (Cagil) for valine. Table 1 shows comparative results of the investigated parameters on the genotypes. Those differences could be welded due to the different genetic structure of the used lentil genotypes. For the enhanced protein ratio, Meyveci genotype was appropriate due to the highest content. For the limiting amino acids methionine and tryptophan, the genotype Cagil and Altintoprak were shown as outshine genotypes to increasing the desired quality components.

A wide array of amino acids, occurring naturally in unconjugated forms in plants (may provoke adverse reactions in both animals and humans. These non-protein amino acids are ubiquitous in the plant, but the seed is normally the most concentrated source. Legumes contain higher concentrations and a more diverse range of non-protein amino acids than any other plant species (D'Mello 1991). In many instances, these compounds bear structural analogy with the physiologically important amino acids or their neurotransmitter derivatives. Consequently, manifestations of deleterious effects range from loss of appetite and reduced nutrient utilization to profound neurological disorders and even death. Although the data are derived primarily from studies with rodent models, it is appropriate and instructive to consider the implications for human health (D'Mello 2012).

As it well known, amino acid profiles of proteins in pulses are unbalanced. Comparing with egg protein, the indispensable sulphur-containing amino acids are at a much lower concentration (Mahe et al. 1994). Those amino acids (i.e. methionine and cystine) are known as the most critical limiting components of the proteins. Several of legume based protein sources may differ significantly in the amino acid composition. Additionally, content in total nitrogen is essential and should prevail, as criteria of selection, over amino acid spectrum. Indeed, low nitrogen content requires a higher amount of the food legume in the diet, with consequently higher antinutritional factors (Baudoin and Maquet 2009). Those findings are supporting the results of present study.

In a research (Pirman et al. 2001), French green lentil "Anicia" was used as material. Content (%) of the investigated parameters were reported as following: 26.7 for protein, 3.64 for isoleucine, 6.57 for leucine, 0.59 for methionine, 4.67 for phenylalanine, 3.33 for threonine, 4.02 for valine, 3.65 for alanine, 6.36 for arginine, 0.07 for cystine, 2.09 for histidine. In another previous research (Kesli 2009), certified lentil genotype "Ciftci" was grown in two locations of Ankara-Turkey ecological conditions. As the means of different harvest times, the following values (%) were reported; 22.6-25.9 for protein, 0.86-0.90 for isoleucine, 1.75-1.76 for leucine, 0.18-0.31 for methionine, 1.18-1.27 for phenylalanine, 0.86-0.88 for threonine, 0.99-1.02 for valine, 0.97-1.01 for alanine, 1.82-1.97 for arginine, 0.12-0.13 for cystine, 0.55-0.57 for histidine respectively. It is concluded from the study (Kuo et al. 2009) that, Spain originated "Castellana" lentil variety was used to determine change in content (%) of amino acids in the seeds under different germination conditions. Germinated lentils showed a dramatic increase for histidine (from 0.30 to 0.80), threonine (from 0.04 to 2.12) and valine (from 0.11 to 2.42). Another former research, a total of 35 introduced lentil genotypes (*Lens culinaris* Medik.) exhibited the following values (%); 25.3-29.3 for protein, 0.34-0.56 for isoleucine, 0.68-0.98 for leucine, 0.09-0.21 for methionine, 0.49-0.82 for phenylalanine, 0.41-0.79 for threonine, 0.06-0.09 for tryptophan, 0.53-0.90 for valine, 0.66-0.10 for arginine, 0.36-0.61 for histidine (Alghamdi et al. 2014).

Similar to the present research, it was implicated that lentil has a good proportion of amino acids. The limiting of the amino acids are the methionine and cysteine that are sulfur containing amino acids as it seen on most of the legume seeds. Otherwise, lentil has adequate to high levels of lysine (Shewry and Halford 2002). Content of amino acid in food sources and nutrition are important topics in biological sciences. Amino acids show a wide range of chemistry, metabolism, physiology, reproduction, immunology, pathology, and cell biology. They act on building blocks of proteins, signaling molecules in cell physiology, regulators of food intake, gene expression, the protein phosphorylation cascade, and cell-to-cell communication. Otherwise, they are key precursors for synthesis of hormones and low-molecular-weight nitrogenous substances, with each having enormous biological importance (Kharitonov et al. 1995; Friedman and Levin 2012; Lei et al. 2012; Fernstrom 2013). Amino acids regulate key metabolic pathways that are necessary for maintenance, growth, development, reproduction, lactation, and immunity. These amino acids include arginine, cysteine, glutamate, glutamine, glycine, leucine, proline, and tryptophan.

As it reported in many of previously findings, lentils can provide many of the dietary nutrients, that are including amino acids (in the form of protein), energy which is primarily in the starch form, most of the essentials minerals and several vitamins besides containing several compounds which are providing good health (Shakra and Tannous 1981; Ceyhan 2006; Grusak 2010; Karadavut and Genc 2010; Hamdi et al. 2012) as a member of legumes. For enhanced health promoting composition of sprout quality, exposing of abiotic stress is more economic and easier method than application of conventional methods (Kahraman et al. 2015; Swieca 2015; Kahraman 2017). Sprouting reduces anti-nutritional factors and increases the bioavailability of minerals and also affects phytochemical levels (Ztotek et al. 2015). Quality and functionality of foods may be modified by affecting of each production phases including plant and animal breeding, processing technology, additives, changing of storage conditions (Francis et al. 2012). Basically, the quality of foods depend on seed quality and germination conditions (Kaya et al. 2008; Balibrea et al. 2011; Swieca et al. 2014). In the basis of literature, it may be suggested that the seed composition changes during germination. Content of protein fraction changes, proportion of the nitrogen containing fractions shifts to the smaller protein fractions and free amino acids (Marton et al. 2010). Consequently, food quality based on quality of the seeds. For that reason, there is a big necessary to introducing of seed characteristics and nutritional values to enhance functionality of foods. Overall, results of the present research were in similar with previous findings. Future breeding programs may consider those findings to improve the nutritional quality.

4. Conclusions

Results of the present research highlighted that, the Meyveci genotype was the most suitable lentil variety for increasing of protein content. By view of the limiting amino acids methionine and tryptophan, the genotype Cagil and Altintoprak were shown as outshine genotypes to enhance the desired quality components.

Assessing of variation is vital to understanding the available genetic variability and potential use for varietal improvement. The most promising lentil genotypes to assist nutritional value could be used as a significant source of yield, total protein, and essential amino acids etc. properties. Therefore, the most widely grown and promising lentil genotypes were used in the present study. Results of the present study will be useful to conclude which genotype should be selected for further purposes.

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