SHORT NOTE

# Lipid contents and fatty acid compositions of some soybean varieties and lines

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The seeds of some soybean genotypes were obtained from the Directorate of Eastern Mediterranean Agricultural Research Institute in Adana/Türkiye were grown in 2022 on the Sivas Science and Technology University were investigated for their lipid contents and fatty acid compositions. The lipid contents of the soybean seeds were found to be between 13.1-20.9%. The seed lipids of different soybean genotypes contained linoleic, oleic, palmitic and linolenic acids as their major components. The seed lipids of the soybean lines contain more linoleic acid than the varieties, as the major unsaturated fatty acids, whereas in the seed lipids of Samsoy and Soyanam varieties and all lines except Line 12 contain palmitic acid as the main component of saturated fatty acids. In the study on soybean genotypes, palmitic acid was found in the major saturated fatty acids, instead linoleic oleic, and linolenic acids were found in major unsaturated fatty acids.
**Keywords:** Soybean, lipid, fatty acid, variety and line

## 1. INTRODUCTION

Soybean (*Glycine max* L.), belonging to the *Fabaceae* family, is an annual warm climate plant. Soybean, originating from East Asia, is one of the most cultivated oilseed crops in the world. It is grown as an essential dietary component due to its high grain protein (25.5-58.9%) and lipid (12.0-23.0%) content [1]. The total amount of soybean production in the world is approximately 371.7 million tons, while the countries with the highest production are Brazil, USA, Argentina and China, respectively, Turkey ranks 31st with a production of 182 thousand tons [2].

Many industrial products such as soy sauce, soy milk, soy flour, lecithin and animal feed are obtained from soybeans, especially lipid [3]. After palm lipid, soybean lipid is used the most in the world to meet the vegetable lipid need. The amount of 1/3 of the vegetable lipid used for cooking is produced from soybeans [4]. Lipid extracted from soybeans is widely used as a component of frying lipid, margarine and salad dressing, and in the manufacture of inks, paints and cosmetics [5].

Fatty acids are the predominant components of soybean lipid. Fatty acids consist of saturated fatty acids (palmitic acid and stearic acid) and unsaturated fatty acids (oleic acid, linoleic acid and linolenic acid) [6]. Soybean lipid contains approximately 9.96, 3.93, 22.09, 53.46 and 9.05%, palmitic, stearic, oleic, linoleic and linolenic acids, respectively. The amount and relative ratios of each fatty acid are important factors as they affect the flavour, stability and nutritional value of the lipid [7]. Therefore, different fatty acid compositions are desired depending on the end uses of soybean lipid [8].

Many studies have been conducted on the lipid and fatty acid contents of the seeds of plants belonging to the Fabaceae family in Turkey [9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21]. The aim of this study was to determine the lipids and fatty acid compositions of the seeds of some soybean genotypes.

## 2. MATERIALS AND METHODS

### 2.1. MATERIALS

The seeds of *Glycine max* were used in this study. The seeds of soybean genotypes obtained from the Directorate of Eastern Mediterranean Agricultural Research Institute in Adana/Türkiye were sown on 28 April 2022 and harvested on 29 October 2022 on the land of Agricultural Research and Development Centre, Sivas Science and Technology University.

### 2.2. METHODS

#### 2.2.1. Oil Extraction and Preparation of Fatty Acid Methyl Esters (FAME)

Impurities were removed from the seeds of some cowpea genotypes, and the clean seeds were ground into powder using a ball mill. Lipids were extracted with hexane/isopropanol (3:2) [22]. The lipid extracts were centrifuged at 1 g for 10 min and filtered; then the solvent was removed on a rotary evaporator at 50°C. Lipid extraction is used to separate seed oil from lean tissue and measure the energy contained in the seed oil. Each sample was performed in three replications.

