ORIGINAL PAPER

VALORIFICATION OF WASTE FROM BIODIESEL PRODUCTION AS FERTILIZER FOR MEDICINAL HERBS

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Abstract. *Refining processes of rapeseed oil generate lechitins, gums or soapstocks. These secondary products have a major valorification potential and could contribute to elaboration of effective management systems for plant growth. Tagetes and Lobelia species need an extra phosphorus contribution and prefere alcaline solutions. In order to ensure the necessary nutritional components and to improve the growth and development conditions of medicinal herbs Tagetes patula L. and Lobelia erinus, it has been applied soapstock treatments in four different preparation forms (wet natural form, 1% (w/w) and 10% (w/w) mixtures with water and dried at 105° C, for 5 hours. The experimental study lasted 21 days. The final evaluation of plant growth has highlighted that Tagetes patula L. treatment with soapstock 10% (w/w) has led to important improvements: increasing with 200 % of buds number, with 200% of ramifications and with 30% of plant height than the start of the experimental study. Lobelia erinus plants from the soil treated with 10 g dry soapstock recorded an increase with 1144% of flowers number, with 457% of buds number and no modification of ramification's plants. The most important increase in Lobelia erinus plant height (117%) was observed in those treated with 1% soapstock/water mixture.*

Keywords: *rapeseed oil, biodiesel, soapstock, fertiliser, medicinal herbs.*

1. INTRODUCTION

In the vegetable oils production result waste with important nutrient concentrations, considered by-products that could be reused as fertilizer. In general, the vegetable oils contain together with triglycerides (TAGs 91.8 to 99%) mono- and diglycerides (MAGs, DAGs), free fatty acids (FFA 0.5-1.8%) [1], unsaponifiables compounds (0.5-1.2%), water (> 0.8%), phospholipids, sterols, tocopherols (700-1000 ppm), pigments (chlorophylls 5-35 ppm), sulf (5-25 ppm), vitamins, protein fragments and trace metals [2]. The mixtures of compounds derived from the mucus found in crude vegetable oils are known as "gums" and in the oils refining process they are removed through various operations of degumming (drying, treatment with acids, water, enzymes [3], EDTA or by using membranes). The main advantage of degumming is that oil losses are reduced due to effective separation of soaps [4].

Soapstock or refining soap contains 70-95% water and 5-30% free fatty acid mixture, neutral oil, hydrolysed phosphatides, unsaponifiable materials, proteins and mucilaginous substances, depending on the refining process and equipment used. The soapstock it is mainly recommended for its fatty acids content, but it can be used as animal feed, raw material for various chemical synthesis, as fertilizer for agricultural crops or as posible adjuvant in the

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composition of herbicides [5-6]. The phospholipids found in the soapstock's composition can be considered biochemical intermediates of great importance in plant metabolism and their developement.

Plants absorb nutrients from the soil [7-11] in the ionic form (for example, P in form of H_2PO_4- P and HPO_4^{2-}, or N in the form of NH_4^+ and NO_3^-) and, in a very small quantity, in the molecular form (C in the form of CO_2, B in the form of boric acid). Nutrients from the soil solution, directly accessible, are absorbed by plant roots, transported in leaves and used depending on the role of each element in plant metabolism. Usually, phosphorus goes into phospholipids composition and plays an essential role in carbohydrates metabolism. Phosphorus is very mobile in plant soil and inside the plant, circulating both in xilem and the phloem. The phosphate ion failure in plant chloroplasts greatly reduces photosynthesis. Large quantities of phosphorus in plants can produce toxicity symptoms manifested by tissue necrosis in the leaves, secondary Zn deficiencies and in severe cases, plant death. Depending on the properties and the role of nutrients, effective management systems for plant growth and plant developement can be designed. Thus, in choosing a proper fertilization system for different plant species their way of rooting must be considered.

