BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Volumul 66 (70), Numărul 1, 2020
Secţia
CHIMIE şi INGINERIE CHIMICĂ

EMULSIONS OF BEESWAX - LAVENDER OIL: CHARACTERISTICS AND PRELIMINARY ANALYSIS FOR USE IN MANUFACTURING OF VALUE-ADDED TEXTILES

BY

CARMEN ZAHARIA[1,*], ANGELA DĂNILĂ[2], EMIL IOAN MUREŞAN[1] and DANIELA ŞUTEU[1]

[1]"Gheorghe Asachi" Technical University of Iaşi, Romania,
"Cristofor Simionescu" Faculty of Chemical Engineering and Environmental Protection
[2]"Gheorghe Asachi" Technical University of Iaşi, Romania,
Faculty of Industrial Design and Business Management

Received: February 12, 2020
Accepted for publication: March 25, 2020

Abstract. This research work presents the results of preliminary preparation and characterization of a few emulsions based on natural wax (beeswax) and lavender essential oil using some quality characteristics (*i.e.* pH, density, acidity index, peroxide index, total content of conjugated dienes and trienes, polyphenols, flavonoids and fatty acids) as well as sensory analysis considering as selected criteria the following ones: adherence, degree of emulsifying, uniformity, consistence and smell. These researches permitted the recommendation of the most corresponding emulsion for impregnation on textile material (*e.g*. cotton or viscose support) and preliminary details on the textile product design recommended for manufacturing of added-value textile material.

Keywords: emulsion; in-time stability; physical-chemical quality indicators; sensory analysis; textile impregnation.

[*]Corresponding author; *e-mail*: czah@ch.tuiasi.ro

1. Introduction

For manufacturing of value-added textiles (*e.g*., textile products designed for skin care benefits and/or aromatherapy in forms of dressing, bandages, special clothes, socks, aromatherapy decorative products), the oil/water (O/W) emulsions are preferred due to their better dispersion on the textiles as well as avoidance of oily sensation which appears after application of the product on textile in contact with the human skin (Dănilă *et al*., 2019a; Zaharia *et al*., 2019a). The main benefit offered by impregnated textiles is the beneficial effect of human wellness, health due to its antibacterial action, pleasure touch, aromatic effects, being environmental-friendly, among others.

The essential oils (EOs) have been used in traditional medicine due to their antimicrobial activity mainly dependent on their chemical composition (Dănilă *et al*., 2019a, 2019b; Zaharia, 2019a, 2019b, 2019c). Thus, essential oils (EOs) act to inhibit the growth of bacterial cells and also inhibit the production of toxic bacterial metabolites. Therefore, it is necessary to formulate essential oils-based products in liquid form (emulsions) or semi-liquid (gels) for the controlled release of active compounds and their protection from the external environment, caused the biological EO activity may be lost by volatilizing, or degradation under the action of high temperature, oxidation and UV light during the storage period and improper manufacturing process.

The research work consisted in preparation of a few formulations of stable emulsions in which the oily phase was made up of natural wax (*i.e*. beeswax) (Zaharia *et al*., 2019b, 2019c) mixed with essential vegetal oil (*i.e. iL*, where L = lavander), glycerin, Tween 80, water (specific formulations for each emulsion series) (Table 1) and the study of the influence of two operating parameters onto emulsion characteristics, *i.e.* the beeswax concentration and essential oil content. The beeswax coating (because of their hydrophobicity and firmly packed crystalline structure) is compatible for use in pharmaceutical, cosmetic and food industries (Dănilă *et al*., 2019a, 2019b; Mureșan *et al*., 2018; Mureșan *et al*., 2020; Radu *et al*., 2017; Zaharia *et al*., 2019a, 2019b, 2019c).

Other aim of this research work is to present our preliminary study on the in-time stability of prepared beeswax-lavender essential oil-based emulsions for a period greater than 8 months at room temperature and its sensory analysis.

