# BIOCHEMICAL ANALYSIS OF MELON SEEDS: THE ROLE OF WATER-SOLUBLE VITAMINS AND FATTY ACIDS IN NUTRITION

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**Abstract**
Melon seeds have been recognized as a nutritional powerhouse, offering a range of essential vitamins and fatty acids that play a critical role in maintaining and enhancing our health. This study aims to analyze the fatty acid profile and water-soluble vitamins in melon seeds in order to highlight the importance of incorporating melon seeds into our diets, not only as a source of nutrients but also as a means of promoting overall health and well-being. It delves into the rich nutritional profile of melon seeds, underscoring their valuable contribution to a balanced diet. Water soluble vitamins C, PP and B1 were detected in melon seeds in this study. Regarding fatty acid profile, PUFA C 18:2 was the most abundant (35.31%), followed by MUFA C18:1 (25.83%), although other unsaturated and saturated fatty acids were also determined. This comprehensive analysis of melon seeds' nutritional benefits encourages further exploration of their potential in enhancing diet quality and supporting long-term health objectives.
**Key words:** melon seeds, oil, nutrition, food insecurity.

## Introduction

The demand for high-quality vegetable oils for food and industrial uses has led to an increased focus on the fat and oil industry. The by-products of oilseed processing, notably the meal, are vital for providing protein-rich feed in animal husbandry, emphasizing the significance of oilseeds for oil extraction industries. The production of oilseeds is influenced by the diverse agricultural climate of the producing countries, their biological characteristics, and traditional preferences for certain vegetable oils.

The *Cucumis melo* L. plant, part of the pumpkin family, finds its roots spread across Asia, Europe, and Africa. Recent increases in melon cultivation have highlighted their economic value, although parts of the fruit remain underutilized. The rapid spoilage of melons limits their shelf life, but their unique aroma, characterized by compounds like (Z,Z)-3,6-nonadiene-1-ol and phenylethyl alcohol, adds to their appeal. According to Rolim *et al*. (2018), typically only the flesh and seeds are used, leaving the peel and other parts wasted. However, melons are valued not only for their taste qualities; they are also a source of nutrients such as vitamins, proteins and fats, as noted by Laur and Tian (2011), and Lester (2008).

Melon seeds, as well as those from other plants of the same family, are highly valued for producing both high quality vegetable oils, and high protein products. Thus, they may be suitable for their use as food additives or functional foods. In addition to their nutritional value, melon seeds are known for their medicinal properties, since they are celebrated in traditional medicine for their pain-relieving, anti-inflammatory, and antioxidant properties (Ivanova, 2012). They are a rich source of biologically active compounds, including vitamins A, D, C, K, E, and B group, along with essential minerals like magnesium, sodium, phosphorus, potassium, and calcium, as documented by Ivanova (2012).

The oil extracted from melon seeds is rich in biologically active substances such as tocopherols, phospholipids, and sterols, offering several health benefits. These seeds, often regarded as a by-product, are protein-rich (12.0-35.0%) and glyceride-dense (30.0-50.0%). Thanks to the cold pressing process, melon seed oil is globally produced for its high nutritional value, high in polyunsaturated fatty acids (PUFA) (Petkova & Antova, 2015). Melon seeds have a moisture content of 4.5%, crude protein of 25.0%, ash of 2.4%, crude fat of 25.0%, crude fiber of 23.3%, and carbohydrates of 19.8% (Mirzoev, 2015). Research by Petkova & Antova (2015) has highlighted that melon seeds have a diverse fatty acid profile, including oleic acid (24.8-25.6%) and linoleic acid (51.1-58.5%), in addition to containing sterols, tocopherols, and phospholipids.

The importance of linoleic acid in human physiology is determined by its involvement in the synthesis of arachidonic acid and the formation of phospholipids in cell membranes. Increased consumption of linoleic acid, as recommended by dietary guidelines, may reduce the risk of cardiovascular and other diseases. An international team of researchers, analyzing data from 20 prospective cohort studies conducted in ten countries from 1970 to 2010, covering a total of 366,073 patient-years, found that linoleic acid may have a long-term positive effect on the prevention of type 2 diabetes, while arachidonic acid did not lead to adverse effects (Wu, Marlund, & Imamura, 2017).

According to previous analyses at our laboratory, melon (from Chillaki variety) seed oil primarily comprises palmitic (22.34%), linolenic (35.31%), and oleic acids (25.83%), besides it is also an abundant source of tocopherols, especially the β+γ-tocopherols fraction (Israilova *et al*., 2023). Literature reports, such as those by Perry and co-workers (2009), confirm that melon seed oil is an important vegetable oil resource, extensively utilized in the food industry for creating a variety of products (Perry, Wang, & Lin, 2009).

The aim of this study is to examine the fatty acids profile and water-soluble vitamins with potential nutritional importance in seeds obtained from various melon varieties grown in the Khoresm region of Uzbekistan.

**Materials and Methods**

Materials: Melons from different varieties, harvested in the Khorezm region of Uzbekistan in 2023, were locally sourced and selected as raw materials. Seeds were kept in clean, dry, odorless, and pest-free storage conditions, as outlined in the GOST 22391-2015 guidelines.

