SUMMARY

of the doctoral thesis entitles:

THE USE OF CAMELINA FOR THE DEVELOPMENT OF PHARMACO-COSMETIC PRODUCTS

PhD-student: **COPACI Ana-Simona**

Scientific coordinator: ***Professor Dr.*** **JURCOANE Ștefana**

KEYWORDS: *Camelina sativa*, 'Mădălina', cold pressing, antioxidant activity, cosmetic products

Camelina sativa is a species that is part of the *Brassicaceae* family of plants. Well-known particularly for its exceptional lipid profile, characterized by over 55% polyunsaturated fatty acids. Other significant compounds include sterols and γ-tocopherol, a lipid-soluble antioxidant. Additionally, it contains phenolic compounds alongside its lipid component.

Agronomically, Camelina is characterized by its low cultivation demands, making it an ideal crop both geographically and economically.

This research investigates the incorporation of Camelina (*Camelina sativa*) oil into cosmetic formulations, focusing on its chemical properties and functional advantages.The research primarily focuses on chemical characterization, purification methods, stability, and the antimicrobial and antifungal activity of Camelina oil.

The aim of this research was to enhance the worth of Camelina oil by examining its physicochemical characteristics and stability, ultimately assessing its potential for incorporation into pharmaco-cosmetic products.

The experimental research conducted had the following **objectives**:

- Obtaining Camelina oil by cold pressing at a laboratory level: Implementing and optimizing the cold-pressing method to obtain high-quality Camelina oil;
- Analysis of the physico-chemical properties of Camelina oil: Performing an in-depth examination of the physico-chemical characteristics of Camelina oil to assess its quality and potential applications;
- Emphasizing the resilience of Camelina oil: Analyzing the robustness of Camelina oil across different conditions to assess its longevity in cosmetic products;
- Studying the antifungal activity against Candida species: Investigating the efficacy

of Camelina oil against Candida species to determine its antifungal potential;

- Designing a dermato-cosmetic product based on Camelina oil: Selecting the best oil variant analyzed for use in a cosmetic formulation;
- Studying the antioxidant and anxiolytic potential of Camelina oil in mouse models.

The biological material utilized in this research was Camelina oil, extracted from seeds of the Mădălina variety (ISTIS Patent 504/2018 – *Camelina sativa*-Mădălina variety). This variety was grown at the Belciugatele farm, how is located in Moara Domnească from Găneasa commune, in Ilfov County, during the period between 2017-2018.

The doctoral thesis is structured into two sections.

The initial section seeks to assess the present understanding of the topic both nationally and internationally about the *Camelina sativa* plant, emphasizing its significance and potential applications in cosmetic products. **This section is composed of two chapters.**

In the first chapter, relevant research and discoveries from the specialized literature, both national and international, are examined to outline a comprehensive framework of existing knowledge about Camelina how can be use in the pharmaco-cosmetic industry. It presents the history of Camelina use, the current state of research, cultivation conditions, international regulations regarding its use in cosmetic products, and the oil extraction methods. Furthermore, recent scientific studies examining the impact of Camelina oil on skin health, particularly its moisturizing, antioxidant, and anti-aging benefits, are being reviewed.

Chapter II discusses the chemical makeup of Camelina oil, highlighting its omega-3 and omega-6 how are essential fatty acids, in addition with γ-tocopherol and sterols. The chapter explores these compounds' roles in diet as well as their applications in topical formulations, particularly the action mechanisms of omega-3 fatty acids. Additionally, it examines the oil's oxidative stability, the description of phenolic compounds, and their associated effects.

Chapter III consists of three main parts represented by subchapters 3.1, 3.2, and 3.3.

Subchapter 3.1 presents the importance of filtration and purification processes in obtaining high-quality oil. During extraction and processing, Camelina oil can be contaminated with solid particles and microorganisms. By applying filtration and purification processes, these impurities can be eliminated, thus improving the organoleptic properties, oxidative stability, and functionality of the oil. Section 3.2 outlines the techniques and materials utilized for the purification of Camelina oil, along with the findings derived from implementing these techniques. The biological material used was Camelina oil obtained by pressing seeds from the Mădălina variety (Romanian patent: ISTIS Patent 504/2018-Camelina Mădălina variety). The variety was developed at the Belciugatele farm, from Moara Domnească (which is located in Găneasa commune, Ilfov County) between 2017 and 2018.

Four filtration methods were performed using two auxiliaries: bentonite and zeolite. Two of the four samples underwent pre-treatment with 0.05% bentonite and 0.05% zeolite. The storage conditions varied: the pre-treated samples were initially kept at room temperature and after that had been transferred to 4°C after the main filtration process. In contrast, the samples that did not undergo pre-treatment were continually stored at a temperature of 4°C during the entire duration. The filtration rates for the four oil samples examined are provided.

The third subchapter of Chapter III describes the results of applying the four filtration methods. The stability of color, appearance, and smell of Camelina oil after various treatments and storage conditions was evaluated. All four samples exhibited a yellow hue, with the oil's appearance ranging from a "transparent liquid" to a "transparent or slightly cloudy liquid." The smell remained specific to the plant, unaffected by filtration. The results show that the treatments applied influenced the pH of Camelina oil, with increases observed in most samples except the zeolite-treated sample, which maintained a constant pH. The filtration method with zeolite exposed in experiment 4 provided the best results, with the pH remaining constant and the oil showing a high degree of clarity.