2. Experimental

2.1. Materials and Reagents

Beeswax was used as shall material for essential oil core, being procured from a private apiary in the Northern-Eastern region of Romania. Beeswax contains a large number of chemical compounds (> 300), which can be grouped in fatty acids with 24-32 carbon atoms (12-14%), monoesters and

hydroxyl iminoesters of palmitic acid, oleic acid with 40-48 carbon atoms (35-45%), hydrocarbons with 27-33 carbon atoms (12-16%) and primary/free alcohols with 28-35 carbon atoms (1%), among others (Dănilă *et al*., 2019a; Zaharia *et al*., 2019a, 2009b, 2019c).

Essential lavender oil (*R*) was purchased from the Turkish contract partner DOĞAL DESTEK, sub-contractor EÜ.

The emulsifying agent, Tween 80 ($C_{32}H_{60}O_{10}$), was supplied by Merck, Germany.

The agent for humidity preservation, 99.5% pure vegetable glycerin, was purchased from SC Elemental SRL Co., Romania.

All other chemical reagents used in different analysis methods are of analytical purity (p.a.) and purchased from Romanian companies (Chemical Company S.A., Iaşi), or from abroad (Sigma Co., or Merck Co.), *i.e.* concentrated nitric acid, concentrated chloride acid, glacial acetic acid, solid potasium hydroxide, solid sodium carbonate, solid sodium tiosulphate, solid KI, phenolphthalein indicator, different solvents as chloroform, methanol, ethanol, and also different prepared working solutions (1% starch, standard quercitin, Folin-Ciocalteu solutions), among others.

2.2. Analysis Methods

The principal analysis methods considered in this research work are for the determination of emulsion pH, density, acidity index, peroxide index, content of conjugated dienes and trienes, total polyphenols, total flavonoids and total fatty acids, but also the emulsions sensory analysis.

***PH determination*.** The pH of prepared emulsions is directly measured using a HANNA high precision KL-009(I) pH-meter immersed in the prepared non-diluted emulsion (*iR*) (Dănilă *et al*., 2019a, Mureșan *et al*., 2018; Zaharia *et al*., 2019a, 2019b, 2019c).

***Density determination*.** All density measurements are directly done with an Anton Paar DMA 4500 Density Meter (Anton Paar GmbH, Granz, Austria) at standard temperature of 20°C, but also 19°C and 32°C (not reported in this work) (Dănilă *et al*., 2019a; Zaharia *et al*., 2019a). For each emulsion, there are performed at least five till eleven measurements and calculated the average density. This average value of density at 20°C is reported in this work.

Determination of the acidity index (AI). Around 1.0 g of emulsion sample is dissolved with chloroform (5 mL) and ethanol (5 mL). Two or three drops of phenolphthalein indicator (1% alcoholic solution) is added in the sample and titrated with potassium hydroxide (0.01 M KOH) till a pink color appeared (minimum 1 min stable). The acidity index (*AI*) is calculated with the relation (1):

$$\textbf{\textit{AI}}\ [\text{mg of KOH/g of emulsion}] = [(V_{KOH} \cdot M_{KOH} \cdot 56.11) / m] \qquad (1)$$

where: *AI* - the acidity index [mg KOH/g of emulsion]; V_{KOH} – the volume of consumed KOH at titration [mL]; M_{KOH} – the concentration of consumed KOH solution [mol/L]; 56.11 – the molecular weight of KOH [g/mol] and *m* – the sample weight [g] (Dănilă *et al*., 2019a; Zaharia *et al*., 2019a, 2019b, 2019c).

