"OVIDIUS" UNIVERSITY OF CONSTANTA

DOCTORAL SCHOOL OF APPLIED SCIENCES

FUNDAMENTAL FIELD: BIOLOGY/BIOMEDICAL SCIENCES

ABSTRACT OF THE DOCTORAL THESIS

STUDIES ON THE DEVELOPMENT OF A PHARMACEUTICAL PRODUCT BASED ON *CAMELINA* OIL - A MULTIPOTENT OILSEED PLANT

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CONSTANTA

2024

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OBJECTIVES AND PURPOSE OF THE WORK

The purpose of this doctoral thesis was to develop a cosmetic preparation based on the properties of camelina oil, mixed with grape seed oil and carrot oil. This goal was ultimately achieved through the patent "OIL FOR SKIN PHOTOPROTECTION," no. A/00278/23, submitted to the State Office for Inventions and Trademarks (OSIM) by the Academy of Scientists of Romania (AOSR) in May 2022, and it is used in the cosmetic product titled "OIL FOR SKIN PHOTOPROTECTION" (A/00278/23, May 2022).

The main objective of this work is to analyze the photoprotective capacity of camelina oil for inclusion in dermatocosmetic product formulations. The photoprotective capacity was analyzed both for camelina oil used alone and for its combinations with other vegetable oils recognized for their properties in the cosmetic industry.

Another objective was to analyze camelina seeds (the raw material used to obtain the oil) in terms of antioxidant capacity and the content of heavy metals and minerals.

Camelina [*Camelina sativa* L. Crantz] is a dicotyledonous plant from the Brassicaceae family, commonly known as "false flax" or "gold-of-pleasure" (Berti et al., 2016). It is native to southern Europe and southwestern Asia (Dobre et al., 2014; Berti et al., 2016). In Romania, the use of camelina is associated with the transition period from the Neolithic to the Bronze Age (Berti et al., 2016). Currently, Dr. Ion Toncea has brought camelina back into attention, having registered the variety "Camelia" at OSIM in 2011. In 2016, a team of researchers from USAMV Bucharest – the Center for Microbial Biotechnologies – BIOTEHGEN patented the variety "Mădălina," which is distinguished by its exceptional winter resistance (Matei et al.,2017).

Camelina oil, obtained from the seeds of the plant, has multiple practical uses due to its composition. The oil contains a saponifiable fraction predominantly composed of polyunsaturated omega-3 and omega-6 fatty acids, which make up more than 55% of its content. It also contains an unsaponifiable fraction that includes
tocopherols and sterols (Toncea et al., 2013).

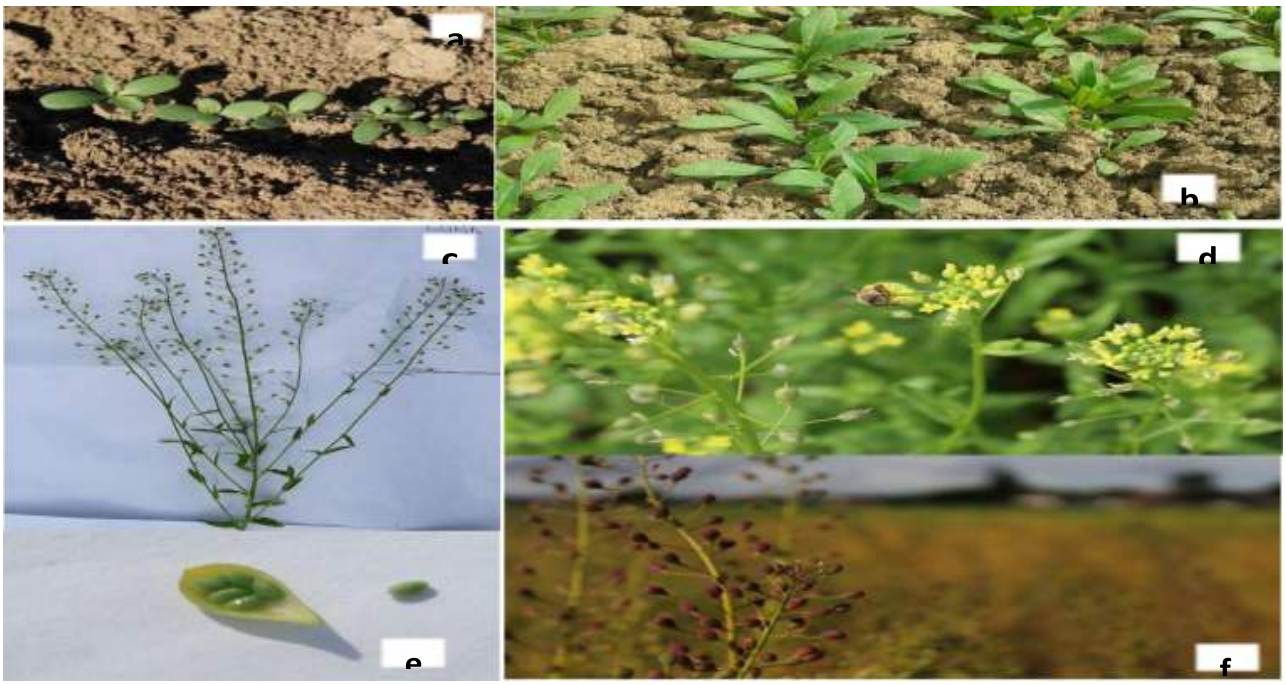
PART I: CURRENT KNOWLEDGE

Camelina [*Camelina sativa* L. Crantz] is a dicotyledonous plant from the Brassicaceae family, commonly known as "false flax" or "gold-of-pleasure." It is native to southern Europe and southwestern Asia.

Camelina can reach a final height of between 0.65 and 1.05 meters and form up to 30 lateral branches. The inflorescence consists of small pale-yellow flowers, which have four petals that further

develop into pear-shaped siliques. The final number of siliques per plant can vary from about 60 to 115. At the end of their expansion, the siliques are 4-5 mm wide and 6-8 mm long. During maturation, the siliques change color from green to reddish-yellow and then dry completely when fully mature. Each silique can contain 10-20 small seeds.

Figure 1.1. Details about the camelina plant.



a) A first pair of true leaves in emerging camelina plants,
b) Camelina in the rosette stage,
c) Camelina branches,
d) Camelina inflorescences,
e) Pear-shaped camelina siliques,
f) Camelina siliques approaching maturity.

The main extraction methods from camelina oilseeds are mechanical extraction, solvent extraction, and enzymatic extraction.Camelina oil has applications in various fields. The most exploited use of camelina oil is the production of biofuels.

In addition to its use in the biofuel industry, camelina oil is used in nutraceutical, medical products, and animal feed. It is also used in products for human consumption and cosmetics. The composition of camelina oil can be distinguished into two fractions: one unsaponifiable (tocopherols, sterols) and the other saponifiable (fatty acids). Most applications of camelina oil are made possible by its fatty acid content. The fatty acid profile is primarily represented by unsaturated fatty acids—mono and primarily polyunsaturated (>55%)—as well as saturated fatty acids (9.1-10.8%).

The major component in the composition of camelina oil is omega-3 fatty acid—linolenic acid. It also contains almost equal percentages of linolenic, linoleic, oleic, eicosenoic, and erucic acids. Regarding the sterol profile, the following compounds have been identified in camelina oil: cholesterol, brassicasterol, campesterol, sitosterol, and Δ5-avenasterol. The proteins in camelina seeds are rich in essential amino acids, with leucine, valine, lysine, phenylalanine, and isoleucine as the main constituents. In addition to essential amino acids, camelina seed proteins are also rich in non-essential amino acids, particularly glutamic and aspartic acids, arginine, proline, and serine. Camelina seeds are rich in antioxidants, such as phenolic acids and flavonoids, tocopherols, and xanthophyll.

PART II: PERSONAL CONTRIBUTIONS

INTRODUCTION

Considering the multiple uses of camelina oil and our desire to use this oil for developing dermatocosmetic preparations, we deemed it appropriate to analyze the raw material source of the oil, specifically camelina seeds, in order to determine the content of metals. Additionally, an important aspect to consider is the antioxidant capacity of camelina oil.

The main objective of this work is to analyze the photoprotective capacity of camelina oil for inclusion in dermatocosmetic product formulations.

The concept of sun protection factor (SPF) was first proposed by Austrian scientist Franz Greiter and subsequently adopted by many authorities in the pharmaceutical and cosmetic industries. He described how long skin covered with photoprotective agents could be exposed to the sun before sunburn would occur, compared to the time for unprotected skin.

SPF represents a numerical evaluation system indicating the degree of protection provided by the cosmetic product. It is defined as the ratio of the amount of UV energy required to produce erythema on protected skin to the amount of UV energy required to produce the same erythema on unprotected skin, according to the following equation (Colipa, 2016).

$$SPF = \text{MED of protected skin} / \text{MED of unprotected skin}$$

Chapter IV: STUDIES ON DETERMINING THE PHOTOPROTECTIVE CAPACITY OF CAMELINA OIL USED ALONE OR IN MIXTURE WITH OTHER VEGETABLE OILS

4.1. Determining the photoprotective capacity of camelina oil

4.1.1. Materials and methods

The biological material used is represented by camelina oil obtained through cold pressing of camelina seeds from the Mădălina variety, sourced from a cultivation established at the Moara Domnească Teaching Farm. The obtained camelina oil has a color and appearance within acceptable limits. The color is yellow, and the appearance is "clear liquid." The smell is characteristic of the plant.