Tagetes patula L., Compositae family (the French marigold by popular name), are part of annual species, often ornamental planted, with different forms (tall by 75-100 cm, middle by 35-50 cm and small under 20 cm), very ramificated, bush aspect. Marigold with yellow-orange or reddish flowers, present therapeutic properties and are considered medicinal herbs. Bloom time is between June and October period. Flowers with maximum content of active principles in bloom time have medical importance. It contains most carotenoids, flavones, volatile oil. Carotenoids are represented by heleniene, with the biggest procent (0.01-1.45%), α-,β- carotene, violaxantine, rubixantinepoxide, fitoene, flavoxantine, lycopene, rubicrome. Flavons from the plant's composition are: patuletine, patuletrine, quercetagetine, 5-methyl quercetagetine, quercetagetrine. The volatile oil components are: tagetone (40%), dihidrotagetone, free linalool (22%) and esterified linalool (13-14%), limonene, ocimene, piperitone, piperitenone, terpinolene and valeric acid. Research by King et al. (1998) showed that marigold extract proved to be efficient in the treatment of eficient in tratamentul planting hyperkeratosis, disease characterised by excesive growth of overgrowth of the layer corneum skin, accompanied by pain and its inflammation [12]. Extracts from flowers have antioxidant properties [13,14], thanks to luteine content. In the preclinics studies [15], alchoolic extract from marigold root, showed hypotensive, anti-inflammatory and anti-ulcer properties. Volatile oil has antifungal activity against two phytopathogenic fungi, *Botrytis cinerea* and *Penicillium digitatum*. Studies done by Prasad et al. (2012) show that extracted volatile oil from marigold root has antispasmodics, antibiotics, diuretics, anthelmintics and insecticidcs properties (for larvae *Aedes aegypti*, *Anopheles stephensi* si *Culex quinquefaciatus*), properties, in particular, due to derivatives of thiophene [16].

In popular medicine, marigold are used as anthelmintic, cathartic (actions due tagetone) and to stop nosebleeds. Also, marigold extracts have tinctorial properties and may be used to colour textile fibers or food. Without special claims to temperature, these plants likes the sunlight, excluding the seedlings when hoar-frost not resistant to late spring, not demanding to soil moisture, supporting even droughts. It can be cultivated in different soils, but prefere drained soils by south-orientation. No special demand for soil fertility and contraindication for acid solis. Soils less rich in nutritive components must be treated with 405 tones/ha stable garbage, well fermented, plus 30 kg s.a. phosphorous and 20 kg s.a. potassium. If no stable garbage available, it is sufficient 50 kg/ha s.a. phosphorous and 20-30 kg s.a. potassium, which is incorporated into the soil as the plowing [17].

Lobelia erinus „Crystal Palace” is part of Campanulceae family, having ramificated stalk, height 8-25 cm, with flowers dark blue to violet. Lobelia genus has over 250 annual or perennial species. *Lobelia sp.* is native of Africa and South America, with bloom time in June-September. Its cultivation is by medium difficulty: fertile flower soil and abundant watering are necessary. The stem is slender, branched, 10-15 cm tall and grows in compact bushes. The leaves are obovate or lanceolate shapes, alternate glossy and the flowers are small, axillary, colored in blue, blue, purple or red [18].

The general objectives of this study are:

A. Organoleptic and physico-chemical characterization of the soapstock resulting from the refining process of rapeseed oil used in the biodiesel production.

B. Experimental design to test the soapstock utilization in different ways as fertilizer for two ornamental and medicinal plants (*Tagetes patula L.* and *Lobelia erinus "Crystal Palace"*).

C. Monitor the investigated plant evolution for 21 days to evaluate soapstock efficiency as fertilizer.

2. MATERIALS AND METHODS

2.1. MATERIALS

The samples of soapstock from rapeseed oil refining were kindly provided by S.C. PRIO Biocombustibil SRL (Lehliu, Romania).

Tagetes patula L. and *Lobelia erinus "Crystal Palace"* plants (Fig. 1(a) and Fig. 1(b)) having the same age, in identic pots with flower soil have been purchased from a local farmer in Constanta County.

(a)

(b)

Figure 1. (a) *Tagetes patula L.* (medicinal species); (b) *Lobelia erinus „Crystal Palace"*

2.2. METHODS

Organoleptic and physico-chemical characterization of soapstock.

The next parameters have been determined: organoleptic (colour, smell, appearance) by tehnical specification of Central administrative board of food industry development of the Ministry of Agriculture and Food of the URSS [19], dry substance content (SR ISO 6496:2001); humidity; pH (SR ISO 10523:1997); lipid content (direct extraction); crude proteins content (SR 13325:1995 Dumas method) [19, 20]; fat content (SR EN ISO 6492:2001); phosphorus content (SR ISO 6491:1995) and metals content (inductively coupled plasma mass spectrometry - ICP-MS). To characterise the fat presence in soapstock [2] there have been determined saturated and unsaturated fats and also the fatty acids by gas chromatography with flame ionisation detector after previous derivatization in methanol/BF_3 system.

