

THE STUDY OF THE CHEMICAL COMPOSITION AND CONTENT OF FATTY ACIDS IN SAFFLOWER CULTIVARS (*CARTHAMUS TINCTORIUS L.*) IN THE REGION OF LUSHNJA, ALBANIA

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ABSTRACT

Safflower (*Carthamus tinctorius L.*) is a relatively new plant in world agriculture. It has been studied and cultivated in a few countries of the world: India, China, the USA, Argentina, Kazakhstan, and Mexico. In Australia, it was first recognized as a weed, while in European countries it was cultivated in Spain. In Albania, there is safflower "Leshatak" (*Carthamus Lanatus L.*) according to Prof. Mustafa Demiri, who has described it: "One-year plant, grows in dry places, mainly in the area of the maquis and the oak." In the 18th century, Egyptian safflower dye was used in Italy, France, and Britain to color cheese and flavor sausage. In some countries, it is also used as a plant with medicinal value against rheumatism, thrombosis, cholesterol, and male and female sterility.

It has been used very effectively against diabetes, reducing it significantly after six weeks of use. Also, in the fight against scabies in small animals (sheep). Today, about one million hectares are cultivated with a production of over one thousand tons. In Europe, the largest producer is Spain and the oil has the highest price, being used mainly for salad, influencing the melting of fats in obese people. The study of the chemical composition and fatty acids in fruits and safflower oil has been a special object of this scientific work. The following were studied: fats, proteins, fibers, as well as moisture and the content of fatty acids: palmitic, stearic, oleic, linoleic, and linoleic acid.

Key words: Safflower, oil, acids, protein, albumin, sterility, weed.

SUMMARY

Oil plants are of interest in world agriculture because they meet more than 50% of the population's needs for fats. They started their journey in 1716 when the method of extracting oil from sunflowers was invented in England. Their diversity from a morphological, genetic, biological, and technological point of view has led to their regionalization in different countries of the world. Studies have been carried out continuously in different aspects. The study of new alternative oil plants has been and continues to be the object of study and scientific research. Studies on the safflower plant (*Carthamus tinctorius L.*) began five decades ago and have been intensified in recent years. In the framework of a bilateral project with the University of Viterbo - Italy, work was started on safflower cultivars (*Carthamus tinctorius L.*) and continued for several years on technological aspects of cultivation.

THE SCIENTIFIC METHODOLOGY

The experiment was set up in the field and was carried out according to the random block scheme with an area of 7.2 m² (3 m x 2.4 m = 7.2 m²) for each variant. Average samples of 1.5 kg were taken from the products of each variety (cultivator) and analyses were performed for protein, moisture, fiber, and fat. These analyses were carried out in the laboratory of the Olim Company in Tirana. For the determination of fatty acids, gas chromatography analyses were performed in the laboratory of the Faculty of Pharmacy of the University of Skopje in North Macedonia. 11 safflower cultivars were included in the study: 1. Espheau, 2. Guaimaro, 3. Ruggero, 4. Belisario, 5. Bocum, 6. Benno, 7. Benno 2, 8. SAFF (2002), 9. VC- 150, 10. Montola 2000, 11. Roberto. The indicators of the chemical composition were analyzed: The proteins were determined according to the method: A1 – 76 NGD (30 EDIZIONE, 1976)

$$(V1 \times N1 - V2 \times N2) \times 0.14^* \times 100^* \times 6.25$$

Protein in % = -----

M

V1- Volume of 0.1N solution of sulfuric acid in ml.

V2- The volume of the sodium hydroxide solution used for titration in ml.

N1- The normality factor for the sulfuric acid solution.

N2- The normality factor of the sodium hydroxide solution used for the titration.

M- Weight in grams of the sample taken for analysis

Definition of fiber:

Referred to methodology: B6 – 76 NGD (3⁰ EDIZIONE, 1976)

"Grexho" fiber means the residue obtained under the test conditions, which consists of cellulose and lignin.