The working method followed Mansur's method (1986), with in vitro SPF evaluation performed to estimate in vivo SPF. Mansur's method is simple and easily reproducible: samples are analyzed using UV spectrophotometry from 290 to 320 nm, with 5 nm intervals (Mansur et al., 1986). The data collected using software are input into Mansur's equation to calculate the sun protection factor for each analyzed sample, which is then statistically processed to accurately evaluate the potential use of the analyzed biological material for developing dermato-cosmetic preparations for sun protection.

The statistical processing of the results obtained was performed using simple linear regression.

Working technique

To analyze the photoprotective capacity of camelina oil, 10 samples of camelina oil solutions in hexane were prepared, with concentrations ranging from 1 to 10%. For each sample, absorption spectra were recorded in the wavelength range of 290-320 nm with a step of 0.5 nm, using the RayLeigh-UV-2601 spectrophotometer with 1 cm cuvettes. For calculating the protection factor, the equation by Mansur et al. (1986) was used.

4.1.2. Results and Discussions

To determine the sun protection factor of camelina oil, we recorded the absorbance values at wavelengths ranging from 290 to 320 nm for the 10 analyzed samples, with a step of 0.5 nm. The absorbance values obtained at each wavelength considered were recorded in the software for later statistical processing.

Table 4.1.3. Absorbance values in the range λ = 290-320 nm for the analyzed samples, camelina oil solutions in hexane, with concentrations from 1% to 10%, along with the corresponding correction factor for calculating the SPF value.

λ(nm)	Corectie	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
290	0.015	0.490	0.765	1.073	1.323	1.724	1.835	2.130	2.288	2.595	2.666
295	0.0817	0.423	0.676	0.954	1.183	1.555	1.663	1.942	2.108	2.434	2.515
300	0.2874	0.408	0.657	0.930	1.155	1.524	1.629	1.896	2.056	2.338	2.440
305	0.3278	0.372	0.600	0.853	1.060	1.407	1.500	1.756	1.912	2.193	2.312
310	0.1864	0.300	0.474	0.670	0.829	1.098	1.171	1.380	1.506	1.762	1.854
315	0.0837	0.287	0.451	0.636	0.782	1.033	1.101	1.291	1.409	1.642	1.730
320	0.018	0.262	0.409	0.575	0.707	0.941	0.996	1.170	1.278	1.497	1.595

The absorption spectra for the analyzed samples, camelina oil solutions in hexane, with concentrations ranging from 1% to 10% in the range of λ = 290-320 nm, are highlighted in Figure 4.1.3. From the graphical representation, it can be observed that the absorbance of the samples increases with the rising concentration of the analyzed samples and that for the same sample, the absorbance decreases as the wavelength increases from 290 nm to 320 nm.

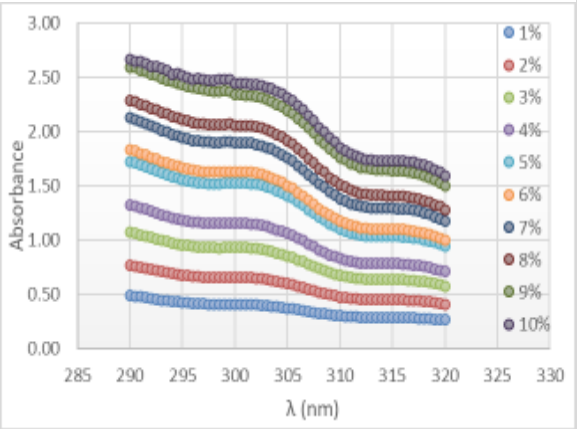


Figure 4.1.4. Absorption spectra for the analyzed samples, camelina oil solutions in hexane, with concentrations ranging from 1% to 10% in the λ = 290-320 nm range.

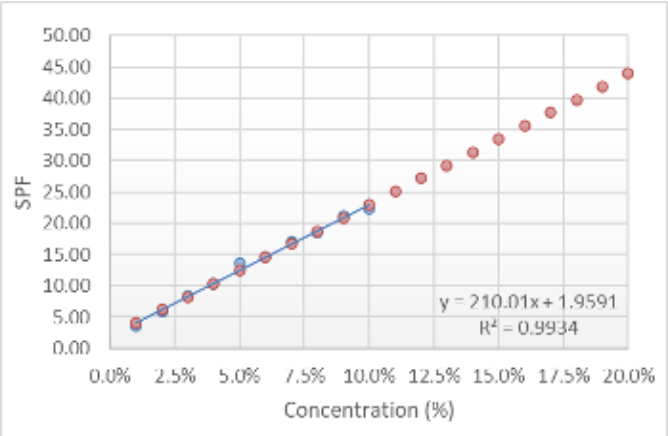


Figure 4.1.5. Scatter Plot representation of the experimental SPF values and the SPF values predicted based on the validated linear regression analysis model in relation to concentration.

In Figure 4.1.4, the experimentally obtained SPF values for the analyzed samples are graphically represented, as well as the SPF values predicted based on the validated linear regression analysis model in relation to concentration.

The experimentally determined SPF values obtained using the Mansur et al. (1986) equation, along with the predicted SPF values based on the regression line, in relation to concentration, are summarized in Table4.1.4.

Table 4.1.4. Experimental SPF values determined along with the predicted SPF values based on the regression line, in relation to concentration.

Conc (%)	SPF	Predicted SPF
1%	3.658	4.059
2%	5.857	6.159
3%	8.294	8.259
4%	10.286	10.360
5%	13.602	12.460
6%	14.516	14.560
7%	16.975	16.660
8%	18.458	18.760
9%	21.214	20.860
10%	22.237	22.960
11%		25.060
12%		27.160
13%		29.260
14%		31.361
15%		33.461
16%		35.561
17%		37.661
18%		39.761
19%		41.861
20%		43.961

As a result of applying linear regression analysis, we make the following statements:

The coefficient of determination R^2 is 0.9934. This value indicates that 99.34% of the variation in the dependent variable (SPF) is determined by the variation in the independent variable (Concentration); that is, the two variables share 99.34% of the variation that characterizes them, while the remaining 1.66% o their variability comes from other sources.

Table 4.1.5.A. Result of the linear regression analysis.

Regression Statistics	
Multiple R	0.997
R Square	0.993
Adjusted R Square	0.993
Standard Error	0.548
Observations	10

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*	*Fcr*
Regression	1	363.862	363.862	1210.635	0.000	5.318
Residual	8	2.404	0.301			
Total	9	366.266				

	Coefficients	*SE*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1.959	0.375	5.231	0.001	1.095	2.823
Conc (%)	210.011	6.036	34.794	0.000	196.092	223.929

Tabelul 4.1.5.B. Result of the linear regression analysis

Conc (%)	***Predicted SPF***	***Residuals***	***Standard Residuals***
1%	4.059	-0.402	-0.777
2%	6.159	-0.303	-0.585
3%	8.259	0.035	0.067
4%	10.360	-0.073	-0.142
5%	12.460	1.142	2.210
6%	14.560	-0.044	-0.084
7%	16.660	0.315	0.609
8%	18.760	-0.301	-0.583
9%	20.860	0.354	0.685
10%	22.960	-0.723	-1.399

The ANOVA test used to evaluate the regression model yields a test statistic of $F_{(^{c}al^{c})} = 1210.653 > F_{(^{c}r)} = 5.318$, with an associated probability of $p < 0.001 < \alpha = 0.05$. The obtained values confirm the hypothesis that there is a significant linear relationship between the two variables (it is accepted that the slope of the regression line is different from zero).

Testing the parameters of the regression model is done using the t-test. For the given situation, a1 = 210.011, and the result of the t-test indicates a statistical value of t = 34.794 with an associated probability of $p < 0.001$, thus confirming that the slope of the regression line corresponds to a significant relationship between the two variables.

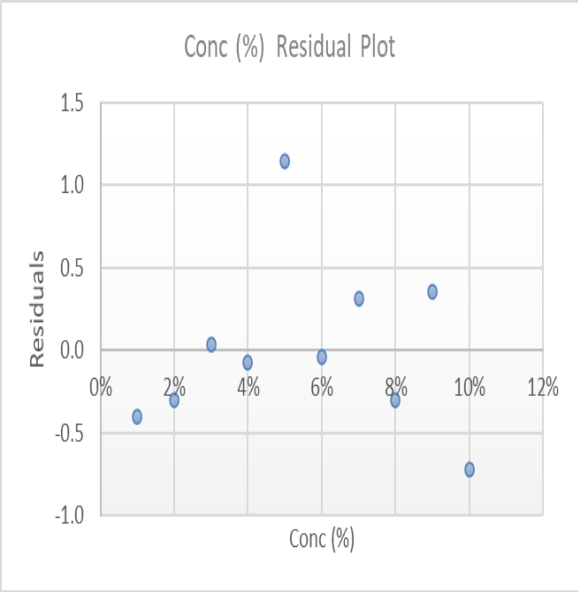


Figure 4.1.6. Graphical representation of the residual values εi = SPF - predicted SPF as a function of concentration.