Determination of the peroxide index (PI). **A**round 1-2 g of weighted emulsion is contacted with chloroform (5 mL), glacial acetic acid (7.5 mL), and KI solution (1 mL of 10% KI) in a closed bottle, thereafter agitated 1 min and let to rest in a dark place (for 15 min). For analysis, the sample is diluted with distilled water (37.5 mL), after treated with a few drops of starch solution (1% aqueous solution) till a dark stable blue color formed. The solution containing iodine is titrated with sodium thiosulfate (0.05 N $Na_2S_2O_3$). In parallel, a control titration is performed (Dănilă *et al*., 2019a; Zaharia *et al*., 2019a). The peroxide index (*PI*) is calculated with relation 2 (Zaharia *et al*., 2019a, 2019b, 2019c):

$$\textbf{\textit{PI}}\ [\text{mmol of peroxide/g of emulsion}]=\{[(V_{ref}-V)\cdot N_{Na2S2O3}\cdot 1000]/m\} \quad (2)$$

where: *PI* – the peroxide index [mmol of peroxide / g of emulsion], V_{ref} – the volume of $Na_2S_2O_3$ solution consumed at the control titration [mL], *V* – the volume of $Na_2S_2O_3$ solution consumed at the analyzed emulsion sample titration [mL], $N_{Na2S2O3}$ – the normal concentration of sodium thiosulfate solution [val/L], 1000 – the recalculation coefficient for conversion of [mol of peroxide/g] in [mmol of peroxide/g] and *m* – sample weight [g].

Determination of conjugated dienes or trienes concentration. It is done by measuring of the absorbance of an emulsion sample at a fixed wavelength in UV light range, *i.e.* 236 nm for dienes and 273 nm for conjugated trienes (Dănilă *et al*., 2019a; Zaharia *et al*., 2019a, 2019b, 2019c). The emulsion sample is prepared by dilution of 0.1 g emulsion with 25 mL distilled water and the absorbance measurement is done at the Camspec M500 spectrophotometer. The total conjugated dienes (CD) and trienes (CT) concentration is calculated with relations (3) or (4) (Dănilă *et al*., 2019a):

$$C_{CD} = \{(A_{236}\cdot 2.5\cdot 10^4)/[(\varepsilon l)/m]\} \quad (3)$$

$$C_{CT} = \{(A_{273}\cdot 2.5\cdot 10^4)/[(\varepsilon l)/m]\} \quad (4)$$

where: C_{CD} – the molar concentration of total conjugated diene [mol/kg, or mmol/g of emulsion], C_{CT} – the molar concentration of total conjugated triene [mmol/cm^{-3}], A_{236} or A_{273} – the absorbance of diluted emulsion at 236, and 273 nm, ε – the molar absorbance (extinction coefficient) for linoleic acid hydroperoxide [$\varepsilon = 2.525\cdot 10^4$ M$^{-1}\cdot$cm^{-3}], *l* – the cuvette length [*l* = 1 cm] and *m* – the sample weight, [g] (Zaharia *et al.*, 2019a).

Determination of the total polyphenols content. Singleton method with Folin-Ciocalteu reagent is used. Thus, 0.5 mL of emulsion is contacted with 10 mL

of distilled water, agitated and after is added Folin-Ciocalteu reagent (0.5 mL) and let to react for 5 min followed by the adding 8 mL of 7.5% Na_2CO_3 in the sample, and after 2 h is measured the absorbance of treated sample at 765 nm under a blank with distilled water. If the absorbance value (measured at the SP 830 Plus spectrophotometer (MeterTech Inc.)) is higher than 1.8, the sample is diluted in ratios of 1:1, 1:2, 1:3, or 1:4. A calibration curve is elaborated for the total content of polyphenols viz. absorbance (A_{765}), expressed as amount of gallic acid (selected model due to its stability and purity)/volume of sample, in range of 0.05-0.5 mg/mL. The linear calibration equation corresponds to the equation: $y = 2.1169x - 0.0831$, where y is the absorbance value (A_{765}) and x is the concentration of gallic acid (μg/mL) (Lamien-Meda *et al*., 2005; Pontis *et al*., 2014; Zaharia *et al*., 2019a, 2019b).