"Grexho" fiber in % = $(f' - f) - (k' - k) : m$

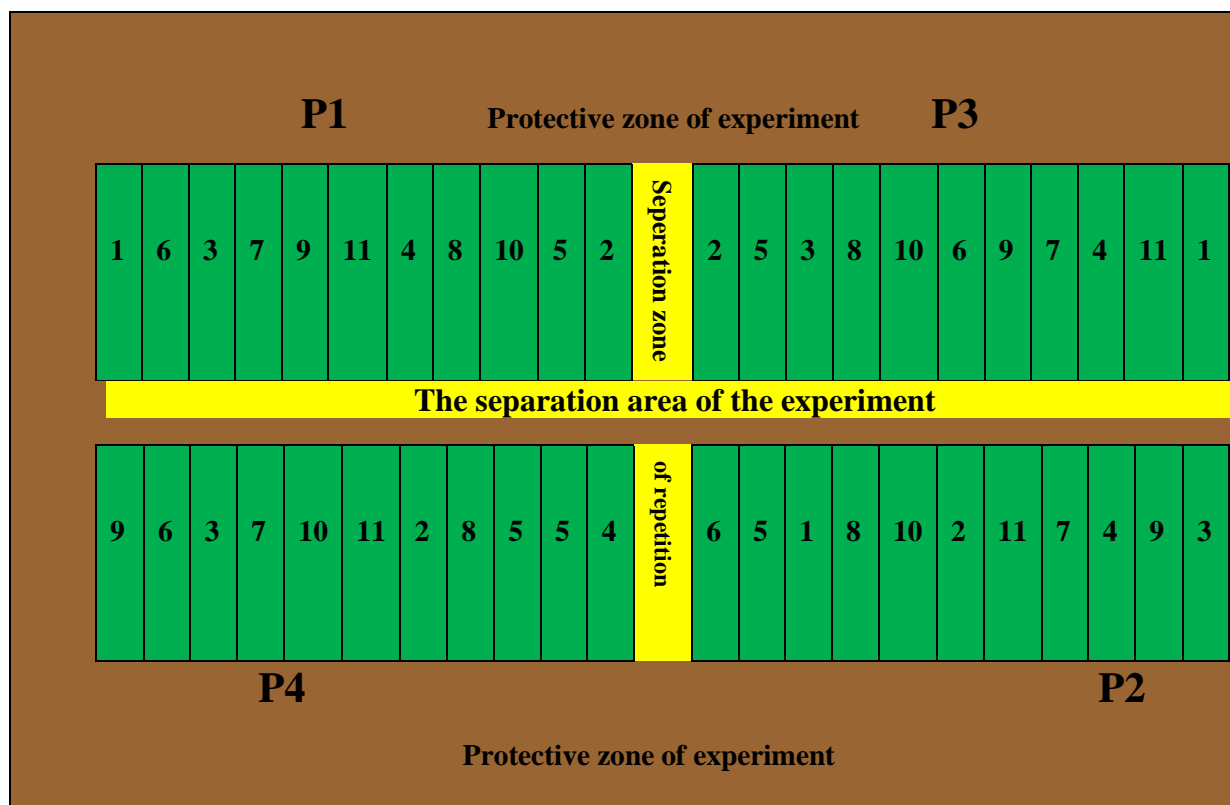
f'- Weight of dried filter with all residue (g)

f- The weight of the empty filter (g)

k'- The weight of the "crucible" with ash (g)

k- Weight of empty "crucible" (g)

m- weight in grams of the sample taken for analysis.



Scheme No. 1 Setting up the experiment

The humidity = $(m - m_1) : m \times 100$

Determination of fat

Referred to methodology: A4 – 76 NGD (3⁰ EDIZIONE, 1976)

Oily substance in % = $(m_1 : m) \times 100$

m_1 – The mass of the extracted oily substance in g

m – The mass of the sample taken for analysis in g

Determination of fatty acids was done with a gas chromatograph at the Faculty of Pharmacy of the University of Skopje in North Macedonia.

RESULTS AND THEIR INTERPRETATION

Based on the objective and goals of this study to determine the quality of fruits from biochemical analysis, all stages of the work were followed as provided in the study methodology with the relevant protocols. Evaluation and comparison of biochemical analyses is the basic factor that differentiates between cultivars for oil quality and quantity for each cultivar.