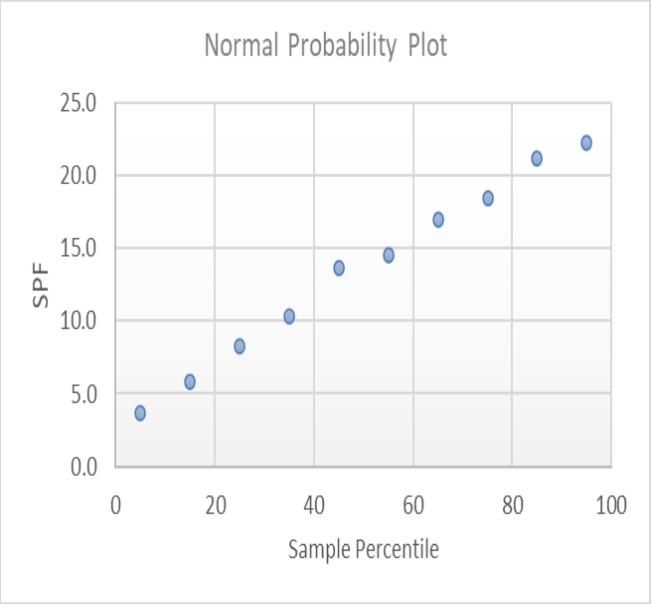


Figure 4.1.7. Normal Probability plot confirming the fulfillment of the normality condition.

Using the unstandardized coefficients, the regression equation can be written (Figure 4.1.4., Table 4.1.5.A.,B.):

SPF = 210.011 · Concentration + 1.959

The predicted values based on the regression line can be found in Table 4.1.4. for the concentration range of 1%-20%.

4.1.3. Partial Conclusions

Based on the information presented, we can draw the following conclusions regarding the photoprotective capacity of camelina oil:

The analyzed camelina oil exhibits satisfactory photoprotective capacity for a dermatocosmetic product, with SPF ranging from 3.658 for the 1% concentration solution to 43.961 for the 20% concentration.

4.2. Determination of the photoprotective capacity of oil obtained as a mixture of camelina oil and grape seed oil

4.2.1. Determination of the photoprotective capacity of oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio

4.2.1.1. Materials and Methods

The biological materials used were camelina oil and grape seed oil. The working method followed the Mansur method (1986), with in vitro SPF evaluation performed to estimate in vivo SPF.

In the working technique, a mixture of camelina oil and grape seed oil was analyzed, obtained by mixing 25 grams of camelina oil with 75 grams of grape seed oil at room temperature. From the obtained oil mixture, 10 samples were prepared, oil solutions in hexane with concentrations ranging from 1% to 10%. For each sample, the absorption spectra were recorded in the wavelength range of 290-320 nm with a step of 0.5 nm, using the RayLeigh-UV-2601 spectrophotometer, utilizing 1 cm cuvettes. The Mansur et al. (1986) equation was used to calculate the protection factor.

4.2.1.2. Results and Discussions

The absorbance values in the range of λ = 290-320 nm can be tracked for the analyzed samples, solutions in hexane of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio (sample 1), at concentrations from 1% to 10% in Table 4.2.2.

Table 4.2.2. Absorbance values in the range of λ = 290-320 nm for the analyzed samples, camelina oil 25% + grape seed oil 75% solutions in hexane, at concentrations from 1% to 10%, along with the corresponding correction factor for calculating the SPF value.

λ(nm)	Corectie	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
290	0.015	0.606	0.513	1.461	1.897	2.330	2.345	2.964	3.059	3.037	3.155
295	0.0817	0.420	0.370	1.028	1.338	1.654	1.665	2.308	2.368	2.489	2.884
300	0.2874	0.359	0.323	0.884	1.143	1.406	1.416	1.966	2.005	2.108	2.452
305	0.3278	0.294	0.270	0.717	0.926	1.137	1.146	1.605	1.640	1.729	2.057
310	0.1864	0.237	0.223	0.568	0.729	0.889	0.900	1.257	1.283	1.356	1.620
315	0.0837	0.228	0.215	0.544	0.696	0.846	0.856	1.192	1.217	1.286	1.534
320	0.018	0.193	0.186	0.454	0.580	0.704	0.715	0.999	1.023	1.081	1.295

The absorption spectra for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio, at concentrations from 1% to 10% in the range of λ = 290-320 nm are highlighted in Figure 4.2.1.

Figure 4.2.2 graphically represents the experimentally obtained SPF values for the analyzed samples, as well as the predicted SPF values based on the validated linear regression analysis model as a function of concentration.

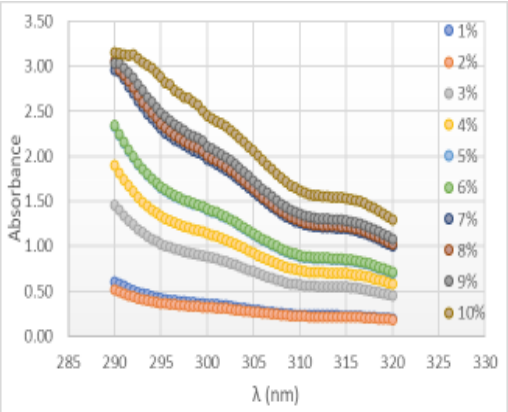


Figure 4.2.1. Absorption spectra for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio (sample 1), at concentrations from 1% to 10% in the range of λ = 290-320 nm.

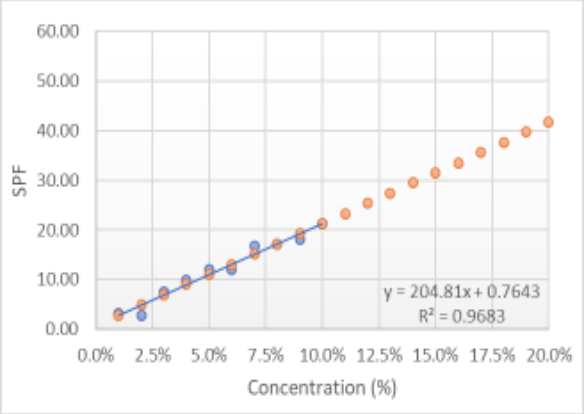


Figure 4.2.2. Scatter Plot representation of the experimental SPF values, and the predicted SPF values based on the validated linear regression analysis model as a function of concentration, for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio.

Table 4.2.3. Centralizes the experimentally determined SPF values obtained using the Mansur et al. (1986) equation, together with the predicted SPF values based on the regression line, as a function of concentration.

Table 4.2.3. SPF values determined experimentally together with predicted SPF values based on the regression line, as a function of concentration, for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio.

Conc (%)	SPF	Predicted SPF
1%	3.097	2.812
2%	2.822	4.861
3%	7.546	6.909
4%	9.744	8.957
5%	11.961	11.005
6%	12.061	13.053
7%	16.762	15.101
8%	17.126	17.149
9%	18.014	19.197
10%	21.156	21.245

11%	23.293
12%	25.341
13%	27.389
14%	29.438
15%	31.486
16%	33.534
17%	35.582
18%	37.630
19%	39.678
20%	41.726

As a result of applying linear regression analysis, we make the following statements: The coefficient of determination R^2 is 0.9683. This value indicates that 96.83% of the variation in the dependent variable (SPF) is determined by the variation in the independent variable (Concentration), meaning that the two variables share 96.83% of the variation that characterizes them; the remaining 3.17% of their variability comes from other sources.

The ANOVA test used for testing the regression model results in a test statistic of $F_{calc} = 244.350 > F_{cr} = 5.318$, with an associated probability of $p < 0.001 < \alpha = 0.05$. The obtained values confirm the hypothesis that there is a significant linear relationship between the two variables (it is accepted that the slope of the regression line is different from zero).

The testing of the regression model parameters is done using the t-test. For the given situation, $a_1 = 204.808$, and the result of the t-test indicates a statistical value of $t = 15.632$ with an associated probability of $p < 0.001$, thus confirming that the slope of the regression line corresponds to a significant relationship between the two variables.

Table 4.2.4.A. Result of the linear regression analysis for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio.

Regression Statistics	
Multiple R	0.984
R Square	0.968
Adjusted R Square	0.964
Standard Error	1.190
Observations	10
ANOVA	

	df	*SS*	*MS*	*F*	*Significance F*	*Fcr*
Regression	1	346.058	346.058	244.350	0.000	5.318
Residual	8	11.330	1.416			
Total	9	357.388				

	Coefficients	*SE*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.764	0.813	0.940	0.375	-1.110	2.639
Conc (%)	204.808	13.102	15.632	0.000	174.595	235.022

Table 4.2.4.B. Result of the linear regression analysis for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio.

Conc (%)	*Predicted SPF*	*Residuals*	*Standard Residuals*
1%	2.812	0.284	0.254
2%	4.861	-2.039	-1.817
3%	6.909	0.637	0.568
4%	8.957	0.787	0.702
5%	11.005	0.956	0.852
6%	13.053	-0.992	-0.884
7%	15.101	1.661	1.481
8%	17.149	-0.023	-0.020
9%	19.197	-1.183	-1.055
10%	21.245	-0.089	-0.079

Percentile	*SPF*
5	2.822
15	3.097
25	7.546
35	9.744
45	11.961
55	12.061
65	16.762
75	17.126
85	18.014
95	21.156

Using the unstandardized coefficients, the regression equation can be written (Figure 4.2.2., Table 4.2.4.A,B):

SPF = 204.808 · Concentration + 0.764

The predicted values based on the regression line can be found in Table 4.2.3. for the concentration range of 1%-20%.