Melon seeds were purified from organic and mineral impurities and crushed to 65% through a sieve with holes of 2 mm. Oil was obtained by cold pressing according to the methodology specified in (Mirzaxmedov *et al*., 2023) to a humidity of 6-7%. Samples were taken from the resulting oil for analysis in accordance with the standards listed below.

Equipment:

High-Performance Liquid Chromatography (HPLC) Shimadzu LC-20 (Shimadzu, Japan). Detector: diode array UV-Vis. Wavelengths used were 270 nm and 361 nm depending on the vitamin.

Gas Chromatography (GC) Shimadzu GC-2030 (Shimadzu, Japan). Detector: Flame ionization detector (FID). Carrier gas: Nitrogen.

Lab Solutions software ver 5.3 (Shimadzu, Japan) was used for data acquisition in both Shimadzu chromatographs.

Oil press: GEMCO model ZX-130 (GEMCO, China).

Methodology:

Fatty acids of extracted oil were analyzed by GC in the laboratory of the Center for Innovation and Pharmacy in Uzbekistan, following standard methods in accordance with AOAC and O'ZDST guidelines: Prior to analysis by GC, fatty acids were transformed into their methylated forms using a derivatization technique. For the fatty acid analysis, the oil underwent hydrolysis with a 10% KOH solution in alcohol. The resulting soap was then acidified with 50% sulfuric acid to separate the fatty acids, which were subsequently extracted using petroleum ether (Miyashita & Takagi, 1986). This extract was filtered, dried, and the fatty acids were methylated with diazomethane before their analysis via gas chromatography. This process enabled the detailed examination of the fatty acid composition in the oil samples (Kostyuchenko & Elagina, 2020).

For the chromatographic analysis of fatty acids, a Restek Stabilwax (Restek, USA) column, 60 m in length and 0.32 mm in diameter, was utilized. The oven temperature was programmed to an initial value of 80°C for 8 minutes, followed by an increase to 130°C, where it remained flat for 10 minutes, and finally, to increase to 180°C in 2 minutes, for a total run time of 22 minutes. The analysis was conducted with a split flow mode of 1/10, and the volume of the sample injected was 1 µl. One analysis was performed and regression from a calibration curve of external standards was used for quantification.

Water-soluble vitamins such as vitamin C, $B_1$ and PP, were analyzed by HPLC and quantified by regression against a calibration curve of external standards. Melon seed cake was used as the sample material.

To prepare the samples, 1 g of sample was accurately weighed into a 50 ml measuring flask, and 20 ml of deionized water were added before placing it in an ultrasonic bath at room temperature for 10 minutes. Following this, 2 ml of 2 mol $l^{-1}$ sodium hydroxide solution were added, and resulting solution was mixed in for 10 seconds. Then, 25 ml of a buffer solution were added, and the volume was made up to the flask's mark with deionized water (Israilova *et al*., 2023). A 0,02 ml aliquot of this solution was then injected into the HPLC for analysis. Area under the curve of peaks at retention times (RT) corresponding to those of standards were considered for quantification. One analysis was performed.

**Results and Discussion**

The chromatogram, at two different wavelengths (270 nm on top, and 361 nm on bottom), of water soluble vitamins standards, is shown in 'Figure 1'. Retention times are as follows (in minutes in all instances): vitamin C: 4.07; Vitamin PP: 4.523; vitamin B6: 7.069; vitamin B2: 9.501; vitamin B1: 13.654; and vitamin B12: 8.15.

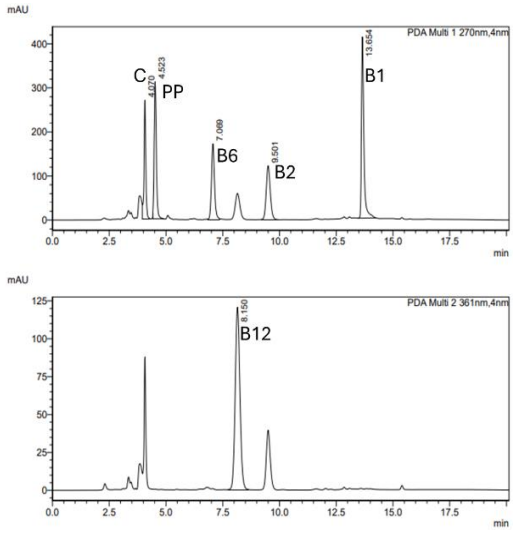


Figure 1. HPLC chromatogram of water soluble vitamins: C, PP, B1, B2, and B6 (top; read at 270 nm); and B12 (bottom; read at 361 nm).

The chromatogram of fatty acids analysis is shown in 'Figure 2'. Each specific fatty acid is displayed in the figure.

The composition (in percentage) of fatty acids in melon seeds is displayed in Table 1, in a comparison with our previously reported results of oil obtained from Chillaky variety melon seeds (Israilova *et al*., 2023), and from oil obtained from seeds of three varieties of melon (Honeydew, Dessert 5, and Hybrid 1), as reported by Petkova & Antova (2015). In Figure 3, the percentage of SAT (saturated), MUFA (monounsaturated), and PUFA (poly unsaturated) fatty acids in the oil investigated in this study are displayed.