#### 2.2.2. Capillary GLC

Fatty acid methylesters were prepared via the methylation of total lipids [23]. Methylesters were separated by gas chromatography in Agilent GC 7890A gas chromatograph equipped with a flame ionisation detector (FID) and a fused silica capillary column Agilent J&W GC Columns (100 m × 0.25 mm id, 0.25 µm film thickness, Part Number 112-88A7). The carrier gas flow (H2) was 1.2, 30 mL min-1 N2 and a minimum of 300 mL min-1 synthetic air (H2). The operation parameters were as follows: the detector temperature was 260°C, the injection port temperature was 250°C and the column temperature was 175°C, programmed to increase at 5°C min-1 to reach 230°C and to hold at this temperature for 21 min. for a running time of approximately 55 min. The sample splitting rate was 1:50. The samples (1 µL) were injected in triplicate. Peak areas were determined using Agilent Chem Station B04.03. To identify the fatty acids retention times were compared with those of standard methyl esters (Supelco 37 Component FAME Mix).



## 3. RESULTS AND DISCUSSION

In this study, the lipid contents and fatty acid compositions of 9 lines and 5 varieties of soybean [*Glycine max* (L.) Merr.] were detected and the results are shown in Table I. The lipid contents in seeds of 14 genotypes of soybean ranged from 13.1 to 20.9% (Table I). The highest lipid content was found in the Arisoy variety, while the lowest lipid content was found in Line 12. The lipid content was higher in 8 genotypes (Arisoy, Traksoy, Line 4, Line 7, Line 8, Line 9, Line 10 and Line 11) as compared to the other genotypes. It has been reported that the oil content of soybean seeds exposed to drought stress varies between 17.6 and 25.4% [24], and the oil contents of soybean seeds that are applied to different agricultural management systems vary between 21.65 and 22.01% [1], and some agricultural practices applied to soybeans in Central South USA had soybean oil contents between 20.1-24.5% [25]. On the other hand, it has been reported that the oil content of some soybean lines and varieties varies between 17.1-21.0% [26] and 19.9-21.7% [27], while the seed oil content of 94 soybean varieties is reported to vary between 12.2-23.6% [28].

The seeds of some soybean genotypes contain palmitic and stearic acids as the major component of fatty acids among the saturated acids. The major unsaturated fatty acids found in the seeds of some soybean genotypes were oleic, linoleic and linolenic acids. Palmitoleic, myristic, palmitoleic, margaric, margoleic, arachidic, gadoleic, behenic, erucic and docosadienoic acids were shown to be lower than 1%. Palmitic and stearic acid contents ranged from 6.69 to 10.54% and from 2.51 to 4.99%, respectively. While the lowest palmitic and stearic acid contents were found in Line 12, the highest palmitic acid content was found in Line 8 and the highest stearic acid content was found in Soyanam variety (Table I). It has been reported that palmitic and stearic acids vary between 11.0-12.2% and 3.4-4.6%, respectively, in soybean seeds exposed to drought stress [24], between 10.07-12.29% and 3.62-6.10%, respectively, in soybeans applied to different agricultural management systems [1], and between 8.2-17.2% and 2.7-5.2%, respectively, in various soybean germplasms from around the world and grown in China [29]. On the other hand, palmitic and stearic acids were reported to vary between 10.45-12.71% and 3.99-5.79%, respectively, [26], and between 11.28-11.97% and 3.62-4.45% [27] in some soybean lines and cultivars, and reported to vary between 3.14-16.56% and 2.14-4.74%, respectively, in 94 soybean cultivars [28].

Myristic, margaric, arachidic, behenic and lignoceric acids from saturated fatty acids were detected in small amounts in seeds of all soybean genotypes. While the lowest myristic, margaric, arachidic and behenic acid contents were found in line 12, the lowest lignoceric acid content was found in line 10. On the other hand, the highest margaric and arachidic acid contents were determined in the Soyanam variety, the highest myristic acid in Traksoy, the highest behenic acid in Atem-7 variety and the highest in Arisoy variety. Palmitoleic, margoleic and gadoleic acids from unsaturated fatty acids were detected in all soybean genotypes and in small amounts; erucic and docosadienoic acids were either not detected or detected in very small amounts.