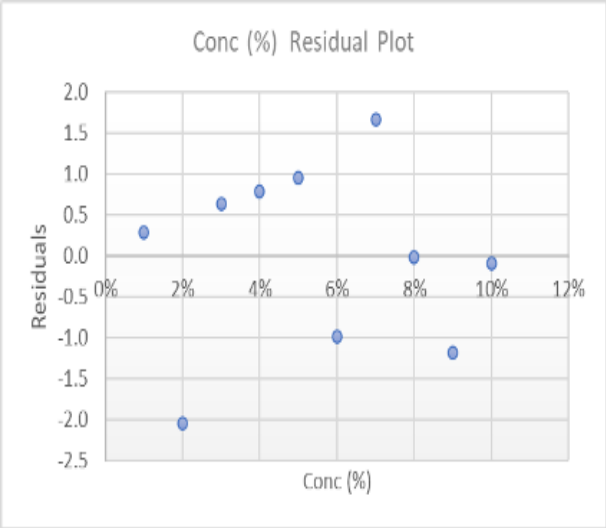


Figure 4.2.3. Graphical representation of the residual values εi = SPF - predicted SPF as a function of concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio

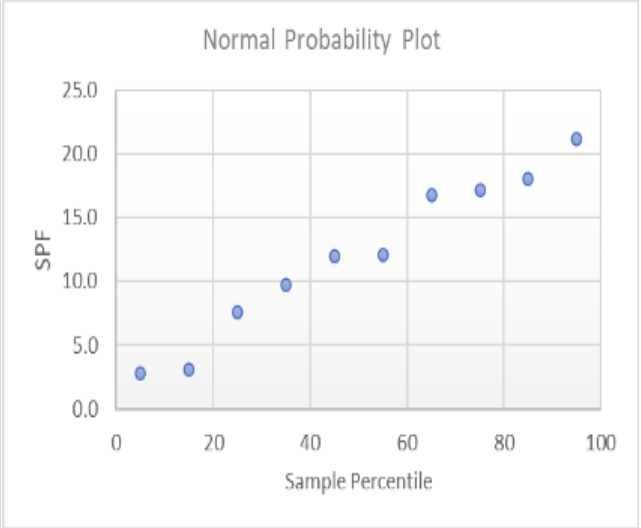


Figure 4.2.4. Graphical representation of the Normal Probability plot, confirming the fulfillment of the normality condition for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio

4.2.1.3. Partial Conclusions

Based on the information presented, we can draw the following conclusions regarding the photoprotective capacity of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio:

The oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio shows satisfactory photoprotective capacity for a dermatocosmetic product, with SPF ranging from 3.097 for the 1% concentration solution to 41.726 for the 20% concentration solution.

The oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio exhibits lower photoprotective capacity compared to pure camelina oil, which has SPF values ranging from 3.658 for the 1% concentration solution to 43.961 for the 20% concentration solution.

4.2.2. Determination of the photoprotective capacity of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio

4.2.2.1. Materials and Methods

The biological materials used were camelina oil and grape seed oil. The working method was according to the Mansur method (1986), with in vitro SPF evaluation conducted to estimate in vivo SPF.

In the working technique, we analyzed a mixture of camelina oil and grape seed oil obtained by mixing 75 grams of camelina oil with 25 grams of grape seed oil at room temperature. From the obtained oil mixture, 10 samples were prepared, oil solutions in hexane with concentrations ranging from 1% to 10%. For each sample, the absorption spectra were recorded in the wavelength range of 290-320 nm with a step of 0.5 nm, using the RayLeigh-UV-2601 spectrophotometer, utilizing 1 cm cuvettes. The Mansur et al. (1986) equation was used to calculate the protection factor.

4.2.2.2. Results and Discussions

To determine the solar protection factor (SPF) of the camelina oil and grape seed oil mixture in a 75:25 ratio, we recorded the absorbance values at wavelengths between 290 and 320 nm for the 10 analyzed samples, with a step of 0.5 nm.

Table 4.2.6. Absorbance values in the range of λ = 290-320 nm for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio (sample 2), at concentrations from 1% to 10%, along with the corresponding correction factor for calculating the SPF value.

λ(nm)	Corectie	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
290	0.015	0.479	0.859	1.189	1.298	1.930	2.198	2.473	2.835	2.998	3.093
295	0.0817	0.379	0.696	0.960	1.047	1.563	1.791	2.030	2.388	2.617	2.854
300	0.2874	0.361	0.673	0.929	1.013	1.504	1.718	1.938	2.266	2.465	2.677
305	0.3278	0.311	0.583	0.804	0.875	1.303	1.495	1.697	2.006	2.216	2.433
310	0.1864	0.250	0.464	0.633	0.684	1.017	1.169	1.326	1.581	1.763	1.972
315	0.0837	0.251	0.469	0.639	0.691	1.022	1.171	1.328	1.577	1.755	1.958
320	0.018	0.216	0.401	0.545	0.587	0.874	1.005	1.141	1.365	1.527	1.718

The absorption spectra for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio (sample 2), with concentrations ranging from 1% to 10% in the wavelength range λ = 290-320 nm, are highlighted in Figure 4.2.5. Figure 4.2.6 displays the experimental SPF values obtained for the analyzed samples, as well as the predicted SPF values based on the validated linear regression analysis model in relation to concentration.

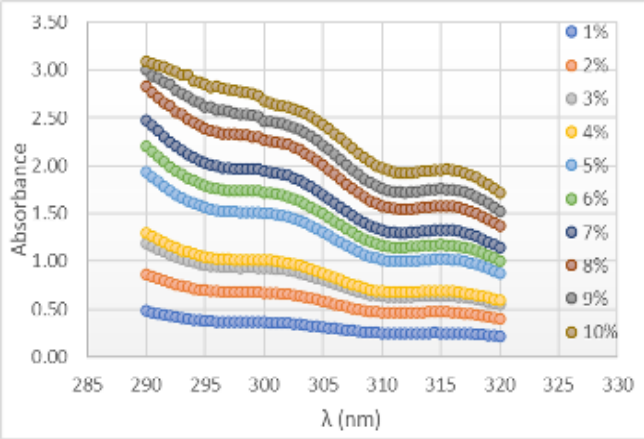


Figure 4.2.5. Absorption spectra for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio (sample 2), with concentrations ranging from 1% to 10% in the wavelength range λ = 290-320 nm.

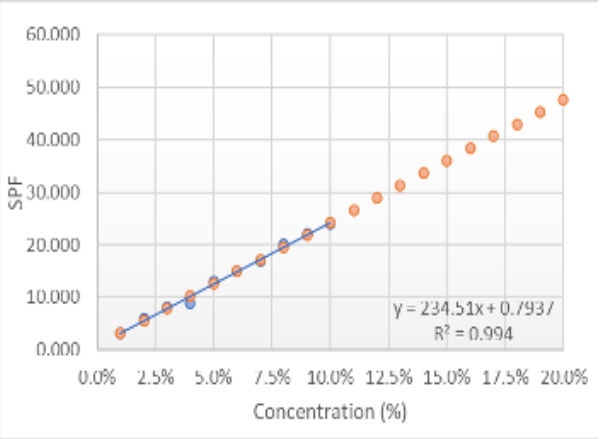


Figure 4.2.6. Scatter Plot representation of the experimental SPF values and the predicted SPF values based on the validated linear regression analysis model in relation to concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio

In Table 4.2.7, the experimentally determined SPF values obtained using the Mansur et al. (1986) equation are summarized, along with the predicted SPF values based on the regression line in relation to concentration.

Table 4.2.7. Experimental SPF values along with the predicted SPF values based on the regression line in relation to concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio.

Conc (%)	SPF	Predicted SPF
1%	3.153	3.139
2%	5.872	5.484
3%	8.081	7.829
4%	8.789	10.174
5%	13.069	12.519
6%	14.971	14.864
7%	16.951	17.209
8%	19.977	19.555
9%	21.966	21.900
10%	24.089	24.245

11%	26.590
12%	28.935
13%	31.280
14%	33.625
15%	35.970
16%	38.315
17%	40.661
18%	43.006
19%	45.351
20%	47.696

Following the application of linear regression analysis, we make the following statements: The coefficient of determination R^2 is 0.9683. This value indicates that 99.40% of the variation in the dependent variable (SPF) is determined by the variation in the independent variable (Concentration), meaning that the two variables share 99.40% of the variation that characterizes them; the remaining 0.60% of their variability comes from other sources.

The ANOVA test used to test the regression model results in a test statistic of $F_{calc} = 1333.704 > F_{crit} = 5.318$, with an associated probability $p < 0.001 < \alpha = 0.05$. The obtained values confirm the hypothesis that there is a significant linear relationship between the two variables (it is accepted that the slope of the regression line is different from zero).

The testing of the regression model parameters is done using the t-test. For the given situation, a1 = 234.511, and the result of the t-test indicates a statistical value of t = 36.520 with an associated probability $p < 0.001$, thus confirming that the slope of the regression line corresponds to a significant relationship between the two variables.

Table 4.2.8.A. Result of the linear regression analysis for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio.

Regression Statistics	
Multiple R	0.997
R Square	0.994
Adjusted R Square	0.993
Standard Error	0.583
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*	*Fcr*

Regression	1	453.711	453.711	1333.704	0.000	5.318
Residual	8	2.722	0.340			
Total	9	456.432				

	Coefficients	*SE*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.794	0.398	1.992	0.082	-0.125	1.713
Conc (%)	234.511	6.421	36.520	0.000	219.703	249.318

Table 4.2.8.B. Result of the linear regression analysis for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio.

Conc (%)	*Predicted SPF*	*Residuals*	*Standard Residuals*
1%	3.139	0.015	0.027
2%	5.484	0.388	0.706
3%	7.829	0.252	0.458
4%	10.174	-1.385	-2.519
5%	12.519	0.549	0.999
6%	14.864	0.107	0.194
7%	17.209	-0.259	-0.471
8%	19.555	0.422	0.768
9%	21.900	0.067	0.121
10%	24.245	-0.156	-0.284

Percentile	*SPF*
5	3.153
15	5.872
25	8.081
35	8.789
45	13.069
55	14.971
65	16.951
75	19.977
85	21.966
95	24.089

Using the unstandardized coefficients, the regression equation can be written as follows (Figure 4.2.6., Table 4.2.8.A,B): SPF = 234.5111 · Concentration + 0.794. The predicted values based on the regression line can be found in Table 4.2.7. for the concentration range of 1%-20%.

