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Quantitative and qualitative assessment of fatty acids of seeds in Armenian cucumber (*Cucumis melo* var. *flexuosus)*

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ABSTRACT

Background & Aim: Armenian cucumber (*Cucumis melo* var. flexuosus) is one of the varieties of Cucurbitaceae family that is freshly consumed in Iran, while due to the presence of useful fatty acids and minerals, it can play a special role in the health diet. The aim of this study was to evaluate the quantitative and qualitative of fatty acids in the seeds of Armenian cucumber.

Experimental: Fruits were harvested in summer of 2018 at a fully ripened stage. The seeds were manually separated from the fruits and dried in room temperature. Evaluation of morphological traits was performed in the laboratory of horticulture sciences department. The seed oil extraction was done using Soxhlet apparatus and fatty acids analysis was performed by gas chromatography at Central Research Institute of Islamic Azad University, Isfahan (Khorasgan) Branch.

Results: The mean of 100-seed weight was 4.08 g, the mean of seed length and diameter were 12.46 and 4.84 mm, respectively, and the ratio of kernel to seed shell was 2.75. The seed oil content was 34.8% and included of 24 kind of different fatty acids. The most important unsaturated fatty acids were linoleic with 51.62% and oleic acid with 28.31% and the most important saturated fatty acids were palmitic and stearic acids with 11.16% and 7.16%, respectively. The sum of unsaturated fatty acids, saturated fatty acids and the ratio of unsaturated to saturated fatty acids were 19.46, 80.54 and 4.13, respectively.

Recommended applications/industries: According to the results of this research, America cucumber seeds are rich in polyunsaturated fatty acids that will make them suitable for food, pharmaceutical and industrial applications.

1. Introduction

Cucumis melo var. *flexuosus*, known as Armenian cucumber and snake melon, is one of the plants of Cucurbitaceae family and belongs to the Cocurbitals (Ali-Shtayeh *et al.*, 2017). The plants of this family are annual and are wildly found in tropical areas (Omidbeigi, 2005). The cultivation of *Cucumis melo* var. *flexuosus* is similar to cucumber and its fruits are usually used immaturely in salads (El Tahir and Pitrat, 1999) or its small green fruits are used in pickles. They are vining plants with large leaves and when the fruits ripen, they turn yellowish (Splittstosser, 1990). The skin of the fruit is very thin and bright green. It often has no bitter taste and is commonly used without

peeling in fresh food and is also cooked, salted and pickled (Besirli and Yanmaz, 1999).

The main origins of cucumber are attributed to Anatolia, Azerbaijan, Iraq, Palestine and central regions of Asia. *Cucumis melo* var. *flexuosus* is a vegetable fruit that has a slim, elongated, and sometimes curved appearance, tasted similar to cucumber. Most melon fruits have a length-to-width ratio of 1 to 1, but this ratio has been reported in cucumber and also in *Cucumis melo* var. *flexuosus* about 4 to 1 (Burger *et al.*, 2010).

The Cucurbitaceae family includes pumpkins, cucumbers, watermelons and melons. Cultivation of cucumbers for kitchen gardening has received increasing attention in recent years (Sarwar *et al.*,2018). The plants of this family are monocotyledonous, but the male flowers are located on one plant apart from the female flowers. The seeds do not have endosperm and their shape is characterized by the delicate coatings that surround them (Omidbeigi, 2005). The seeds of many species of this family are rich in the fats and proteins, and in different countries in Africa and central Asia, in addition to home use, the extracted oils also used in the food industry (Badifu *et al.*, 2001; Mariod *et al.*, 2009). Therefore, the economic value of theseeds has gradually been considered by the food industry in different countries (Jeffrey, 1990).

In the last decades, the seeds of vegetables and fruits have been considered as disposable materials, and only a few years ago based on the scientific researches, the identification of the nutritional and medicinal value of seeds has led the food industries to have a special attention to the extraction of seed oil as a natural source of antioxidants and biological compounds (Mallek-Ayadi *et al*, 2018).

According to the scientific reports, the amount of fiber in 100 grams of the cucumber seeds is 36.04%, its fat content is 22.33% and its carbohydrate and protein content are 16.9% and 15.75%, respectively, which confirm the high nutritional value in cucumber seeds (Karrar *et al.*, 2018). The fatty acids of seeds of pumpkin and pepo,due to their economic value and their common use in the diet, have been studied more than the other species (Nakic *et al.*, 2006; Applequist *et al.*, 2006; Al-Khalifa, 1996). It is reported that the cucumber seeds contained 18.3% saturated fatty acids and 81.7% unsaturated fatty acids, and the ratio of unsaturated to saturated fatty acids was 4.5 (Mariod *et al.*, 2009). In another study, the amount of saturated fatty acids and the oil content in *Cucurbita pepo* was reported 17.56% and 28.97%, respectively, and in *Cucumis melo* var. *flexuosus* these values were reported 16.36% and 30.70%, respectively (Kaymak, 2012). The seed oil content in melon, was reported in a range of 25% to 54% (De Mello *et al.*, 2000). In addition, pumpkin seeds because of the minerals content (such as zinc, potassium, sodium, magnesium and iron) and significant amounts of vitamins like vitamin C, B_1, B_6 and B_9 can be considered in the human diet (Karrar *et al.*, 2018).