Determination of the total flavonoids content. Around 2 mL of emulsion is treated with 2 mL of $AlCl_3$ dissolved in 2% methanol (Zaharia *et al*., 2019a) and let to rest in a dark room for 10 min. After the absorbance at 415 nm under a blank (1 mL methanol mixed with 1 mL of 2% $AlCl_3$) is measured at the SP 830 Plus spectrophotometer (MeterTech Inc.). The total content of flavonoids is calculated based on the standard calibration curve of quercetin (selected model due to its stability and purity), in range of 0.005-1.2 mg/mL. The linear calibration equation corresponds to: $y = 0.0005x - 0.037$, where y is the absorbance value measured at 415 nm (A_{415}) and x is the concentration of quercetin [μg of quercetin equivalent (QE)/mL]. The total content can be expressed also in [μg of quercetin equivalent (QE) / g of emulsion] if are known the weight [g] of a certain emulsion volume [mL]) (Lamien-Meda *et al*., 2004; Muresan *et al*., 2020; Pontis *et al*., 2014; Zaharia *et al*., 2019a, 2019b, 2019c).

***Determination of the total fatty acids*.** Around 1 g of emulsion sample is dissolved with 20 mL of hot water and after acidified by adding around 8 mL acid (0.5 N HNO_3). The sample is warmed up till fatty acids are separated as a film layer of organic matter at the solution surface and thereafter cooled in ace for solidification of fatty acids. The fatty acids are separated in a weighted porcelain crucible, and the aqueous solution is treated with 10 mL of chloroform for removal of residual fatty acids. The separated fatty matter is mixed in the porcelain crucible with that already introduced, the solvent was evaporated and the amount of fatty matter is weighted. The content of total fatty acids is calculated with the relation (5) (https://www.classle.net/book/estimation-total-fatty-matter-contentsoaps):

$$\textit{Total fatty acids}\ (TFA)[\%] = [(x - y)\ \text{x}\ 100]/m \tag{5}$$

where, x – the weight of porcelain crucible with fatty matter after drying [g]; y – the weight of porcelain crucible [g], and m – the emulsion sample weight [g].

Sensory analysis. It considers to be one of the most important analysis of oil-water (O/W)-based emulsions used for appreciation and comparison of its

sensory properties, *i.e.* adhesion, degree of emulsifying, in-time stability, consistency and odor/smell. There were performed tastings by a speciality commission of minimum five members. Each sensory property is appreciated with an evaluation score in range of 1 - 5 points, as described in other authors reports (Dănilă *et al*., 2019a; Zaharia *et al*., 2019a, 2019b, 2019c). All scores are compared and analyzed in order to appreciate the prepared *iL* emulsion stability and its quality when it will be used for impregnation of different textile products (*e.g*. dressings, patches, socks, or decorative products).

2.3. O/W Emulsion Preparation Methodology

Emulsions are prepared by varying the concentration of beeswax as basic matrice of emulsion and lavender essential oil (*iL*) as in Table 1.

The preparation of emulsions consists in three distinct steps: (1) melting of the beeswax at 65°C in a thermostatic water bath (700 rpm); (2) adding of the glycerin, Tween 80 solution (30%) and water in melting beeswax, and (3) sample cooling at 40°C and essential lavender oil (*iL*) addition dropwisely under continuous agitation.

Table 1
Formulation of Lavender Essential Oil-Beeswax-Based Emulsions

Emulsion	1*L*	2*L*	3*L*	4*L*	5*L*	6*L*	7*L*	8*L*	9*L*
Beeswax [g]	0.06	0.36	0.06	0.36	0	0.42	0.21	0.21	0.21
Glycerin [mL]	1	1	1	1	1	1	1	1	1
Water [mL]	6.82	6.52	6.22	5.92	6.58	6.16	6.79	5.95	6.37
Tween 80 [mL]	2	2	2	2	2	2	2	2	2
Lavender oil [mL]	0.12	0.12	0.72	0.72	0.42	0.42	0	0.84	0.42