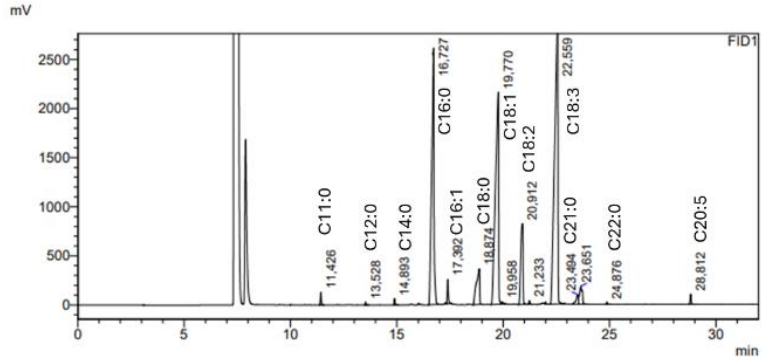


Figure 2. GC chromatograph of fatty acids profile in melon seeds oil.

According to data in 'Figure 3', the most abundant type of fatty acids are PUFA, which account for a 45% of total fatty acids content in melon seeds oil.

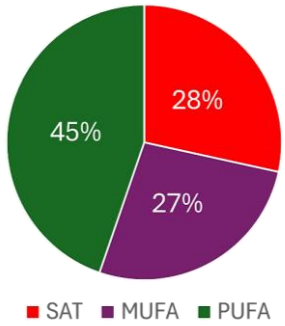


Figure 3. Type of fatty acids in melon seed oil according to saturation status.

According to data in Table 1, the most abundant individual fatty acid both in our study and in all other studies compared there, is linoleic acid (C18:2). As stated by Wu, Marlund, & Imamura (2017), consumption of this fatty acid may contribute to reducing the risk of cardiovascular and other diseases. Therefore, the potential health benefits of melon seed oil may be established. Other abundant fatty acids are oleic acid (C18:1), and palmitic acid (C16:0). Although percentages change, as is expected considering both different varieties, extraction methods, and geographic locations, there are also similitudes regarding the most abundant fatty acids found in melon seeds oil in this study, and those previously reported.

In terms of water-soluble vitamins, our study detected quantifiable concentrations of vitamin C, vitamin B1, and vitamin PP, as shown in Table 2.

Table 1

**Fatty acid profile of melon seeds oils from different varieties**

| | | **Current study** | **Previously published studies** | | | |
|---|---|---|---|---|---|---|
| Fatty acid | Type of fatty acid | Khorezm region (%) | Chillaky[a] (%) | Honeydew[b] (%) | Dessert 5[b] (%) | Hybrid [b] (x) |
| C11:0 | SAT | 0.42 | | | | |
| C12:0 | SAT | 0.06 | | | | |
| C14:0 | SAT | 0.16 | 2.32 | 0.1 | 0.1 | 0.2 |
| C16:0 | SAT | 22.34 | 9.76 | 9.4 | 12.3 | 16.4 |
| C16:1 | MUFA | 0.91 | | 0.1 | 0.1 | 0.2 |
| C18:0 | SAT | 4.48 | 4.21 | 6.6 | 6.1 | 6.5 |
| C18:1 | MUFA | 25.83 | 27.98 | 25 | 25.6 | 24.8 |
| C18:2 | PUFA | 35.31 | 42.10 | 58.5 | 55.2 | 51.1 |
| C18:3 | PUFA | 6.97 | 1.76 | | 0.1 | 0.2 |

*Source: a: Israilova et al., 2023; b: Petkova & Antova, 2015.*

It is important to mention that, although investigated (as displayed in 'Figure 1') by also analysing corresponding standards, no vitamin B6, B2, or B12 was found in melon seeds. The presence of vitamins C, PP, and the B1 in melon seeds may also contribute to fostering a nutritious diet. Vitamin C acts as a potent antioxidant, safeguarding cells from harm and bolstering the immune system. Vitamin PP is instrumental in metabolic processes, and B complex vitamins are crucial for the smooth functioning of the nervous system and metabolism (Elagina & Pankov, 2020; Elagina & Smirnova, 2019).

Table 2

**Water soluble vitamin content (in mg $g^{-1}$) in melon cake**

| **Title** | **Results (mg $g^{-1}$)** |
|---|---|
| Vitamin C | 0.53 |
| Vitamin B1 | 0.07 |
| Vitamin PP | 0.19 |

**Conclusions**

1. The most abundant type of fatty acids in melon seeds oil are poly unsaturated fatty acids (PUFA), which account for the 45% of total fatty acids.
2. The most abundant individual fatty acid in melon seeds is linolenic acid (C18:2) (35.31%), followed by oleic acid (C18:1) (25.83%), and palmitic acid (C16:0) (22.34%).
3. Out of the investigated water-soluble vitamins, vitamin C, vitamin B1, and vitamin PP were quantified in melon seeds. There was no presence of B6, B2, or B12 vitamins.

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