**Table I -** Lipids and fatty acid composition of the seeds of some soybean varieties and lines

| Genotypes | Lipid | C14:0 | C16:0 | C16:1 | C17:0 | C17:1 | C18:0 | C18:1 | C18:2 |
|---|---|---|---|---|---|---|---|---|---|
| | (%) | | | | | | | | |
| Arisoy | 20.9 | 0.05 | 9.81 | 0.06 | 0.08 | 0.06 | 3.98 | 24.18 | 51.31 |
| Traksoy | 20.3 | 0.08 | 9.86 | 0.06 | 0.08 | 0.04 | 4.11 | 24.07 | 50.94 |
| Samsoy | 18.9 | 0.05 | 10.30 | 0.10 | 0.09 | 0.06 | 4.30 | 24.32 | 50.25 |
| Soyanam | 18.8 | 0.05 | 10.47 | 0.07 | 0.11 | 0.06 | 4.99 | 24.81 | 49.38 |
| Ataem-7 | 19.3 | 0.05 | 9.95 | 0.10 | 0.08 | 0.06 | 3.97 | 23.26 | 51.49 |
| Line 4 | 20.4 | 0.06 | 10.20 | 0.10 | 0.08 | 0.06 | 3.94 | 23.10 | 52.09 |
| Line 5 | 19.2 | 0.06 | 10.27 | 0.06 | 0.09 | 0.06 | 3.90 | 21.02 | 53.45 |
| Line 6 | 18.8 | 0.06 | 10.25 | 0.07 | 0.10 | 0.06 | 3.83 | 21.60 | 53.52 |
| Line 7 | 20.0 | 0.06 | 10.37 | 0.07 | 0.09 | 0.05 | 3.73 | 21.41 | 53.62 |
| Line 8 | 20.4 | 0.07 | 10.54 | 0.07 | 0.09 | 0.05 | 3.77 | 21.18 | 53.50 |
| Line 9 | 20.4 | 0.06 | 10.29 | 0.08 | 0.09 | 0.04 | 4.10 | 21.88 | 53.32 |
| Line 10 | 20.3 | 0.06 | 10.19 | 0.08 | 0.09 | 0.05 | 3.93 | 21.96 | 53.29 |
| Line 11 | 20.4 | 0.06 | 10.23 | 0.07 | 0.08 | 0.06 | 3.95 | 21.50 | 53.47 |
| Line 12 | 13.1 | 0.04 | 6.69 | 0.05 | 0.05 | 0.03 | 2.51 | 14.97 | 68.85 |
| SD | 0.93 | 0.02 | 0.30 | 0.03 | 0.01 | 0.01 | 0.45 | 1.89 | 2.17 |
| **Genotypes** | **C18:3** | **C20:0** | **C20:1** | **C22:0** | **C22:1** | **C22:2** | **C24:0** | **SFA** | **USFA** |
| | | | | | (%) | | | | |
| Arisoy | 8.42 | 0.34 | 0.39 | 0.06 | 0.06 | 0.05 | 1.16 | 15.48 | 84.52 |
| Traksoy | 8.68 | 0.35 | 0.48 | 0.12 | 0.21 | 0.03 | 0.89 | 15.48 | 84.52 |
| Samsoy | 9.15 | 0.39 | 0.44 | 0.09 | 0.21 | 0.05 | 0.21 | 15.43 | 84.57 |
| Soyanam | 8.86 | 0.43 | 0.46 | 0.09 | < 0.01 | 0.04 | 0.19 | 16.33 | 83.67 |
| Ataem-7 | 8.75 | 0.39 | 0.46 | 0.35 | 0.03 | 0.02 | 1.05 | 15.83 | 84.17 |
| Line 4 | 9.14 | 0.34 | 0.45 | 0.05 | 0.20 | 0.02 | 0.19 | 14.85 | 85.15 |
| Line 5 | 10.20 | 0.32 | 0.36 | 0.05 | < 0.01 | < 0.01 | 0.17 | 14.86 | 85.14 |
| Line 6 | 9.60 | 0.32 | 0.36 | 0.04 | < 0.01 | 0.03 | 0.17 | 14.77 | 85.23 |
| Line 7 | 9.68 | 0.31 | 0.37 | 0.08 | < 0.01 | < 0.01 | 0.17 | 14.81 | 85.19 |
| Line 8 | 9.80 | 0.31 | 0.37 | 0.05 | < 0.01 | 0.02 | 0.17 | 15.00 | 85.00 |
| Line 9 | 9.13 | 0.34 | 0.21 | 0.04 | 0.19 | 0.05 | 0.16 | 15.09 | 84.91 |
| Line 10 | 9.49 | 0.31 | 0.19 | 0.04 | 0.13 | 0.05 | 0.13 | 14.75 | 85.25 |
| Line 11 | 9.67 | 0.31 | 0.32 | 0.07 | < 0.01 | 0.07 | 0.14 | 14.84 | 85.16 |
| Line 12 | 6.13 | 0.20 | 0.22 | 0.02 | < 0.01 | 0.07 | 0.17 | 9.68 | 90.31 |
| SD | 0.05 | 0.87 | 0.14 | 0.15 | 0.19 | 0.69 | 0.05 | 0.71 | 2.06 |