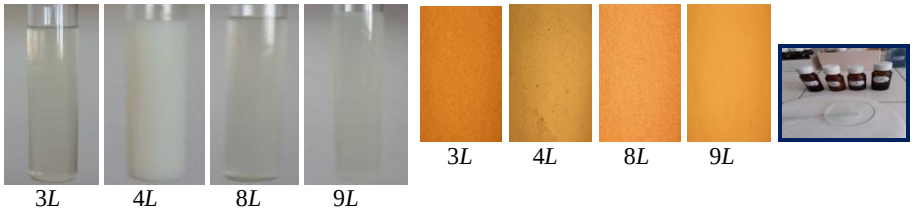
3. Results and Discussion

Preliminary investigations were necessary for selection of a few emulsion compositions with *increased value* and *physical*, *oxidative* and *microbiological stability* considering essential vegetal oil content and beeswax content which can be applied by using different types of essential vegetal oil and beeswax. This work presents only the results performed by using the essential lavender oil.

From the nine prepared emulsions, stable and adequate for use in added-value textiles manufacturing were found to be relative stable only four emulsions, *i.e.* 3*L*, 4*L*, 8*L* and 9*L*.

3.1. Characteristics and 'In-Time' Stability of Selected *iL* Emulsions

The visual images for the four selected emulsions based on lavender essential oil and beeswax are illustrated in Fig. 1.



a *b*

Fig. 1 – Emulsions (*iL*) appearance. (*a*) visual images; (*b*) optical microscopy (20x magnification).

Related to visual images, the emulsions 3*L* and 9*L* are translucent and emulsion 9*L* is free of particles in suspension, but the 4*L* and 8*L* emulsions are white homogeneous dispersed phases/states illustrated as compact, dense small globular phases, without agglomerations of particles and easily handle.

For all prepared emulsions are very important their stability in time and fixation on textile supports for beneficial effects such as antibacterial effects and/or aromatherapy (wellbeing sensation) due to release in time of essential oil containing different contents of polyphenols and flavonoids (as recognized antibacterial and antioxidant agents), being known the fact that the emulsion composition and odor (same for impregnated textile support) can alter/change in time due to the variation of storage conditions, composition alteration and additional chemical transformations of emulsion and treated textile support.

Thus, possible alteration processes (*e.g.*, slow primary oxidation associated with hydro-peroxides formation, reduction, complexation, precipitation, other conversion in this complex organic system) can act due to the high number of components and the variation in their stability in time that allow to interact in different steps (*i.e.* initiation, development and breaking of different macromolecular chains) (Mureşan *et al*., 2020; Zaharia *et al*., 2019a).

The periodic control of the 'in time' variation of a few quality indicators values is required and all possible existing alteration processes identified. Thus, the values of the acidity indice (*AI*), peroxide indice (*PI*), total contents of conjugated dienes (*CD*) and trienes (*CT*), total polyphenols, flavonoids and fatty acids are analyzed and the results are summarized in Table 2 for the selected emulsions, *i.e.* 3*L*, 4*L*, 8*L*, and 9*L*.

The variations of quality indicators of emulsions for a storage period of eight months are in range of 4.6-5.2 for pH, 1.0269-1.0873 g/cm^3 for absolute density normalized at 20°C, 1.1472-10.4612 mg KOH/g of emulsion for acidity indice (*AI*), 3.7794-13.8408 mmol/g of emulsion for peroxide indice (*PI*),

2.8139-17.3564 mmol/g of emulsion for total content of conjugated dienes (*CD*), 2.4369-14.855 mmol/g of emulsion for total content of conjugated trienes (*CT*), 0.3680-0.7712 ug/g of emulsion for total content of polyphenols (*TPF*) and 0.5866-1.5790 ug/g of emulsion for total content of flavonoids (*TF*), 21.22-38.43% for total fatty matter separated (FM) and 61.57-78.78% for aqueous phase.