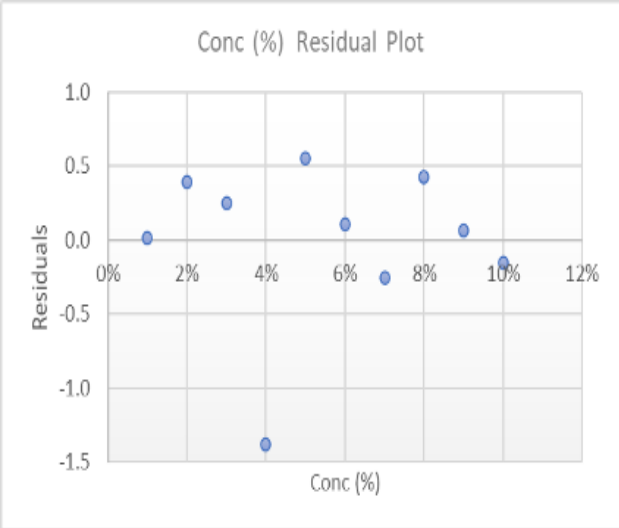


Figure 4.2.7. Graphical representation of the residual values εi = SPF - predicted SPF as a function of concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio.

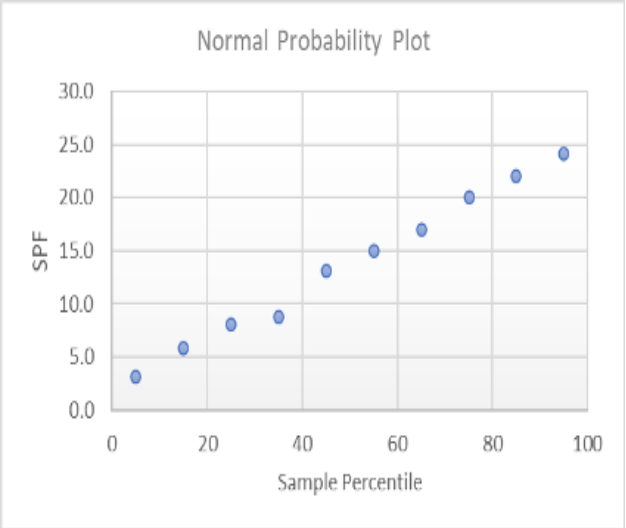


Figure 4.2.8. Graphical representation of the Normal Probability plot confirming the fulfillment of the normality condition for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio.

4.2.2.3. Partial Conclusions

Based on the information presented, we can draw the following conclusions regarding the photoprotective capacity of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio: The oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio analyzed shows satisfactory photoprotective capacity for a dermocosmetic product, with SPF ranging from 3.153 for the 1% concentration solution to 47.696 for the 20% concentration solution.

The oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio analyzed exhibits a lower photoprotective capacity for the 1% concentration solution compared to pure camelina oil (SPF 3.658 for the 1% concentration solution) and a higher photoprotective capacity for the 20% concentration solution, with SPF 47.696 compared to SPF 43.961 for the 20% concentration solution of pure camelina oil.

The oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio analyzed shows higher photoprotective capacity than the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio, with an SPF of 3.153 at a concentration of 1% compared to 3.097, and at a concentration of 20%, it has an SPF of 47.696 compared to 41.726.

4.3. Determination of the photoprotective capacity of the oil obtained as a mixture of camelina oil and carrot oil

4.3.1. Determination of the photoprotective capacity of the oil obtained as a mixture of camelina and carrot oil in a 25:75 ratio

4.3.1.1. Materials and Methods

The biological material used was camelina oil and carrot oil.

Working Technique - A mixture of camelina oil and carrot oil was analyzed, obtained by mixing 25 grams of camelina oil with 75 grams of carrot oil at room temperature. From the obtained oil mixture, 10 samples of oil solutions in hexane with concentrations ranging from 1% to 10% were prepared. For each sample, the absorption spectra in the wavelength range of 290-320 nm were recorded in steps of 0.5 nm, using the RayLeigh-UV-2601 spectrophotometer with 1 cm cuvettes. The Mansur et al. (1986) equation was used to calculate the protection factor.

4.3.1.2. Results and Discussions

To determine the solar protection factor (SPF) of the camelina oil: carrot oil mixture in a 25:75 ratio, we recorded the absorbance values at wavelengths between 290 and 320 nm for the 10 analyzed samples, in steps of 0.5 nm.

Table 4.3.2. Absorbance values in the range λ = 290-320 nm for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 25:75 ratio, with concentrations ranging from 1% to 10%, along with the corresponding correction factor for calculating the SPF value.

λ(nm)	Corectie	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
290	0.015	0.415	0.649	0.888	1.187	1.326	1.637	1.908	2.077	2.355	2.528
295	0.0817	0.329	0.522	0.706	0.942	1.049	1.285	1.509	1.645	1.883	2.047
300	0.2874	0.300	0.477	0.641	0.848	0.950	1.153	1.356	1.476	1.685	1.829
305	0.3278	0.247	0.385	0.510	0.670	0.749	0.906	1.068	1.162	1.332	1.450
310	0.1864	0.203	0.305	0.396	0.514	0.569	0.681	0.805	0.872	0.998	1.081
315	0.0837	0.202	0.303	0.394	0.506	0.565	0.675	0.796	0.861	0.983	1.063
320	0.018	0.189	0.282	0.365	0.465	0.522	0.626	0.740	0.801	0.918	0.994

The absorption spectra for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 25:75 ratio (sample 1), with concentrations ranging from 1% to 10% in the wavelength range λ = 290-320 nm are highlighted in Figure 4.3.1.

Figure 4.3.2. graphically represents the experimentally obtained SPF values for the analyzed samples as well as the predicted SPF values based on the validated linear regression analysis model as a function of concentration.

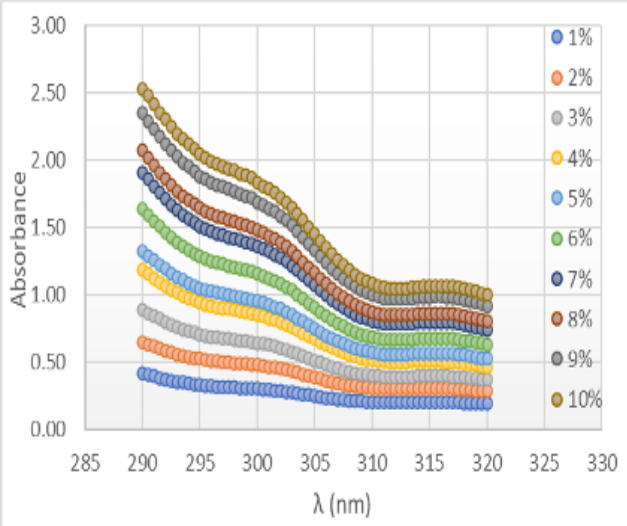


Figure 4.3.1. Absorption spectra for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 25:75 ratio (sample 1), with concentrations ranging from 1% to 10% in the wavelength range λ = 290-320 nm.

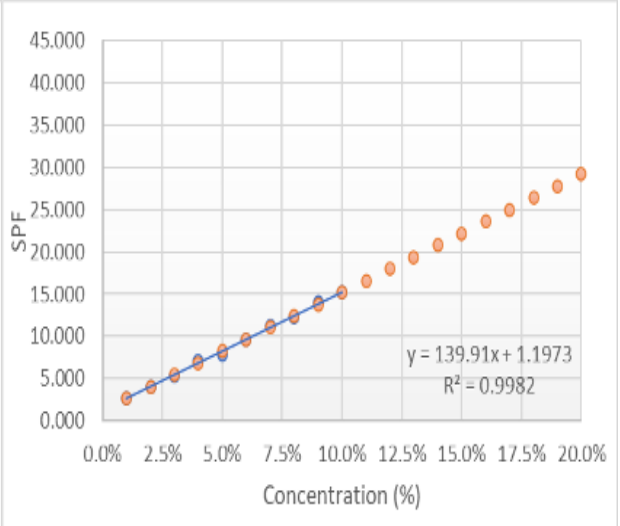


Figure 4.3.2. Scatter Plot representation of the experimental SPF values and the predicted SPF values based on the validated linear regression model as a function of concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 25:75.

Table 4.3.3. summarizes the SPF values determined experimentally, obtained using the Mansur et al. (1986) equation, along with the predicted SPF values based on the regression line as a function of concentration.
Table 4.3.3. Experimental SPF values along with the predicted SPF values based on the regression line for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 25:75 ratio , as a function of concentration.

Conc (%)	SPF	Predicted SPF
1%	2.584	2.596
2%	4.030	3.995
3%	5.358	5.394
4%	7.046	6.793
5%	7.869	8.193

6%	9.526	9.592
7%	11.217	10.991
8%	12.197	12.390
9%	13.949	13.789
10%	15.145	15.188
11%		16.587
12%		17.986
13%		19.385
14%		20.784
15%		22.183
16%		23.582
17%		24.981
18%		26.380
19%		27.779
20%		29.178

Following the application of linear regression analysis, we make the following statements: The coefficient of determination R^2 is 0.9982. This value indicates that 99.82% of the variation in the dependent variable (SPF) is determined by the variation in the independent variable (Concentration), meaning that the two variables share 99.82% of the variation characterizing them, with the remaining 0.18% of their variability coming from other sources.

