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ASSESSMENT OF THE QUALITY OF MELON OIL BASED ON THE CONTENT OF RETINOL AND TOCOPHEROLS.

Annotation: In this study, fat-soluble vitamins A and E were quantified in Mirzachul melon seed oil obtained by mechanical pressing. The analysis was performed by high performance liquid chromatography (HPLC). To confirm the accuracy and reproducibility of the measurements, each determination was performed in three parallel repetitions. The obtained chromatographic profiles are characterized by stable separation of the target analytical components and stable retention times. The authors examined scientific literature to compare the obtained indicators, determined the content of vitamin A (retinol) and the concentration of vitamin E (alpha-tocopherol) in melon oil. The research was carried out in order to further use melon seeds on a production scale. In addition to oil, cake is also of practical interest, which retains a significant portion of protein and dietary fiber and can be used in food products or in feed production. In general, the study shows the prospects for further study and application of melon seed processing products to obtain functional ingredients.

Key words: melon oil, retinol, tocopherol, HPLC, melon seeds.

Аннотация: В настоящем исследовании проведено количественное определение жирорастворимых витаминов А и Е в масле семян дыни сорта *Мирзачуль*, полученном методом механического прессования. Анализ выполнен методом высокоэффективной жидкостной хроматографии (ВЭЖХ). Для подтверждения точности и воспроизводимости измерений каждое определение проводили в трёх параллельных повторностях. Полученные хроматографические профили характеризуются устойчивым разделением целевых аналитических компонентов и стабильностью времён удерживания.

Авторами были исследованы научные литературы для сравнения полученными показателями, определены содержание витамина А (ретинола) и концентрация витамина Е (α-токоферола) в дынном масле. Исследования были проведены в целях дальнейшего использования семена дыни в производственном масштабе. Помимо масла, практический интерес представляет и жмых, который сохраняет значительную часть белка и пищевых волокон и может быть использован в составе пищевых продуктов или в кормопроизводстве. В целом исследование показывает перспективность дальнейшего изучения и применения продуктов переработки семян дыни для получения функциональных ингредиентов.

Ключевые слова: дынное масло, ретинол, токоферол, ВЖЭХ, семена дыни.

Introduction

Edible vegetable oils occupy a key place in the human daily diet, as they provide the body with energy, and are also a source of important nutritional and phytochemical compounds that have beneficial effects on health [1]. As the global population grows, the task of finding sustainable and high-quality alternative sources of vegetable oils that can meet the increasing demand for food is becoming more urgent. In recent years, scientists have been paying special attention to technologies for producing oil from agricultural by—products and waste [2, 3]. Melon (Cucumis melo L.) is a member of the Pumpkin family and one of the most important tropical fruit crops on the world market. Melon seeds make up about 10% of the fruit's weight, but they remain an extremely underutilized resource and are usually discarded [4]. In recent years, it has been established that seeds contain a high amount of oil (from 30.7 to 44.5% by weight) [5, 6] and are rich in unsaturated fatty acids and biologically active substances— primarily linoleic acid, retinol and tocopherols [7, 8].

Literary review

The work of Rabadán and co-authors analyzes the vitamin E content not only in oil, but also in other by-products of melon (seeds, peel, pulp). γ-tocopherol has been shown to be the dominant form of vitamin E in seeds, while other vitamin forms such as α-tocopherol and tocotrienols are also found, albeit in lower concentrations. This highlights the potential of melon byproducts as a source of vitamin E, which is relevant to the concept of circular economy of food systems [9].

Zhang, Li, Guo, and Charalampopoulos conducted a comparative analysis of three melon oil extraction methods: Soxhlet, cold pressing, and water-enzymatic extraction (AEE). They found that although the composition of fatty acids practically does not change between the methods, the extraction method significantly affects the content of biologically active components and the resistance of the oil to oxidation. It is especially important that the oil extracted by the AEE method demonstrated a higher tocopherol content and better oxidative stability compared to other methods [10].