Table 2
The Values of Some Physical-Chemical Quality Indicators for Selected (iL) Emulsions Based on Beeswax-Essential Lavender Oil

Physical-chemical quality indicators	Storage time	Values for *iL* prepared emulsions			
		3*L*	4*L*	8*L*	9*L*
pH (room temperature, t=23.7°C)	initial	5.0	4.9	4.8	5.2
	1 month	5.0	4.9	4.8	5.2
	8 months	4.8	4.7	4.6	5.0
Density (absolute) (20°C), [g/cm^3]	initial	1.029	1.026	1.024	1.031
	1 month	1.021	1.024	1.022	1.029
	8 months	0.998	0.984	0.944	1.020
Density normalized (20°C), [g/cm^3]	initial	1.0620	1,0873	1.0860	1.0380
	1 month	1.0528	1.0594	1.0822	1.0364
	8 months	1.0325	1.0286	1.0269	1.0301
Acidity indice (AI), [mg KOH/g of emulsion]	initial	1.1472	1.7231	1.2264	1.6503
	1 month	1.8642	2.2364	1.9543	2.3846
	8 months	10.4612	8.2672	7.2059	8.1084
Peroxide indice (PI), [mmol/g of emulsion]	initial	6.0643	5.4627	3.7594	3.8660
	1 month	6,4426	5.6183	4.1468	4.2264
	8 months	13.8408	10.1332	9.2937	9.4238
Total content of conjugated dienes, [umol/g of emulsion]	Initial	4.6733	16.9485	7.7723	2.8139
	1 month	4.6771	16.9496	7.7865	2.8263
	8 months	5.6224	17.3564	8.9035	3.1003
Total content of conjugated trienes, [umol/g of emulsion]	Initial	3.9650	15.996	6.6902	2.4369
	1 month	3.8654	15.623	6.6825	2.6349
	8 months	4.1204	14.855	6.9892	3.9436
Total content of polyphenols (TPF), [ug/g of emulsion]	Initial	0.3680	0.6586	0.4918	0.4568
	1 month	0.3846	0.6558	0.4978	0.4592
	8 months	0.7712	0.6303	0.5575	0.4739
Total content of flavonoids (TF), [ug/g of emulsion]	Initial	0.8732	0.8546	1.5368	0.5866
	1 month	0.8788	0.8564	1.5410	0.5884
	8 months	0,8856	0.8932	1.5790	0.5925
Total fatty acids content (FA), [%]	Initial	29.18	29.15	36.46	38.43
	1 month	28.65	28.36	36.04	38.32
	8 months	21.22	23.45	30.31	32.18

All values after more than 8 months of emulsion storage are respecting the norms for skin care (cosmetics) and pharmacy products and additives, but much different from the initial ones.

Separation of aqueous and fatty phases was performed in the storage period of 8 months and also different quality emulsion alterations caused of organics degradation in-time (easy oxidation/reduction, co-precipitation/ coagulation-flocculation), but it can be concluded that the selected (*iL*) emulsions had a relative good stability till 1-3 months, and relative good sensorial properties.

The presence of a minimal content of total polyphenols in range of 0.3680-0.6586 [μg/g of emulsion]) and flavonoids in range of 0.5866-1.5368 [μg/g of emulsion] suggests that these selected emulsions can have beneficial antibacterial action against active bacteria/microorganisms in contact with which can be present or developed on the textile support impregnated with *iL* emulsions. Usually, a few constituents of selected emulsions, *i.e.* peroxides and hydro-peroxides, are instable compounds which can decompose in the storage period with formation of secondary oxidation products such as aldehydes, cetones and its derivatives with carbonyl chains of different lengths (Dănilă *et al*., 2019a; Zaharia *et al.*, 2019a). Peroxides does not have direct influence toward emulsions sensorial properties, but the formed aldehydes and cetones can modify the sensorial properties, *e.g.* odor or smell.