The ANOVA test used to evaluate the regression model has a test statistic result of $F_{calc} = 4429.905 > F_{cr} = 5.318$ and an associated probability $p < 0.001 < \alpha = 0.05$. The obtained values confirm the hypothesis that there is a significant linear relationship between the two variables (it is accepted that the slope of the regression line is different from zero).

The testing of the regression model parameters is done using the t-test. For the given situation, $a_1 = 139.906$, and the t-test result indicates a statistical value of $t = 66.558$ with an associated probability $p < 0.001$, thus confirming that the slope of the regression line corresponds to a significant relationship between the two variables.

Table 4.3.4.A. Result of the linear regression analysis for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 25:75 ratio.

Regression Statistics	
Multiple R	0.999
R Square	0.998

Adjusted R Square	0.998
Standard Error	0.191
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*	*Fcr*
Regression	1	161.482	161.482	4429.905	0.000	5.318
Residual	8	0.292	0.036			
Total	9	161.774				

	Coefficients	*SE*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1.197	0.130	9.180	0.000	0.896	1.498
Conc (%)	139.906	2.102	66.558	0.000	135.058	144.753

Table 4.3.4.B. The result of the linear regression analysis for the analyzed samples, solutions in hexane of the oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio.

Conc (%)	*Predicted SPF*	*Residuals*	*Standard Residuals*
1%	2.596	-0.012	-0.066
2%	3.995	0.034	0.190
3%	5.394	-0.037	-0.204
4%	6.793	0.253	1.405
5%	8.193	-0.324	-1.798
6%	9.592	-0.066	-0.364
7%	10.991	0.226	1.258
8%	12.390	-0.193	-1.072
9%	13.789	0.160	0.890
10%	15.188	-0.043	-0.239

Percentile	*SPF*
5	2.584
15	4.030
25	5.358
35	7.046
45	7.869
55	9.526
65	11.217
75	12.197
85	13.949
95	15.145

As a result of applying the linear regression analysis, we make the following statements:

The coefficient of determination, R^2, is 0.9982. This value indicates that 99.82% of the variation in the dependent variable (SPF) is determined by the variation in the independent variable (Concentration), meaning that the two variables share 99.82% of their variation, while the remaining 0.18% comes from other sources.

The ANOVA test used to evaluate the regression model yielded a test statistic of Fcalc = 4429.905 > Fcr = 5.318, with an associated probability of $p < 0.001 < \alpha = 0.05$. These values confirm the hypothesis that there is a significant linear relationship between the two variables (it is accepted that the slope of the regression line is different from zero).

The parameters of the regression model were tested using the t-test. In this case, a1 = 139.906, and the t-test result indicates a statistical value of t = 66.558, with an associated probability of $p < 0.001$, thus confirming that the slope of the regression line corresponds to a significant relationship between the two variables.

Using the unstandardized coefficients, the regression equation can be written as (Figure 4.3.2, Table 43.4.A, B):

SPF = 139.906 · Concentration + 1.197

The predicted values based on the regression line can be found in Table 4.3.3 for the concentration range of 1%-20%.

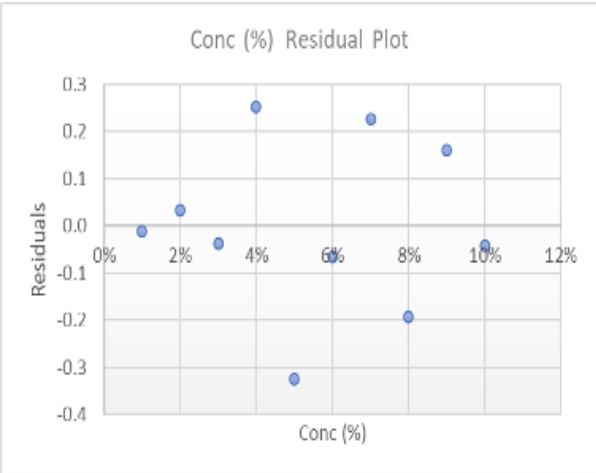


Figure 4.3.3. Graphical representation of the residual values εi = SPF - predicted SPF as a function of concentration for the analyzed samples, solutions in hexane of the oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio.

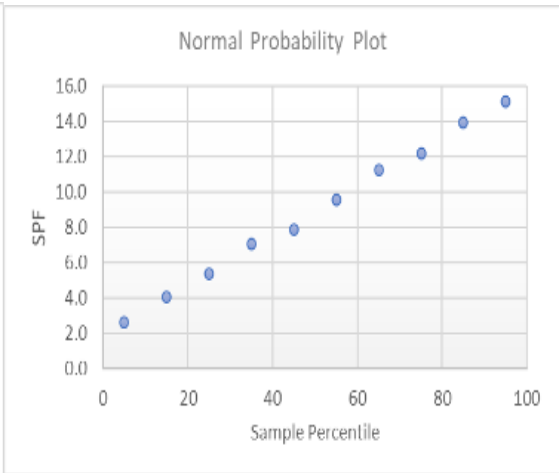


Figure 4.3.4. Graphical representation of the Normal Probability plot, confirming the fulfillment of the normality condition for the analyzed samples, solutions in hexane of the oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio.

4.3.1.3. Partial Conclusions

Based on the presented information, we can draw the following conclusions regarding the photoprotective capacity of the oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio.

The oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio exhibited satisfactory photoprotective capacity for a dermocosmetic product, with SPF values ranging from 2.584 for the 1% concentration solution to 29.178 for the 20% concentration solution.

The oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio showed lower photoprotective capacity for both the 1% concentration solution (SPF 3.658 for the 1% Camelina oil solution) and the 20% concentration solution (SPF 29.178 compared to SPF 43.961 for the 20% Camelina oil solution).

The oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio exhibited lower photoprotective capacity compared to the oil obtained as a mixture of Camelina oil and grape seed oil in a 25:75 ratio, as well as compared to the oil obtained from a Camelina and grape seed oil mixture in a 75:25 ratio.

4.3.2. Determination of the Photoprotective Capacity of the Oil Obtained as a Mixture of Camelina Oil and Carrot Oil in a 75:25 Ratio

4.3.2.1. Materials and Methods

The biological material used was Camelina oil and carrot oil.

Working technique - We analyzed a mixture of Camelina oil and carrot oil obtained by mixing, at room temperature, 75 grams of Camelina oil with 25 grams of carrot oil. From the resulting oil mixture, 10 samples were prepared, oil solutions in hexane with concentrations ranging from 1% to 10%. For each sample, the absorption spectra were recorded in the wavelength range of 290-320 nm, with a step of 0.5 nm, using the RayLeigh-UV-2601 spectrophotometer and 1 cm cuvettes.

For the calculation of the sun protection factor (SPF), the equation by Mansur et al. (1986) was used.

4.3.2.2. Results and Discussions

In order to determine the sun protection factor (SPF) of the oil obtained as a mixture of Camelina oil and carrot oil in a 75:25 ratio, absorbance values were recorded at wavelengths ranging from 290 to 320 nm for the 10 analyzed samples, with a step of 0.5 nm.

Table 4.3.6. Absorbance values in the range λ = 290-320 nm for the analyzed samples, hexane solutions of the oil obtained as a mixture of Camelina oil and carrot oil in a 75:25 ratio (sample 2), with concentrations ranging from 1% to 10%, along with the corresponding correction factor for calculating the SPF value.

λ(nm)	Corectie	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
290	0.015	0.478	0.801	0.991	1.318	1.641	1.858	2.217	2.408	2.552	2.840
295	0.0817	0.382	0.692	0.852	1.133	1.408	1.599	1.921	2.097	2.241	2.589
300	0.2874	0.365	0.689	0.849	1.127	1.395	1.585	1.890	2.059	2.199	2.510
305	0.3278	0.319	0.603	0.739	0.983	1.216	1.382	1.666	1.821	1.946	2.262
310	0.1864	0.260	0.481	0.580	0.766	0.945	1.067	1.295	1.411	1.515	1.796
315	0.0837	0.263	0.492	0.593	0.783	0.961	1.086	1.313	1.427	1.530	1.804
320	0.018	0.235	0.435	0.519	0.688	0.845	0.952	1.163	1.265	1.361	1.618

The absorption spectra for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio, with concentrations ranging from 1% to 10% in the wavelength range λ = 290-320 nm, are highlighted in Figure 4.3.5.

Figure 4.3.6. graphically represents the experimentally obtained SPF values for the analyzed samples, as well as the SPF values predicted based on the validated linear regression analysis model according to concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio.

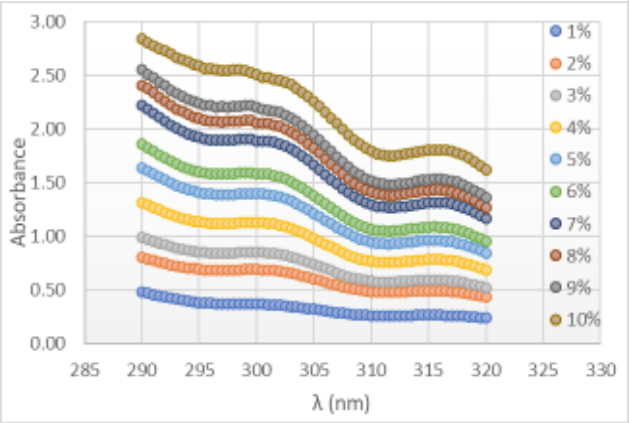


Figure 4.3.5. Absorption spectra for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio, with concentrations ranging from 1% to 10% in the wavelength range λ = 290-320 nm.