Soapstock preparation

To achieve the study there have been used four forms of soapstock fertilizers: wet natural form (S); 1% and 10% mixtures with water (M1, M10) and dried form (SD). The mixtures were prepared as follows: 3g (for M1) or 38 g (for M10) soapstock were introduced in a mixing bag with 297 mL (for M1) respectively 342 mL (for M10) of distilled water, homogenized for 1 minute and stored in a glass container (Fig. 2(a)). After homogenization, on the surface it has been formed a white foam, milky, that dissapeared in 24 hours. The mixtures'pH it was measured with a pH-meter. The dried form (SD) obtained after 5 hours of drying at 105° C in a laboratory oven, grinded and stored in a sterile bag (Fig. 2(b)).

(a) (b)

Figure 2. (a) M1 and M10 samples; (b) SD sample

Experimental design to test the soapstock utilization as fertilizer

Nine plants of *Tagetes patula L,* identified as A0 - A8 and nine plants of *Lobelia erinus "Crystal Palace"*, identified as B0-B8, having the same age, in identic pots with flower soil have been used for the experiment. A0 and B0 plants were used as controls. For each form of fertilizer there have been designed two plants (A1, A2 and B1, B2 – for M1; A3, A4 and B3, B4 – for M10; A5, A6 and B5, B6 – for S; A7, A8 and B7, B8 – for SD). The treatments have been applied in day 1, 6, 11 and 16. For M1 and M10 in the pots there have been added 10 mL mixture. In the case of solid form of fertilizers, each plant was removed from the pot, then 10g of fertilizer have been mixed with the soil and the plant has been replanted. All the investigated plants have been watered with 30 mL of the same tap water stored in a plastic container. For A0-A8 samples (*Tagetes patula L*.), watering was carried out at 5 days (days 1, 6, 11, 16 and 21) for B0-B8 samples (*Lobelia erinus "Crystal Palace"*) watering of the plants was done daily. The experiment was run for 21 days, with initial (day1), intermediate (days 7 and 14) and final (day 21) assessment of the state of the plant.

In order to assess the plants statement [21, 22], the following criteria have been established: the number of flowers, their size and color, the number of buds and size, the number of branches of the main stem and leaf color, plant height, seen from the top of the vessel up to the level of the most advanced vertical branches of plants (flower, bud, leaf), expressed in cm.

3. RESULTS AND DISCUSSION

3.1. RESULTS

Organoleptic characterization

The color of the soapstock resulted from refining process is ocher and it has been maintained after sampling and storage in a closed container for four weeks at room temperature (15 - 25°C).

Physico chemical characterization

Three parallel determinations of the studied characteristics on soapstock sample have been performed and the mean values are reported. The Table 1 presents the obtained results.

Table 1. Soapstock physico-chemical parameters (mean values)

Parameter	UM	Value
pH	units	8.61
Dry substance (4 h at 103°C)	%	50.4
Humidity[a]	%	49.6
Lipids[b]	%	36.2
N[c] [12]	%	0.18
Ca[d]	mg/kg	930
P[e]	%	1.6
Fe[d]	mg/kg	28
K[d]	mg/kg	670
Cu[d]	mg/kg	<0.05
Mg[d]	mg/kg	400
Mn[d]	mg/kg	5.8
Zn[d]	mg/kg	8.5

[a] calculation; [b] Direct extraction; [c] Dumas method; [d] Inductively coupled plasma mass spectrometry method; [e] UV-Vis spectrometric method.

In soapstock have been identified and quantified 35 fatty acids. The fatty acids and their concentration determined by GC – FID after derivatization in the soapstock are presented in Table 2.

Table 2. Fatty acids composition of the soapstock resulted in rapeseed oil refining

Fatty acid	Mean Value, %
C 16:0 palmitic acid	4.21
C 16:1 palmitoleic acid	0.18
C 18:0 stearic acid	1.29
C 18:1 oleic acid	64.5
C 18:2 linoleic acid	20.42
C 18:3 α-linoleic acid	8.5
C 20:0 arachidic acid	0.3
C 20:3 cis-11,14,17-eicosatrienoic acid	0.19
C 20:4 arachidonic	0.14

Plant evolution to evaluate soapstock efficiency as fertilizer

Final indicators of plants growing are given in Table 3 for A0-A8 and in Table 4 for the B0-B8 samples.

Table 3. Final evaluation of *Tagetes patula L.* plants.