In the Jalili and Rashidi experiment, oils of three varieties of melon (Cucumis melo) were analyzed, and it was demonstrated that γ-tocopherol makes up a significant part of all tocopherols (in the range of ~ 71.6–84.1 mg/100 g of oil). This confirms that different genotypes of melon can be a source of oil with a variable but always high content of vitamin E, which is important for breeding and industrial use [11].

A study by Mallek-Ayadi et al. (2019) showed that melon seed oil (Cucumis melo L.) contains about 2.43 mg/kg of carotenoids, which gives it its characteristic yellow color and provides provitamin-A activity. The carotenoids in the oil are able to convert into retinol in the human body, performing antioxidant functions and supporting vision. Thus, melon oil is a promising source of bioactive compounds for functional nutrition.

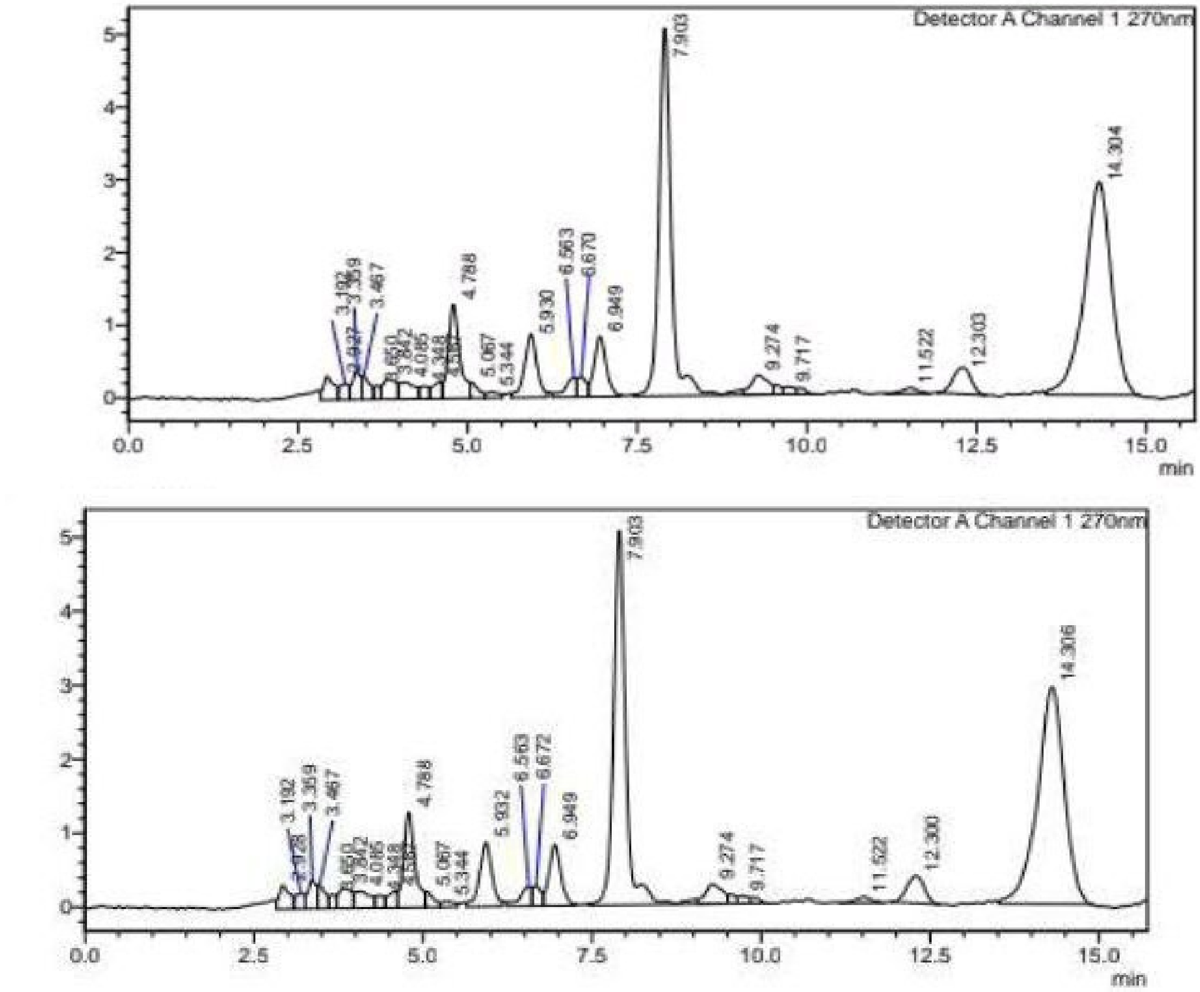
Methodology

The quantitative determination of fat-soluble vitamins A (retinol) and E (α-tocopherol) in Mirzachul melon seed oil obtained by mechanical pressing was carried out using high performance liquid chromatography (HPLC). The analysis was performed under conditions providing selective registration of compounds with a developed conjugation system characteristic of carotenoids and tocopherols at a wavelength of 270 nm. Sample preparation The selected oil samples were sequentially saponified in order to isolate the non-identifiable fraction. The obtained extracts were dissolved in the mobile phase and filtered through a membrane filter (0.45 microns). Each sample was analyzed three times, which confirmed the stability of the chromatographic profile and