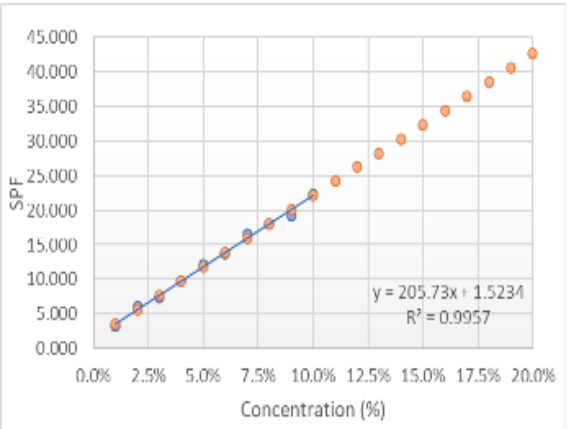


Figure 4.3.6. Scatter plot representation of the experimental SPF values and the predicted SPF values based on the validated linear regression analysis model according to concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio.

Table 4.3.7. Contains the experimentally determined SPF values obtained using the Mansur et al. (1986) equation, along with the predicted SPF values based on the regression line according to concentration for

the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio.

Table 4.3.7. Experimentally determined SPF values along with the predicted SPF values based on the regression line according to concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio.

Conc (%)	SPF	Predicted SPF
1%	3.226	3.581
2%	6.029	5.638
3%	7.378	7.695
4%	9.792	9.753
5%	12.110	11.810
6%	13.740	13.867
7%	16.517	15.924
8%	18.013	17.982
9%	19.262	20.039
10%	22.319	22.096
11%		24.154
12%		26.211
13%		28.268
14%		30.326
15%		32.383
16%		34.440
17%		36.497
18%		38.555
19%		40.612
20%		42.669

Following the application of linear regression analysis, we make the following statements:

The coefficient of determination R^2 is 0.9957. This value indicates that 99.57% of the variation in the dependent variable (SPF) is determined by the variation in the independent variable (Concentration), meaning that the two variables share 99.57% of the variation that characterizes them, with the remaining 0.43% of their variability coming from other sources.

The ANOVA test used to evaluate the regression model has a test statistic result of $F_{calc} = 1871.440 > F_{cr} = 5.318$ and an associated probability $p < 0.001 < \alpha = 0.05$. The obtained values confirm the hypothesis that there is a significant linear relationship between the two variables (it is accepted that the slope of the regression line is different from zero).

The testing of the regression model parameters is done using the t-test. For the given situation, a1 = 205.730, and the t-test result indicates a statistical value of t = 43.260 with an associated probability p < 0.001, thus confirming that the slope of the regression line corresponds to a significant relationship between the two variables.

Using the unstandardized coefficients, the regression equation can be written as (Figure 4.3.6., Table 4.3.8.A,B): SPF = 205.730 · Concentration + 1.523.

The predicted values based on the regression line can be found in Table 4.3.7. for the concentration range of 1%-20%.

Table 4.3.8.A. Result of the linear regression analysis for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio.

Regression Statistics	
Multiple R	0.998
R Square	0.996
Adjusted R Square	0.995
Standard Error	0.432
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*	*Fcr*
Regression	1	349.179	349.179	1871.440	0.000	5.318
Residual	8	1.493	0.187			
Total	9	350.672				

	Coefficients	*SE*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1.523	0.295	5.163	0.001	0.843	2.204
Conc (%)	205.730	4.756	43.260	0.000	194.763	216.696

Table 4.3.8.B. Result of the linear regression analysis for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio.

Conc (%)	*Predicted SPF*	*Residuals*	*Standard Residuals*
1%	3.581	-0.355	-0.872
2%	5.638	0.391	0.960
3%	7.695	-0.317	-0.779
4%	9.753	0.039	0.096
5%	11.810	0.300	0.736
6%	13.867	-0.127	-0.313
7%	15.924	0.593	1.455
8%	17.982	0.032	0.078

9%	20.039	-0.777	-1.908
10%	22.096	0.222	0.546

Percentile	*SPF*
5	3.226
15	6.029
25	7.378
35	9.792
45	12.110
55	13.740
65	16.517
75	18.013
85	19.262
95	22.319

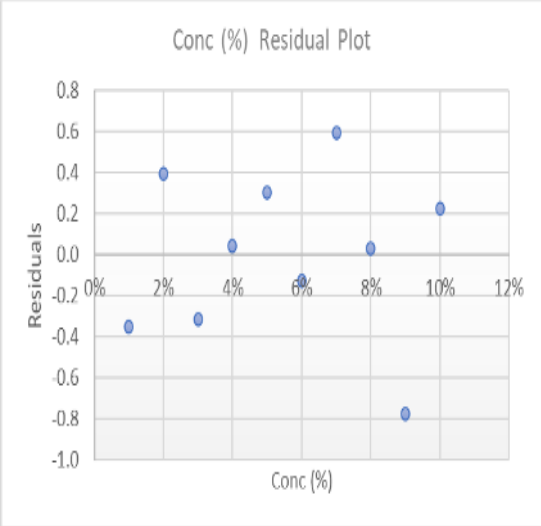


Figure 4.3.7. Graphical representation of the residual values εi = SPF - predicted SPF as a function of concentration for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio.

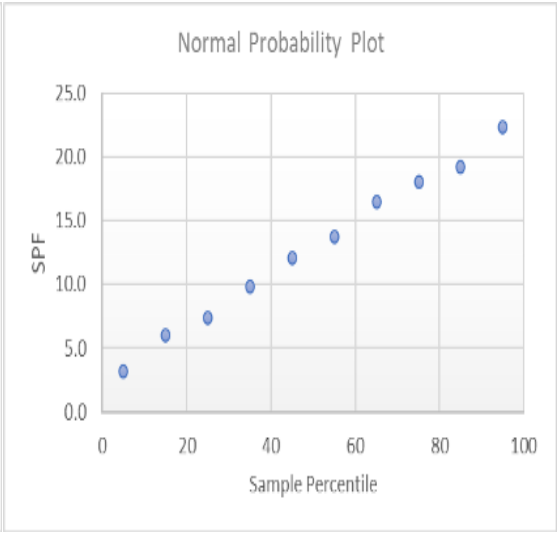


Figure 4.3.8. Graphical representation of the Normal Probability plot confirming the fulfillment of the normality condition for the analyzed samples, hexane solutions of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio.

4.3.2.3. Partial Conclusions

Based on the presented information, we can draw the following conclusions regarding the photoprotective capacity of the oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio: The oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio analyzed shows satisfactory

photoprotective capacity for a dermocosmetic product, with SPF values ranging from 3.226 for the 1% concentration solution to 42.699 for the 20% concentration solution.
The oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio analyzed has, for the 1% concentration solution, a lower photoprotective capacity than pure camelina oil (SPF 3.658 for the 1% concentration solution) and for the 20% concentration solution (SPF 42.699 compared to SPF 43.961 for the 20% concentration camelina oil solution).

The oil obtained as a mixture of camelina oil and carrot oil in a 75:25 ratio analyzed exhibits a higher photoprotective capacity than the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio, as well as compared to the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio for the 1% concentration. However, for the 20% concentration, the photoprotective capacity of the camelina and carrot oil mixture in a 75:25 ratio is greater than that of the oil obtained as a mixture of camelina oil and grape seed oil in a 25:75 ratio but less than that of the oil obtained as a mixture of camelina oil and grape seed oil in a 75:25 ratio.

Chapter V. DETERMINATION OF METAL CONTENT IN THE PLANT PRODUCT (Camelina sativa seeds). DETERMINATION OF TOTAL ANTIOXIDANT CAPACITY OF CAMELINA OIL USING PHOTOCHEMILUMINESCENCE METHOD.

5.1. Determination of metal content (zinc, iron, lead, cadmium, potassium, magnesium) in the plant product - Camelina sativa seeds.

5.1.1. Materials and Methods

The biological material used was the dried plant product - seeds from the species Camelina sativa (classical and ecological area), with a mass of the plant product taken for analysis of 0.25 g. The method used: Atomic Absorption Spectrometry; For samples where the concentrations to be analyzed are on the order of mg/L (ppm), the Flame Technique with a continuous high-resolution source (HRC-AAS-F) is used.

5.1.2. Results and Discussions

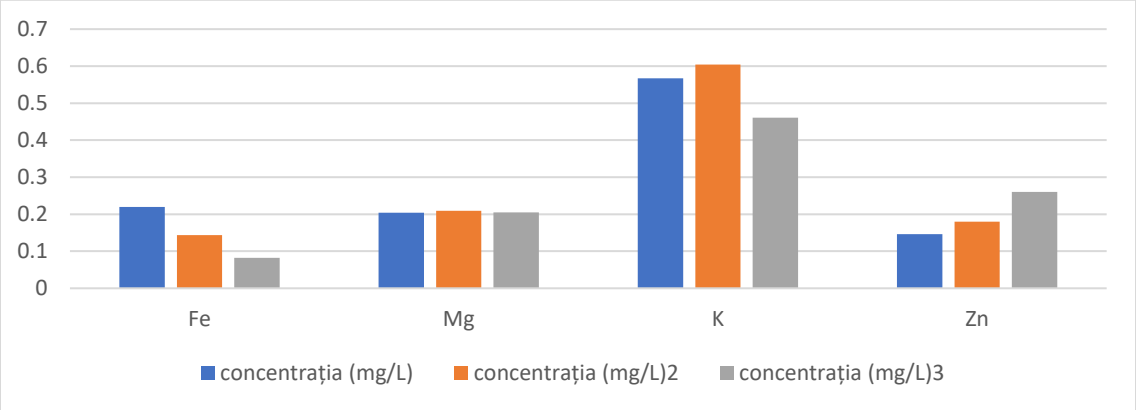


Figure 5.6. Metal content of camelina seeds grown under standard conditions.