Chemical composition of safflower cultivars (*Carthamus tinctorius L.*) Table No. 1

No.	Cultivars	Protein (%)	The humidity (%)	Fiber (%)	Fats (%)
1	Espheau	15.47	6.86	29.24	29.61
2	Guaimaro	15.41	7.1	25.01	32.77
3	Ruggero	17.99	6.31	25.4	30.64
4	Belisario	15.75	6.96	27.84	31.92
5	Bacum	15.66	6.51	27.05	28.11
6	Benno	15.395	5.53	23.64	35.16
7	Beno 2	16.36	6.46	24.26	31.26
8	SAFF (2002)	16.805	5.565	15.89	33.11
9	VC – 150	17.05	6.925	25.88	28.92
10	Montola 2000	16.195	5.875	12.85	33.45
11	Roberto	16.715	5.695	26.14	35.53

Based on the results of the protein analysis, it results that the cultivars with the highest protein content in the seed are the cultivars: Ruggero 17.99% protein, VC-150 17.05% protein, and SAFF 2002 16.805% protein. The lowest protein value is the cultivar Benno with 15.395% protein. Meanwhile, the protein content in safflower sprouts after processing the seeds reaches 35%, being a very good feed for livestock.

The humidity in safflower cultivars is lower than in all other oilseeds. Respecting the moisture content is a very important factor in the quality of fruit storage because, with the increase in humidity, the possibility of spoilage of safflower fruits increases. The maximum value of moisture content is 7.1% in the cultivar Guaimaro and the lowest value is 5.53% in the cultivar Benno.

The fiber content (cellulose and lignin) is very different between the cultivars specifically the highest is in the Espheau cultivar with 29.4% and the lowest value is in the Montola 2000 cultivar with 12.85%. The high fiber content affects the reduction of fat content.

Fat content is the main parameter for which safflower cultivars are evaluated. The Roberto cultivar has the highest fat content with 35.53% and the Bacum cultivar has the lowest content with 28.11%, i.e. 7.42% less than the Bacum cultivar. This indicator greatly affects the yield of the oil.

Production indicators of safflower cultivars (*Carthamus tinctorius L.*) Table No. 2

No.	Cultivars	Fat content (%)	Industrial oil jet (%)	The obtainedoil (%)	Fruit yield (kv/ha)	Total oil yield (kv/ha)	Yield of oil obtained (kv/ha)
1	Espheau	29.61	88.76	26.2818	20.87	6.1796	5.4818
2	Guaimaro	32.77	88.76	29.0867	17.9	5.8658	5.2065
3	Ruggero	30.64	88.76	27.9606	13.79	4.2252	3.7503
4	Belisario	31.92	88.76	28.3322	18.78	5.9945	5.3207
5	Bacum	28.11	88.76	24.9504	17.9	5.0316	4.4661
6	Benno	35.16	88.76	31.2081	10.91	3.8359	3.4047
7	Beno 2	31.26	88.76	27.7464	16.78	5.2454	4.6558
8	SAFF (2002)	33.11	88.76	29.3884	15.39	5.0956	4.5229
9	VC – 150	28.92	88.76	25.6694	22.14	6.4028	5.6931
10	Montola 2000	33.45	88.78	29.6969	12.75	4.2548	3.7774
11	Roberto	35.53	88.76	31.5364	14.64	5.2015	4.6166

Comparison of cultivars for fruit and oil yield makes the essential difference between cultivars. The cultivars with the highest fruit yield are VC-150 with 22.14 kv/ha and Espheau with 20.87 kv/ha, while the cultivars with the lowest fruit yield are Benno with 10.91 kv/ha and Montola 2000 with 12.75 kv/ha.