The experimental results indicate that the values of acidity indices were increased more than 4.798 times (4*L* emulsion) till 9.119 times (3*L* emulsion) demonstrating the presence of acidic groups such as possible carboxyl, carbonyl groups and/or other acidity-carrier groups resulted from the slow emulsion alteration. In addition, the values of peroxide indices were increased more than 1.855 times (4*L* emulsion) till 2.438 times (9*L* emulsion) demonstrating the formation of peroxides and hydro-peroxides by the slow oxidation of selected emulsions, but the odor of prepared emulsions was not significantly modified in the storage period of more than 8 months fact that demonstrates no cetones or aldehydes formation (caused of no presence of characteristic rancid smells).

Thus, it can suppose that only easy superficial primary oxidative and/or reductive alterations take place due to increasing of the values of acidity and peroxide indices, content of conjugated dienes and trienes (more than 1.024 times (4*L*) till 1.618 times (9*L*) for total conjugated dienes content and more than 0.929 times (4*L*) till 1.618 times (9*L*) for conjugated trienes content, fact demonstrating the increasing number of new C=C and C≡C bonds formed).

The decreasing of total polyphenols and flavonoids concentrations present in each emulsion composition during the storage period (*i.e.* more than 0.957 times (4*L*) till 2.096 times (3*L*) for total polyphenols content and more than 1.01-1.047 times for the total flavonoids content) indicates that these constituents are antioxidant agents with beneficial effects in fighting over the oxidative alteration, or have antibacterial effects.

3.2. Sensory Analysis for Selected (*iL*) Emulsions

The sensory properties of selected *iL* emulsions, *i.e.* adherence, consistency, emulsifying degree, stability and odor, are dependent of the chemical composition and characteristics of all integrated constituents in each emulsion. Generally, the sensorial characteristics are appreciated as result of different testings organized for a speciality commission (minimum five specialists) which evaluates the selected emulsions. In the present work, the five evaluated sensory properties of *iL* emulsions are the adherence, degree of emulsifying, stability in time, consistence and odor. Each specialist fulfills a report with individual scores for each sensorial property which can vary as value from 1 till 5.

The results of sensory analysis are synthesized in Fig. 2 for the prepared (*iL*) emulsions. After data processing, the most indicated emulsion to be used for impregnation of textiles for added value of designed products (*e.g.*, antibacterial activity of cotton or viscose products) (Radu *et al.*, 2017; Mureşan *et al.*, 2020) and anti-oxidative effects is the 4*L* emulsion, followed by 8*L* emulsion.

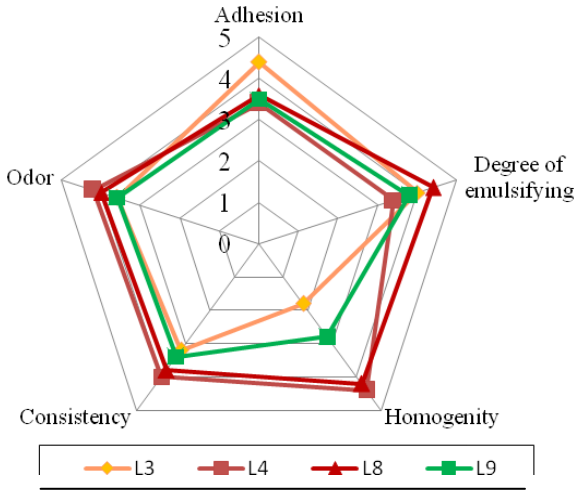


Fig. 2 – Diagram of sensory analysis for lavender oil-beeswax-based emulsions (*iL*).

These two emulsions (*4L* and *8L*) have the highest beeswax concentration (4*L*) and also high essential oil content (the highest essential oil content has the 8*L* emulsion). It seems that it is significant the beeswax concentration followed by the essential lavender content in the emulsion composition design.

4. Conclusions

1. A series of beeswax-essential lavender oil-based emulsions (*iL*, i = 1…9) were prepared for use to impregnate a few textile supports for added value to their designed textile products (*e.g.*, skin care benefits, antibacterial effects and aromatherapy). The studied *iL* emulsions were in-time controlled for a few physical-chemical quality indicators (more than 8 months) for finding of the most stable and corresponding emulsion to use for added-value textiles design.