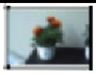
Sample	Flowers			Buds			Ramifications/Leaves		Height	Picture
	No.	Dimension	Color	No.	Dimension	Color	No.	Color		
A0	2	4.5/4	orange	8	1/2=0.5/5<0.5	green/ brown	8	one dried leaf	11.5	
A1	1	4.5	orange	7	3=1/5<0.5	green/ brown	9	one dried leaf	11	
A2	2	3.5/2.5	red-brown/ orange	13	1/2=0.5/6<0.5	green/ brown	15	four dried leaves	11	
A3	2	4.5/3.5	red-brown/ orange	6	2=0.5/4< 0.5	green/ brown	11	two dried leaves	11.5	
A4	2	4.5/4.5	red-brown/ orange	6	6<0.5	green/ brown	12	green	13	
A5	1	3.5	orange	7	1.5/0.5/3<0.5	green/ brown	10	green	10	
A6	2	4/3.5	red-brown/ orange	7	1.5/0.5/3< 0.5	green/ brown	12	two dried leaves	12.5	
A7	2	4/3.5	red-brown/ orange	5	2=1/0.5/3< 0.5	green/ brown	11	green	12.5	
A8	1	5	red-brown/ orange	6	2=1.5/0.5/3<0 .5	green/ brown	13	one dried leaf	11.5	

Table 4. Final evaluation of *Lobelia erinus „Crystal Palace”* plants

Sample	Flowers			Buds			Ramifications/Leaves		Height	Picture
	No.	Dimension	Color	No.	Dimension	Color	No.	Color		
B0	103	83-1/20-1	dark blue	138	18>0.5/ 120<0.5	18 B*/ 120 P**	7	four dried leaves	19	
B1	37	30-1/7<1	dark blue	106	5>0.5/ 101<0.5	5 B*/ 101 P**	7	three dried leaves	17.5	
B2	41	33-1/8<1	dark blue	82	5>0.5/ 77<0.5	7 B*/ 77 P**	7	five dried leaves	19	
B3	69	58-1/11<1	dark blue	111	9>0.5/ 102<0.5	9 B*/ 102 P**	8	four dried leaves	19.5	
B4	46	32-1/14<1	dark blue	65	12>0.5/ 53<0.5	12 B*/ 53 P**	7	two dried leaves	16	
B5	86	80-1/6<1	dark blue	63	6>0.5/ 57<0.5	6 B*/ 57 P**	6	six dried leaves	11.5	
B6	67	59-1/8<1	dark blue	63	8>0.5/ 55<0.5	8 B*/ 55 P**	6	two dried leaves	14	
B7	47	40-1/7<1	dark blue	94	9>0.5/ 75<0.5	9 B*/ 75 P**	8	three dried leaves	16.5	
B8	92	82-1/10<1	dark blue	83	8>0.5/ 75<0.5	8 B*/ 75 P**	9	three dried leaves	16	

(B* - blue; P-purple)**

Table 5 presents the percentage variations of the plant evolution indicators reported to the initial and the previous stage of evaluation for *Tagetes patula L.* Plants of *Lobelia Erinus* species “*Crystal Palace*” had during the experiment increasing evolutions of the monitorized indicators (Table 6), indicating a proper development of plants, except the number of ramifications.

Table 5. Evolution of *Tagetes patula L* plants.