reproducibility of quantitative results. Analytical measurements were performed on a reversed-phase column C18 (250 × 4.6 mm, 5 microns). A gradient mode based on a mixture of acetonitrile, methanol, and water was used as the mobile phase, ensuring effective separation of the components. The flow rate was maintained at 1.0 ml/min, the column temperature was 30 °C, and the volume of the injected sample was 20 µl. The target vitamins were identified by retention time compared with standard retinol and alpha-tocopherol samples. The quantitative assessment was carried out by the area of the corresponding peaks using calibration graphs.

Results

The obtained chromatograms (n = 3) demonstrate stable separation and high reproducibility. Two groups of analytical signals are clearly distinguished on the profile, which can be observed in the chromatogram below, Figure 1. In the first zone (2.5–5.0 min), a series of low-intensity peaks are recorded, reflecting the presence of minor aromatic compounds of the non-personalized fraction. In later intervals, diagnostic peaks of the target vitamins appear: the vitamin A signal is recorded in the region of 6.6 min, while vitamin E is represented by a pronounced high-intensity peak at 7.60 min, which is the dominant component of the profile. The stability of retention times and peak areas in three consecutive injections confirms the correctness of the chosen technique and the reliability of the quantitative assessment. Based on three independent chromatographic analyses, the following vitamin content was determined:

- Vitamin A (retinol): 1.67 mg/100 g of oil
- Vitamin E (alpha-tocopherol): 9.79 mg/100 g of oil