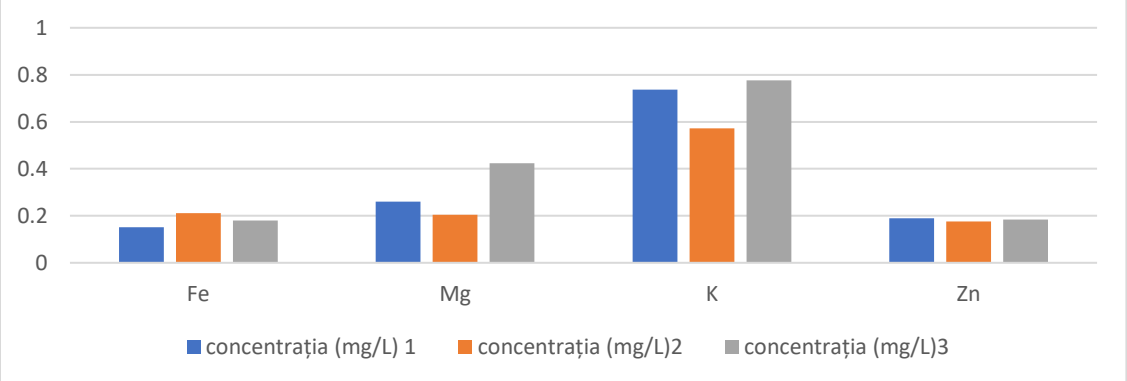


Figure 5.7. Metal content of camelina seeds grown under ecological conditions.

5.1.3. Partial Conclusions

Based on the results obtained for the dry plant product samples - classical Camelina seeds and ecological area Camelina seeds studied, there is a very high content of potassium and magnesium (some values exceeding the calibration curve), as well as a high content of iron in both types of samples, with higher values of these metals recorded in the ecological area Camelina samples.

The lowest values were obtained for the heavy metals Pb and Cd, indicating that both types of samples either do not contain these elements or have values below the calibration curve of the device.

5.2. Determination of total antioxidant capacity of camelina oil using the photochemiluminescence method.

5.2.1. Materials and Methods

The biological material used is the vegetable oil - obtained by cold pressing of camelina seeds from the Mădălina variety, sourced from a crop established at the Moara Domnească Teaching Farm. Determination of total antioxidant capacity (TEAC) for the vegetable oil.

A comparative evaluation of the total antioxidant capacity was conducted for six samples of camelina oil (stock solution) and for its dilutions of 1:10, 1:20, 1:50, 1:100 with methanol - the working reagent R1 of the ACL method, Analytik Jena AG, and repeated in triplicate, with the results presented as average values of the three measurements.

5.2.2. Results and Discussions

The average values of the recorded results regarding the total antioxidant capacity (TEAC) of camelina oil in hexane are presented in Table 5.2.

Table 5.2. Total antioxidant capacity (TEAC) of camelina oil in hexane, stock solution and dilutions.

Nr. crt.	**Type of sample**	**Sample volume taken into account (µL)**	**Maximum inhibition of free radicals**	**Amount (*TEAC*) (nmol echiv. Trolox/ trial vol)**
1	Camelina oil in hexane, sol. stock	10	1.000	8.901 Concentration too high, exceeds calibration curve
2	Camelina oil in hexane, sol. stock	5	0.935	7.159 Concentration too high, exceeds calibration curve

3	Camelina oil in hexane, dilution1:10 cu R_1	5	0.740	4.350
4	Camelina oil in hexane, dilution1:20 cu R_1	5	0.629	3.417
5	Camelina oil in hexane, dilution 1:50 cu R_1	5	0.506	2.738
6	Camelina oil in hexane, dilution1:100 cu R_1	5	0.321	1.764

5.2.3. Partial Conclusions

Based on the obtained results, the following observations were made:

For the Camelina oil stock solution, both at a working volume of 10 µL and 5 µL, the recorded total antioxidant capacity values were too high and exceeded the calibration curve of the apparatus. Consequently, the oil sample required dilution in molar ratios of 1:10, 1:20, 1:50, and 1:100 with methanol - working reagent R1, according to the ACL procedure.

At the minimum working volume of 5 µL, optimal values of total antioxidant capacity (TEAC) were recorded for the Camelina oil for all applied dilutions, with values ranging between 4.350 nmol Trolox equivalents/sample volume and 1.764 nmol Trolox equivalents/sample volume.

It was observed that for a dilution greater than 1:100 with methanol - working reagent R1, for the same working volume of 5 µL, the recorded total antioxidant capacity values were too low, falling below the calibration curve of the apparatus.

GENERAL CONCLUSIONS

From the analysis of the obtained experimental data, the following observations, comments, and conclusions can be formulated:

- A significant content of potassium, iron, magnesium, and zinc was observed in the analyzed plant product.
- Higher values of these metals were recorded in the samples of Camelina cultivated under ecological conditions.
- The highest determined amount was of potassium, with an average of 0.544 mg/L in Camelina seeds cultivated conventionally and 0.695 mg/L in seeds cultivated under ecological conditions.

- The lowest values were obtained for the heavy metals Pb and Cd, demonstrating that both types of samples either do not contain these elements or show values below the calibration curve of the instrument.
- The analyzed Camelina oil presents a satisfactory photoprotective capacity for a dermocosmetic product, with an SPF ranging from 3.658 for the 1% concentration solution to 43.961 for the 20% concentration solution.
- The oil obtained as a mixture of Camelina oil and grape seed oil in a 25:75 ratio showed satisfactory photoprotective capacity for a dermocosmetic product, with an SPF ranging from 3.097 for the 1% concentration solution to 41.726 for the 20% concentration solution.
- The oil obtained as a mixture of Camelina oil and grape seed oil in a 25:75 ratio exhibited a lower photoprotective capacity compared to pure Camelina oil, which had an SPF between 3.658 for the 1% concentration solution and 43.961 for the 20% concentration solution.
- The oil obtained as a mixture of Camelina oil and grape seed oil in a 75:25 ratio presented satisfactory photoprotective capacity for a dermocosmetic product, with an SPF ranging from 3.153 for the 1% concentration solution to 47.696 for the 20% concentration solution.
- The oil obtained as a mixture of Camelina oil and grape seed oil in a 75:25 ratio exhibited a lower photoprotective capacity for the 1% concentration solution compared to pure Camelina oil (SPF 3.658 for the 1% solution) and a higher photoprotective capacity for the 20% concentration solution, with an SPF of 47.696 compared to SPF 43.961 for the 20% Camelina oil solution.
- The oil obtained as a mixture of Camelina oil and grape seed oil in a 75:25 ratio showed a higher photoprotective capacity than the oil obtained as a mixture of Camelina oil and grape seed oil in a 25:75 ratio, with an SPF of 3.153 versus 3.097 for the 1% concentration solution and an SPF of 47.696 versus 41.726 for the 20% concentration solution.

The oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio showed satisfactory photoprotective capacity for a dermocosmetic product, with an SPF ranging from 2.584 for the 1% concentration solution to 29.178 for the 20% concentration solution.

- The oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio showed a lower photoprotective capacity for both the 1% concentration solution (SPF 3.658 for the 1% Camelina oil solution) and the 20% concentration solution (SPF 29.178 compared to SPF 43.961 for the 20% Camelina oil solution).
- The oil obtained as a mixture of Camelina oil and carrot oil in a 25:75 ratio presented lower photoprotective capacity than the oil obtained as a mixture of Camelina oil and grape seed oil in a 25:75 ratio, as well as the oil obtained from a Camelina and grape seed oil mixture in a 75:25 ratio.

- The oil obtained as a mixture of Camelina oil and carrot oil in a 75:25 ratio exhibited satisfactory photoprotective capacity for a dermocosmetic product, with an SPF ranging from 3.226 for the 1% concentration solution to 42.699 for the 20% concentration solution.
- The oil obtained as a mixture of Camelina oil and carrot oil in a 75:25 ratio showed lower photoprotective capacity for both the 1% concentration solution (SPF 3.658 for the 1% Camelina oil solution) and the 20% concentration solution (SPF 42.699 compared to SPF 43.961 for the 20% Camelina oil solution).
- The oil obtained as a mixture of Camelina oil and carrot oil in a 75:25 ratio presented higher photoprotective capacity than the oil obtained from a Camelina and grape seed oil mixture in a 25:75 ratio, as well as the oil obtained from a Camelina and grape seed oil mixture in a 75:25 ratio for the 1% concentration. However, for the 20% concentration, the photoprotective capacity of the Camelina and carrot oil mixture in a 75:25 ratio was higher than that of the Camelina and grape seed oil mixture in a 25:75 ratio, but lower than that of the Camelina and grape seed oil mixture in a 75:25 ratio.

In conclusion, by associating the known data on the composition and antioxidant capacity of Camelina oil with the photoprotective capacity demonstrated through the conducted studies, we can confidently assert that Camelina oil can be used in photoprotective dermocosmetic formulations.

The originality of this PhD Thesis lies in the creation of a dermocosmetic product, protected by a patent.