Sample/criterion	Initial	after 7 days		after 14 days			after 21 days		
	No.	No.	% initial	No.	% 7 days	% initial	No.	%14 days	% initial
A0 - flowers	1	2	100	2	0	100	2	0	100
A0 - buds	6	5	-17	6	20	0	8	33	33
A0 - ramifications/leaves	4	4	0	6	50	50	8	33	100
A0 - height	9.6	9.7	1	11	13	15	11.5	5	20
A1 - flowers	1	2	100	1	0	0	1	0	0
A1 - buds	6	5	0	6	20	0	7	17	17
A1 - ramifications/leaves	4	6	50	6	0	50	9	50	125
A1 - height	9	9.2	2	10.3	12	14	11	7	22
A2 - flowers	3	3	0	3	0	0	2	-33	-33
A2 - buds	4	4	0	14	250	250	13	-7	225
A2 - ramifications/leaves	3	3	0	16	433	433	15	-6	400
A2 - height	10.5	11	5	10.5	-5	0	11	5	5
A3 - flowers	1	2	100	2	0	100	2	0	100
A3- buds	4	3	-25	6	100	50	6	0	50
A3 - ramifications/leaves	4	5	25	4	-20	0	11	175	175
A3 - height	8.6	10	16	11	10	28	11.5	5	34
A4 - flowers	1	3	200	2	0	100	2	0	100
A4 - buds	2	2	100	6	200	200	6	0	200
A4 - ramifications/leaves	4	4	0	5	25	25	12	140	200
A4 - height	9.9	10.7	8	12	12	21	13	8	31
A5 - flowers	1	2	100	2	0	100	1	-50	0
A5 - buds	3	4	67	5	25	67	7	40	133
A5 - ramifications/leaves	6	6	0	7	17	17	10	43	67
A5 - height	9.2	9.5	3	9.5	0	3	10	5	9
A6 - flowers	1	2	100	2	0	100	2	0	100
A6 - buds	6	6	20	7	17	17	7	0	17
A6 - ramifications/leaves	4	4	0	6	50	50	12	100	200
A6 - height	9.1	11	21	12	9	32	12.5	4	37
A7 - flowers	1	3	200	2	0	100	2	0	100
A7 - buds	5	5	25	4	-20	-20	5	25	0
A7 - ramifications/leaves	4	4	0	8	100	100	11	38	175
A7 - height	10.3	10.7	4	11.5	7	12	12.5	9	21
A8 - flowers	1	2	100	1	0	0	1	0	0
A8 - buds	6	5	0	5	0	-17	6	20	0
A8 - ramifications/leaves	6	6	0	9	50	50	13	44	117
A8 - height	9.5	9.5	0	10.5	11	11	11.5	10	21

Table 6. Evolution of Lobelia erinus „*Crystal Palace*” plants.

Sample/criterion	Initial	after 7 days		after 14 days			after 21 days		
	No.	No.	% initial	No.	% 7 days	% initial	No.	%14 days	% initial
B0 - flowers	15	44	193	70	59	367	103	47	587
B0 - buds	41	51	24	113	122	176	138	22	237
B0 - ramifications/leaves	7	7	0	7	0	0	7	0	0
B0 - height	9.2	13.4	46	15.5	16	68	19	23	107
B1 - flowers	6	18	200	23	28	283	37	61	517
B1 - buds	21	51	200	98	92	367	106	8	405
B1 - ramifications/leaves	5	5	0	5	0	0	7	40	40
B1 - height	10	14.4	44	18	25	80	17.5	-3	75

Table 6. Evolution of Lobelia erinus „*Crystal Palace*" plants (continued).

B2 - flowers	7	11	57	27	145	286	41	52	486
B2 - buds	31	47	57	91	94	194	82	-10	165
B2 - ramifications/leaves	7	7	0	7	0	0	7	0	0
B2 - height	7.3	10.6	45	14.5	37	99	19	31	160
B3 - flowers	5	18	260	33	83	560	69	109	1280
B3- buds	47	65	66	143	120	204	111	-22	136
B3 - ramifications/leaves	7	7	0	7	0	0	8	14	14
B3 - height	10.6	14.2	34	20	41	89	19.5	-3	84
B4 - flowers	5	17	240	27	59	440	46	70	820
B4 - buds	24	37	104	95	157	296	65	-32	171
B4 - ramifications/leaves	7	7	0	7	0	0	7	0	0
B4 - height	8.1	11.2	38	13.5	21	67	16	19	98
B5 - flowers	15	27	80	52	93	24	86	65	475
B5 - buds	28	67	182	95	42	239	63	-34	125
B5 - ramifications/leaves	6	6	0	6	0	0	6	0	0
B5 - height	9.2	9.4	2	10.5	12	14	11.5	10	25
B6 - flowers	3	14	367	28	100	833	67	139	2133
B6 - buds	17	54	282	105	94	518	63	-40	271
B6 - ramifications/leaves	4	5	25	5	0	25	6	20	50
B6 - height	8	10.7	34	12.3	15	54	14	14	75
B7 - flowers	4	9	125	19	111	375	47	147	1075
B7 - buds	11	62	509	108	74	882	94	-13	755
B7 - ramifications/leaves	8	8	0	8	0	0	8	0	0
B7 - height	8.7	11.3	30	13.5	19	55	16.5	22	90
B8 - flowers	7	27	286	51	89	629	92	80	1214
B8 - buds	32	74	194	132	78	313	83	-37	159
B8 - ramifications/leaves	9	9	0	9	0	0	9	0	0
B8 - height	8.2	11.5	40	13	13	59	16	23	95

3.2. DISCUSSION

The odor, characteristic of soaps, has a medium intensity without other flavors indicating chemical degradation phenomena. The appearance is semi-viscous having small and very small (0.1 – 1mm) solid hydrosoluble or insoluble particles.