In health diet, the amount of saturated and unsaturated fatty acids should be considered and the seed oils of vegetables, in addition to their value in human nutrition, can be used for non-food purposes such as their applications in soap and polymers industries. On the other hand, the vegetable oils can be used as a high-energy biofuel (Bates *et al.*, 2013).

Despite numerous studies on the fatty acids in pumpkin seeds and other seeds of fruits in Cucurbitaceae family, the researches on the fatty acids in *Cucumis melo* var. *flexuous* is not noticeable. Therefore, in this study, the morphological characteristics of seeds, oil percentage and fatty acids profile of seeds of *Cucumis melo* var. *flexuosus* were studied.

2. Materials and Methods

2.1. Sample collection and seeds characterization

In order to quantitative and qualitative study of fatty acids of seeds of *Cucumis melo* var. *flexuosus*, the fully ripen fruits were harvested in a private field in the Khorasgan area of Isfahan, Iran, in summer 2018. The Armenian cucumber fruits were transported to laboratory and then the seeds were manually separated from the fruits and dried in normal conditions.

The morphological characteristics including seed length and diameter were measured by digital calipers. The weight of one hundred seeds by digital balance with 0.001 g accuracy,were assessed in the laboratory of Horticultural Sciences Department of Islamic Azad University, Isfahan (Khorasgan) Branch.

2.2. Oil extraction and fatty acids analysis

To extract the oil, 10 g of the sample was pulverized and transferred to the Soxhlet apparatus, and the extraction was performed for 6h. Hexane was used as a

solvent. After extraction, a vacuum rotary evaporator was used to separate the oil from the hexane (AOAC, 1995). After that, the fatty acids were converted to their methyl esters using the method of Metcalf *et al.* (1996). Then, obtained solution was injected into gas chromatography (GC) device model 6980 (USA), with flame ionization detector (FID) and capillary column HP-88 with a length of 100 m, internal diameter of 0.25 and thickness of 0.2 µm. Nitrogen was used as the carrier gas at a flow rate of 1 ml/ min. The rate of injection of the sample into the device was 2µl and the detection of fatty acids based on their inhibition time was performed by comparing the inhibition time of methyl ester of standards prepared under the same experimental conditions.

3. Results and discussion

The results of some morphological traits of *Cucumis melo* var. *flexuosus* seeds, including seed length, seed diameter, weight of 100 seeds and the ratio of kernel to seed shell, are shown in Table1.

Table 1. Some morphological traits of *Cucumis melo* var. *flexuosus* seeds**.**

Seed length(mm)	Seed diameter(mm)	Weight of 100 seeds	The ratio of kernel to seed shell
1.03±12.46	4.84± 0.32	0.12±4.08	0.22±2.75

Measurement of the oil content of the seeds and fatty acids profile in the seeds oil showed that they contained 34.8% oil including 24 different types of fatty acids (Figure 1 and Table 2).

The number and amounts of saturated and unsaturated fatty acids identified in *Cucumis melo* var. *flexuosus* seeds are shown in Table 2. As it can be seen, among 24 detected fatty acids, 14 fatty acids are saturated and the other 10 are unsaturated fatty acids. The total oil was included 19.46% of saturated and 80.54% of unsaturated fatty acids.

In terms of saturated fatty acids, seeds oil showed the highest amount of palmitic (11.16%), stearic (7.16%), myrsitic (0.33%) and arachidic acid (0.29%), respectively. Among the unsaturated fatty acids, linoleic and oleic acids had the highest values with 51.62% and 28.31%, respectively.

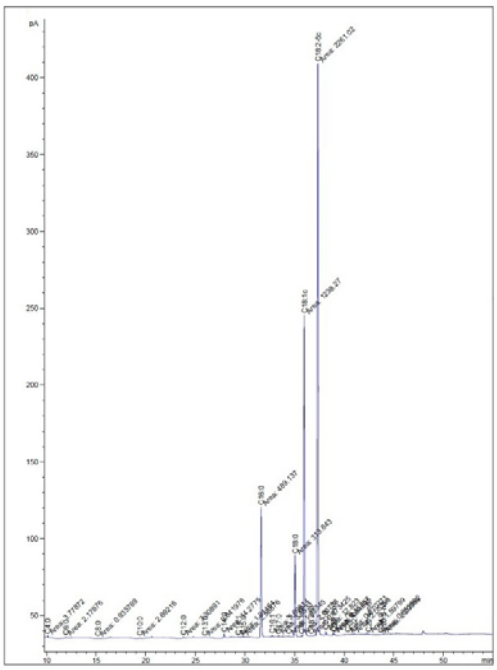

Figure 1. Chromatogram of fatty acids in *Cucumis melo* var. *flexuosus* seeds oil.

Table 2. Oil content and fatty acids composition (%) of *Cucumis melo* var. *flexuosus* seeds oil.