C14:0 Myristic acid; C16:0 Palmitic acid; C16:1 Palmitoleic acid, C17:0: Margaric acid, C17:1: Heptadecenoic acid, C18:0: Stearic acid, C18:1 Oleic acid; C18:2 Linoleic acid; C18:3 Linolenic acid; C20:0 Arachidic acid; C20:1: Eicosenoic acid, C22:0: Behenic acid, C22:1: Erucic acid, C22:2: Docosadienoic acid, C24:0: Lignoceric acid; SFA: Saturated fatty acid; USFA: Unsaturated fatty acid; SD: standard deviations



Linoleic, oleic and linolenic acids were identified as the main USFA components, and these acids constituted the majority of seed lipids. Oleic acid ranged from 14.97 to 24.81%. Soyanam, (24.81%), Samsoy (24.32%), Arisoy (24.18%) and Traksoy (24.07%) had the highest oleic acid contents. Linoleic acid was the predominant component of seed oils of all studied genotypes. Linoleic acid contents ranged from 49.38 to 68.85%, whereas linolenic acid contents ranged from 6.13 to 10.20%. The highest linoleic and linolenic acids contents were found in Line 12 and Line 5 genotypes, respectively, while the lowest linoleic and linolenic acid contents were found in Soyanam and Line 12 genotypes, respectively.

While oleic, linoleic and linolenic acids in soybean seeds were found to be 23.1-29.6%, 48.5-53.8% and 5.1-7.4%, respectively, [24], 18.7-28.2%, 48.2-57.2% and 5.4-9.7%, respectively, [1] in studies conducted in the USA, they were determined as 13.5-31.9%, 45.6-63.9% and 3.4-12.8%, respectively, in a study conducted in China [29], as 13.4-60.5%, 24.7-64.0% and 2.2-12.9%, respectively, in a study conducted in Brazil [28], and as 21.7-27.6%, 49.2-54.2% and 5.2-6.8%, respectively, [26], as 22.7-27.9%, 50.0-55.3% and 5.4-6.6%, respectively, [27] in studies conducted in Türkiye.

Unsaturated fatty acid (USFA) contents of studied genotypes were between 83.67 and 90.31% (Table I). Saturated fatty acid (SFA) contents of the studied genotypes were between 9.68 and 16.33%. Soyanam variety had the highest level of SFA; it was respectively followed by Ataem-7 (15.83%), Arisoy (15.48), Traksoy (15.48%) and Samsoy (15.43%) varieties. It has been reported that the saturated and unsaturated fatty acids of some soybean lines and cultivars vary between 15.0-17.5% and 81.5%-85.3%, respectively [26].

## 4. CONCLUSION

In this study on soybean genotypes, the fatty acid content was composed of 15 different fatty acids. The carbon numbers of these fatty acids range from 14 to 24. The major fatty acids were linoleic (C18:2),

oleic (C18:1), palmitic (16:0) and linolenic (C18:3), respectively. Because of these high values, the seeds can be evaluated as a good source for food, pharmaceutical and other industrial uses. In addition, when compared to these values in the literature, it is understood that soybean seeds are richer in total fat than the other legume seeds. In conclusion, this study highlights the potential of soybean seeds due to their high total fat content.

### Conflict of interest

The authors declare that they have no conflict of interest.

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