The pH mean value recorded of the soapstock is 8.61, which indicates that it can be used for acid soils remediation, taking into account that it contains also macro and micronutrients essential for plant nutrition.

The investigated sample is characterized by 36.2% total lipids content, 49.6% humidity and other volatile compounds. The total lipids are made up of 2.1% saturated, 23.5% monounsaturated and 10.6% polyunsaturated fats.

The best represented of 16 essential elements for living organisms in soapstock is phosphorus (1.6%), that explains its potential use as fertilizer [2, 15], knowing that phosphorus is a major nutrient assuring the optimum plant growth and reproduction. The mean nitrogen content is 0.18% that corresponds to 1.1% proteic content and potassium represents 0.067%. Resulted N : P : K ratio in soapstock is about 3: 24: 1. In soapstock there are also important quantities of other essential elements: calcium (0.093%), magnesium (0.04%) and iron (0.028%). Manganesse (5.8 mg/kg) and zinc (8.5 mg/kg) are in small concentrations and copper is under the detection limit.

The experimental observations indicate that the chosen quantities of fertilizer applied to medicinal plants *Tagetes patula L.* and decorative *Lobelia erinus* had no toxic effects on all their growing from the initial stage of monitoring. There were no changes in the color of the flowers, buds and leaves.The size of flowers and buds were not quantifiable indicators relevant to the characterization of plant evolution during the experiment.

In order to evaluate the most effective form of treatment for investigated plants, it were calculated the percentage variations in plant growth indicators. When calculating the percentage indices, was carried out the average of the growth rates for identical treated plants to limit the effects of each organism specific genetic factors. Negative values for number of buds variation is due to the transformation from bud to flower, without the apparition of a new one. In the case of height variation negative values, that is due to the decrease of flower corolla in time. It can be observed that the plants A3 and A4, have the maximum increase percentages for all growing indicators that means the maximum efficiency is performed using the fertilizer M10. All samples have registered important increase in height.

The analysis of *Lobelia erinus* plants evolution at the end of the experiment indicates that the the most useful form of fertilizer is as dried soapstock (SD). Plants treated with M1 fertilizer (B1, B2) recorded three indicators higher (number of buds, ramifications, height), those treated with M10 and S (B3, B4, B5 and B6) have two indicators higher (number of flowers and ramifications) and those treated with SD (B7, B8) have three indicators higher (number of buds, flowers and height) than the control plants. The general appearance of *Tagetes patula L.* plants, monitored for 21 days, shows the beneficial effect of their treatment with all the four types of soapstock (M1, M10, S, SD), the indicators of evaluation being relevant to quantify the evolution of the plants.

In the case of *Lobelia Erinus "Crystal Palace"* plants it can be considered that the used treatments had less effects compared with *Tagetes patula L.* plants, but the aspect of the treated plants compared to the control plant appearance recommends the soapstock usage.

4. CONCLUSIONS

The paper aimed to investigate the potential utilization of a by product resulted from the refining process of rapeseed oil used in the biodiesel production as fertilizer.

To achieve this purpose it has been done the organoleptic and physico chemical characterization of the soapstock sample. The chemical analysis indicates a complex composition with important concentration in phosphorus (1.6%), a limitating essential element for the living organisms growing, nitrogen (0.18%) and potassium (0.067%), the resulted N : P : K ratio in soapstock being about 3: 24: 1. In soapstock there have also determined other essential elements: calcium (0.093%), magnesium (0.04%), iron (0.028%), manganesse (5.8 mg/kg) and zinc (8.5 mg/kg).

The performed experiments during 21 days to test the soapstock utilization in different ways as fertilizer for two ornamental and medicinal plants (*Tagetes patula L.* and *Lobelia erinus "Crystal Palace"*) led to the following conclusions:

- the chosen quantities of fertilizer applied to medicinal plants *Tagetes patula L.* and decorative *Lobelia erinus* had no toxic effects on all their growing from the initial stage of monitoring. There were no changes in the color of the flowers, buds and leaves.
- to the *Tagetes patula L* plants, the most promising results were obtained with 10% mixture soapstock-water (M10) administrated as fertilizer.
- to the *Lobelia erinus Crystal Palace* plants the the most useful form of fertilizer is as dried soapstock (SD).

As a final conclusion, the soapstock resulted from the refining process of rapeseed oil used in the biodiesel production has good potential to be reused as fertilizer for ornamental and medicinal plants.

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