Fatty acid content of safflower (*Carthamus tinctorius L.*) Table No. 3

No.	Cultivars	Fatty acids (%)				
		Palmitic	Stearic	Oleic	Linoleic	Linolic
1	Espheau	8.281	0.319	19.176	70.068	0.368
2	Guaimaro	8.859	0.745	21.67	68.163	0.455
3	Ruggero	8.213	1.013	41.523	48.213	0.513
4	Belisario	9.504	0.025	22.133	66.801	0.455
5	Bacum	8.833	0.667	25.885	63.693	0.442
6	Benno	8.596	0.457	36.831	53.288	0.407
7	Beno 2	8.491	0.255	22.205	64.249	0.601
8	SAFF (2002)	8.926	0.626	24.347	64.249	0.601
9	VC – 150	8.110	1.600	21.251	65.900	0.483
10	Montola 2000	8.661	1.045	31.186	57.567	0.474
11	Roberto	8.736	0.404	33.756	56.146	0.475

The content of fatty acids distinguishes safflower oil from other arable plant oils (sunflower, peanut, castor, rapeseed, and sesame). The higher content of unsaturated fatty acids (oleic, linoleic, and linoleic) distinguishes safflower oil from other arable plant oils, as well as between cultivars.

Palmitic acid content does not vary between cultivars, ranging from 8.11% in cultivar VC-150 to 9.504% in cultivar Belisario. Stearic acid content ranges from 0.025% in the Belisario cultivar to 1.6% in the VC-150 cultivar. But it should be noted that in most cultivars there are no great changes and it ranges from 0.25% to 0.667%. The content of oleic acid has greater differences than the first two acids, so the lowest content is in the cultivar Espheau with 19.176% and the highest content is in the cultivar Ruggero with 41.523%. The content of linoleic acid is higher than oleic acid in all cultivars the Espheau cultivar has the highest content with 70.068% and the Ruggero cultivar has the lowest content with 48.213%. The linoleic acid content is lower and with smaller variations. The highest content has the cultivars Benno " and SAFF (2002) with 0.601% and the lowest is the cultivar Espheau with 0.368%.

CONCLUSIONS AND RECOMMENDATIONS

From the detailed analysis of the indicators of the chemical composition of safflower cultivars (*Carthamus tinctorius L.*), we can draw some conclusions and recommendations, among which we will mention the most important ones.

A. CONCLUSIONS

After analyzing the chemical composition of the fruits of eleven cultivars of safflower (*Carthamus tinctorius L.*) studied in Lushnjë - Albania, we draw the following conclusions:

1. The level of oil content in safflower cultivars (*Carthamus tinctorius L.*) reaches up to 35.5% and can be increased with the application of improvement techniques.
2. The cultivar with the highest yield of oil production is VC-150.

3. The presence of many empty fruits affects the reduction of the range of the oil.

This phenomenon deserves attention in the best application of cultivation technology to increase the number of whole fruits, especially plant food.

4. The cultivars with the highest fat content are Roberto e Benno cultivars.
5. The protein content in safflower (*Carthamus tinctorius L.*) fruits reaches 17% and after extraction, the protein content in the remaining pods reaches 35%, this indicator shows that safflower pods are very good food for poultry.
6. The humidity of the fruit is within the required parameters, below 8%. Also, an inverse relationship between moisture content and fat content is observed, the lower the moisture content, the higher the fat content.
7. The spectrum of fatty acid content in safflower (*Carthamus tinctorius L.*) oil makes this plant the leader among all vegetable oils.
8. The content of oleic, linoleic and linolic acid in safflower oil (*Carthamus tinctorius L.*) has a similar composition to olive oil. Containing less saturated fatty acids than olive oil makes for better taste and value. It should be noted that it contains less saturated fatty acids than all other vegetable oils (sunflower, peanut, sesame, castor and rapeseed).
9. Compared to sunflower oil, which dominates the world market, safflower (*Carthamus tinctorius L.*) has several advantages: Higher fruit yield, higher oil yield, higher protein content, higher oil quality (higher unsaturated acid content and lower saturated acid content), it's simpler in cultivation and being cultivated in lands where other plants do not produce, possibility of higher mechanization in all processes from planting to harvesting production, less affected by diseases and pests.

B. Recommendations

From the experience of several years of study and the conclusions drawn, we can advise:

1. It is important to continue the study for the determination of fatty acids in safflower oil (*Carthamus tinctorius L.*), as one of the basic criteria for determining the quality of vegetable oil.
2. Conducting studies in other ecological areas determining the most suitable area to achieve the highest yield of safflower oil (*Carthamus tinctorius L.*).

For the future successful cultivation of this plant, complex technological studies must be carried out to achieve higher yields and better oil quality.

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