Fatty acids	Amount (%)
Butyric acid (C4:0)	0.09±0.01
Hexanoic acid (C6:0)	0.05 ±0.01
Octanoic acid (C8:0)	0.02 ±0.08
Decanoic acid (C10:0)	0.06 ±0.02
Lauric acid (C12:0)	0.07±0.01
Tridecanoic acid (C13:0)	0.01±0.07
Myristicacid (C14:0)	0.33±0.08
Pentadecanoic acid (C15:0)	0.06±0.03
Palmitic acid (C16:0)	11.16±0.30
Margaric acid (C17:0)	0.09±0.02
Stearic acid (C18:0)	7.16±0.18
Arachidic acid (C20:0)	0.29±0.05
Behnic acid (C22:0)	0.05±0.08
Lignoceric acid (C24:0)	0.02±0.04
∑SFA	**19.46±0.50**
Myristolic acid (C14:1 n-5)	0.04±0.05
Palmitoleicacid (C16:1 n-7)	0.13±0.02
Heptadecanoic cis acid (C17:1 n-7)	0.04±0.01
Oleic acid (C18:1 n-9)	28.31±0.8
Eicosenoic acid (C20:1 n-9)	0.11±0.08
Linoleic acid (C18:2 n-6)	51.62±0.8
Eicosadienoic acid (C20:2 n-6)	0.01±0.04
Alpha-Linolenic acid (C18: 3)	0.19±0.07
Arachidonic acid (C20:4 n-6)	0.04±0.01
Eicosapentaenoic acid (C20:5 n-3)	0.05±0.06
∑UFA	**80.54±0.96**
UFA/SFA	**4.13**
Crude Oil	34.8±1.02

According to the previous researches, linoleic acid plays a preventive role in many severe diseases such as cancer (Oomah *et al.*, 2000), so it is suggested in health diet because of its nutritional values (Carvalho *et al.*, 2011) and.

In previous studies, the amount of unsaturated fatty acids in the seeds of fruits in cucurbitaceae family has been reported between 77.1% to 80.8% (Mariod *et al.*, 2009), and the amount measured in this study (80.58%) was in the same range. Also, the amount of linoleic acid in *Cucumis melo* var. *flexuous* seed oil in the present study was 51.62% that is less than some common seed oil such as sesame oil but more than peanut oil (12-43%) (Karrar *et al.*, 2018).

Mariod *et al.* (2009) reported that linoleic and oleic acids as unsaturated fatty acids, and palmitic and stearic acids as saturated fatty acids had the highest values in seeds of different species of cucumbers in Sudan. The values reported by Mariod *et al*. (2009) for *Cucumis melo* var. *flexuosus* seeds were 61.4% for linoleic acid, 19.4% for oleic acid, 12.9%for palmitic, and 6%for stearic acid. It is noticeable that the amounts of unsaturated fatty acids in the present study were significantly more than the amounts reported by Mariod *et al.* (2009), whereas the amounts of saturated fatty acids (palmitic and stearic) were less than their findings.

Other studie by Kaymak (2012) reported the highest levels of palmitic, oleic and linoleic fatty acids, followed by stearic, myristic, palmitolic and arachidic acid, respectively.

Karrar *et al*. (2018) reported 19.2%, 80.8% and 4.2% for saturated fatty acids, unsaturated fatty and the ratio of total unsaturated fatty acids to the total saturated fatty acids, respectively. In present study, consistent with Karrar *et al.* (2018), 19.46%, 80.54% and 4.13 were seen for the mentioned variables, respectively.

The amount of saturated fatty acids in the seeds of the cucurbitaceae family is reported to be 18.3 to 22.9%, while the amount of saturated fatty acids in the seeds oil such as sesame is 12.5 to 18.7%, in sunflower 7.90 to 14.14%, and in peanuts 9.10 to 18.5% (Karrar *et al.*, 2018). These fatty acids can be used in the food industry and in addition as the dietary supplement. The amount of saturated fatty acids in seeds of *Cucum is melo* var. *flexuosus* were more than the amounts of saturated fatty acids in some other species in this family. The composition of fatty acids is an important indicator in determining the nutritional value of the oils. High levels of unsaturated fatty acids have significant physiological effects in preventing the growth of cancer and cardiovascular disease. According to scientific researches, unsaturated fatty acids are involved in reducing heart disease, clogged arteries, diabetes and cancer treatment (Gercekcioglu *et al.*, 2017). The therapeutic effects of omega-6 as anti-inflammation and regulator of nervous system and brain function have also been confirmed (Patterson *et al.*, 2012).

Overall, based on the findings of this study, the use of seed oil of *Cucumis melo* var. *flexuosus* due to the presence of significant amounts of unsaturated fatty acids can be suggested to improve nutritional status and increase community health.

4. Conclusion

According to researches published in recent decades, the use of vegetable oil has become popular because of beneficial effects on human health. The results of this study showed that *Cucumis melo* var. *flexuosus* seeds oil have a high nutritional value with significant amounts of unsaturated fatty acids, especially linoleic acid (omega-6), as well as low amounts of saturated fatty acids. Therefore, it can be applied as a valuable supplement to prevent cardiovascular disease, diabetes and cancer.

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