Chapter IV presents the physico-chemical analysis of the oil which was obtained from the filtration process detailed in subchapter 3.2. The analysis encompasses several physico-chemical parameters of Camelina oil, including clarity, color, aroma, peroxide value, acidity value, refractive index, relative density, saponification value, and iodine value, all measured using the methods outlined in the 9th edition of the European Pharmacopoeia. Furthermore, gas chromatography (GC) was employed to analyze the fatty acid composition of Camelina oils, while HPLC was utilized for the identification of γ-tocopherol.

Regarding the physico-chemical parameters determined for all four analyzed oil samples, the refractive index and iodine index It has been established that Camelina oil contains a notable amount of unsaturated fatty acids. The analyzed oil samples had refractive indices within acceptable limits, indicating that oxidation processes of fatty acids had not occurred in the tested oil. For sample four (without pre-treatment + 0.05% zeolite treatment), based on the physico-chemical parameters, this oil can be classified as comparable with vegetable oils used in cosmetics.

All four oil samples exhibited a significant proportion of omega-3 (linolenic acid) and omega-6 (linoleic acid) which are essential fatty acids. The amount of linolenic acid ranged between 25.45 – 28.35 g/100g oil. For omega-6 (linoleic acid), the amount of linoleic acid ranged between 15.34 – 16.42 g/100 g oil. The results of the analyses for all four samples, treated with bentonite and zeolite, both with and without pre-treatment, indicate that all fatty acid values exceed the minimum admissibility conditions, **indicating high-quality oil in terms of fatty acid content.**

γ-tocopherol was detected exclusively in the two samples that were not pretreated, as these specimens were kept at a temperature of 4 degree, which helped to preserve it.

Chapter V examines the antioxidant capacity of the oil at the dermato-epidermal level. **Both concentrations of camelina extract (0.02% and 0.04%) demonstrated a significant reduction in oxidative stress induced by TNFα, with a stronger effect at 0.04%.** Interestingly, the camelina extract, particularly at this concentration, proved to be more effective than N-acetyl cysteine (NAC) in this context, suggesting a superior antioxidant potential. Due to these properties, camelina extract could be explored for use in antioxidant therapies, including in combination with NAC for a synergistic effect.

Additionally, **the camelina extract at 0.04% significantly stimulated catalase activity in fibroblasts**, indicating that it may strengthen the antioxidant protection of the cells, enhancing their resilience to oxidative stress. In comparison, the effect of NAC on catalase activity was less pronounced, suggesting that camelina extract may have a different or complementary mechanism of action. Furthermore, **camelina extract enhanced superoxide dismutase (SOD) activity in stimulated keratinocytes, highlighting its potential to protect against oxidative stress by boosting antioxidant activity**.

Chapter VI examines the levels of fungi and bacteria, in addition to the potential antifungal effects of Camelina oil. It outlines the techniques used to assess bacterial presence and identify harmful bacteria, including *Salmonella spp., Escherichia coli, and Staphylococcus spp*. Notably, none of the three samples tested positive for *Salmonella*; however, *E. coli* was detected in sample 2, while samples 1 and 3 showed elevated levels of *Staphylococcus spp*. and total bacteria. Consequently, Camelina oil cannot be utilized in its raw form without implementing microbiological decontamination processes. Furthermore, the examination did not validate the antifungal properties of the oil.

Chapter VII examines the ability of methanolic and ethanolic extracts from *Camelina sativa* plant to reduce oxidative stress, memory impairment, and symptoms associated with irritable bowel syndrome. Studies in mouse models have shown that these extracts can have beneficial effects on animal behavior and markers of oxidative stress, suggesting promising therapeutic uses for camelina extracts.

Extracts of *Camelina sativa* in methanol and ethanol have demonstrated **promise in enhancing memory and alleviating oxidative stress and anxiety symptoms** in research conducted on mouse models.

The extracts are **high in flavonoids and phenolic acids, which contribute to their antioxidant and antidepressant effects.**

Chapter VIII outlines the findings and suggestions related to the potential application of camelina oil in cosmetic products.

The results obtained in the doctoral thesis **" The Use of Camelina for the Development of Pharmaco-Cosmetic Products"** bring significant insights into the potential use of camelina oil within cosmetic formulations. The data obtained suggest the potential of camelina oil in cosmetic formulations, especially due to its oxidative stability and chemical composition. Improving filtration techniques by using natural adjuvants such as zeolite in filtration processes can improve the final quality of the oil without adversely affecting its properties.

The research findings indicate that, following appropriate purification and characterization, camelina oil is a viable ingredient for cosmetic formulations. It demonstrates advantageous chemical properties and sufficient stability. Consequently, camelina oil shows significant promise within the cosmetic sector, having been incorporated into patented products aimed at skin photoprotection. This summary encapsulates the key results of the thesis while also emphasizing potential avenues for future research and practical implementation.

Based on the research findings, the purified oil **has been incorporated into the patent titled "OIL FOR SKIN PHOTOPROTECTION" (no. A/00278/23), which was filed with the Romanian Academy of Scientists (AOSR) in May 2022 and is utilized in the cosmetic product also named "OIL FOR SKIN PHOTOPROTECTION."**