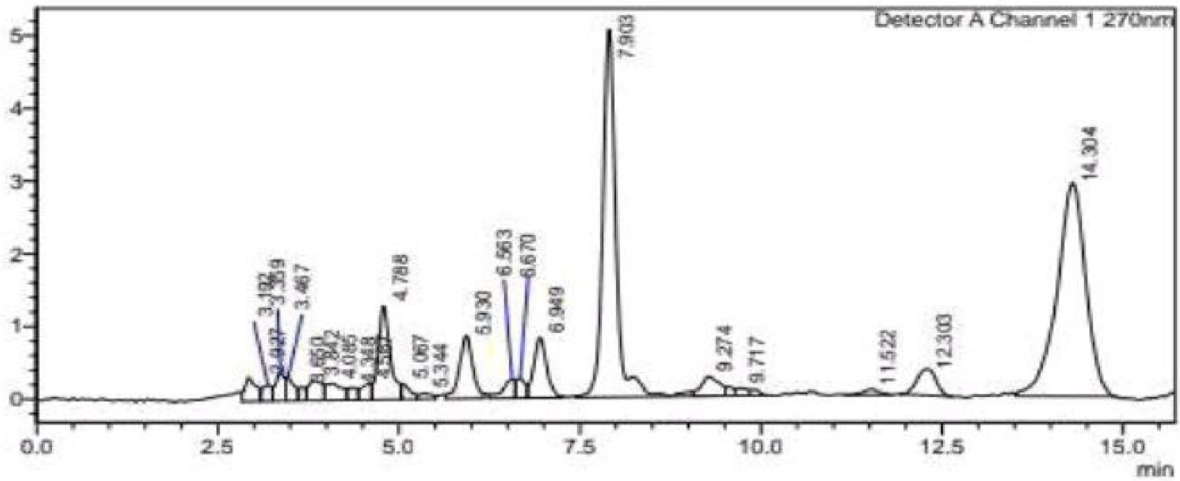


Figure 1. Triple HPLC analysis of vitamins A and E in Mirzachul grade oil

The obtained values indicate that Mirzachul melon seed oil is a natural source of biologically active antioxidants, and the content of alpha-tocopherol significantly exceeds the content of retinol, which is consistent with the typical profile of Cucurbitaceae family oils. The high concentration of vitamin E highlights the prospects of the oil under study as a functional component of food products and biologically active additives.

Discussion

A comparison of the obtained concentrations of vitamins A and E in Mirzachul melon seed oil with the literature data confirms the high biological value of the sample under study and demonstrates the advantage of the pressing method used. According to Mallek-Ayadi et al. (2019), the alpha-tocopherol content in melon seed oil ranges from 4.2–7.8 mg/100 g, depending on the variety and the oil extraction technology used. In a study by El-Adawy et al. (2001) noted that Cucurbitaceae family oils are characterized by an increased concentration of tocopherols, but their values rarely exceed 8 mg/100 g. In our study, the concentration of α-tocopherol was 9.79 mg/100 g, which is higher than most of the values described in the literature, which may be due to the varietal characteristics of the raw materials (Mirzachul), a milder pressing regime and minimal degradation of thermosensitive components. The vitamin A content in the oils of this group is usually much lower and varies in the range of 0.8–1.5 mg/100 g, according to Fokou et al. (2009). In our study, the retinol concentration reached 1.67 mg/100 g, which also exceeds the typical values described for rice oilseeds. This suggests that the seeds of the Mirzachul variety have an increased accumulation of carotenoid precursors, or the technology of mechanical pressing without intensive heating contributes to better preservation of vitamin A. Thus, a comprehensive comparison shows that Mirzachul melon seed oil contains higher levels of natural antioxidants compared to the published data, which emphasizes the functional value of the oil and also demonstrates the effectiveness of the chosen technological scheme for oil production.

Conclusion

According to the results of the conducted research, it can be concluded that the melon seed oil of the Mirzachul variety, obtained by pressing, is characterized by an increased content of biologically active substances. Certain concentrations of vitamin A (1.67 mg/100 g) and especially vitamin E (9.79 mg/100 g) indicate that this product is a promising source of natural antioxidants. The high level of α-tocopherol allows melon oil to be considered as a functional component capable of strengthening the antioxidant status of the body and maintaining metabolic health.Of particular importance is that the values obtained exceed the range described in the literature for most representatives of the Cucurbitaceae family. This indicates both the varietal potential of Mirzachul seeds and the correctness of the chosen technological approach, which ensures the preservation of thermolabile vitamins during pressing. It should be noted that not only the oil is valuable, but also the cake remaining after extraction. Due to its high content of vegetable protein, dietary fiber, and minor components, it has significant nutritional and technological potential. The cake can be used as a protein and fiber additive in the composition of flour products, dry mixes, dietary products, as well as in the production of protein supplements. Its structural features and moderate degree of protein denaturation after pressing make it suitable for both food and biotechnological processes.Thus, the complex processing of melon seeds of the Mirzachul variety makes it possible to obtain two valuable products — oil and cake, each of which has its own industrial significance. The high levels of vitamins in the oil and the favorable composition of the cake make this raw material base promising for the creation of functional foods, enriched ingredients and nutraceutical preparations. The data obtained confirm the need for further research aimed at expanding the use of melon oil and its processed products, as well as the development of technologies for deep processing of non-traditional oilseeds.

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