2. The experimental results performed for the acidity index (*AI*) and peroxide index (*PI*) were permitted a few preliminary information concerning possible slow oxidation or oxidative alteration during the storage period at room temperature (1 and more than 8 months). Moreover, the results conclude the almost complete separation of aqueous and organic phases, the formation of a few primary oxidation products (hydroperoxides), but not formation of secondary oxidation products (aldehydes and cetones) with their specific odor.

3. The content of total conjugated dienes and trienes increases during the storage period at room temperature, indicating the increasing of double and triple carbon bonds in the prepared emulsion composition due to possible very slow reductive or oxidative alteration.

4. The potential antibacterial action of selected *iL* emulsions is mainly due to the satisfactory content of polyphenols and flavonoids, and all selected prepared *iL* emulsions are respecting the norms in cosmetics, pharmacy and textiles, especially for applications in added-value textiles manufacturing.

Acknowledgements. This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CCCDI – UEFISCDI, project no. 29/2018 COFUND-MANUNET III-AromaTex, project title "*Manufacturing of value-added textiles for aromatherapy and skin care benefits*", within PNCDI III.

REFERENCES

Dănilă A., Zaharia C., Şuteu D., Mureşan E.I., Lisă G., Karavana S.Y., Toprak A., Popescu A., Chirilă L., *Essential Mint Oil-Based Emulsions: Preparation and Characterization*, Industria Textila, **70**, *1*, 83-87 (2019a).

Dănilă A., Mureşan E.I., Zaharia C., Popescu A., Macarel V., *Beeswax-Based Emulsions for Topical Application*, Conference Proceedings of the 19th International Multidisciplinary Scientific EcoConference - SGEM 2019, 30 Iune - 6 July 20l9, Albena, Bulgaria, **19**, *6.1*, Nano, Bio, Green and Space Technologies for Sustainable Future, 43-50 (2019b).

Lamien-Meda A., Lamien C.E., Romito M., Millogo J.F., Nacoulma O.G., *Determination of the Total Phenolic, Flavonoid and Proline Contents in Burkina Fasan Honey, as well as their Radical Scavenging Activity*, Food Chemistry, **91**, *3*, 571-577 (2005).

Mureşan A., Zaharia C., Dănilă A., Șuteu D., Mureșan E.I., Popescu A., Chirila L., Doru R.C., *Preliminary Research on Preparation Emulsions Containing Essential Mint Oil*, Proceedings of the XXII[nd] International Scientific Conference - "INVENTICA 2018", Iaşi, June 28-29, Ed. Performantica, 27-34 (2018).

Mureșan E.I., Diaconu M., Zaharia C., Roșu G., Dănilă A., Pui A., *Bioactive Textiles Obtained by Using Aqueous Extracts of Vine Leaves*, *Fibers and Polymers*, accepted manuscript FIPO-D-19-01153, 1-8, ISSN 1875-0052 (2020).

Pontis J.A., Mendonça Alves da Costa L.A., da Silva S.J.R., Flach A., *Color, Phenolic and Flavonoid Content, and Antioxidant Activity of Honey from Roraima, Brazil*, Food Science and Technology, Campinas, No. 006158, ISSN 0101-2061 (2014).

Radu C.D., Cerempei A., Salariu M., Parteni O., Ulea E., Campagne C., *The Potential of Improving Medical Textile for Cutaneous Diseases*, In: IOP Conference Series: Materials Science and Engineering, **254**, 1-8 (2017).

Zaharia C., Dănilă A., Mureșan E.I., Șuteu D., *Emulsions Based on Rosemary Essential Oil – Beeswax System Used in Manufacturing of Value – Added Textiles for Skin Care Benefits*, Bul. Inst. Polit. Iaşi, Secţia: Chimie şi Inginerie Chimică, **65(69)**, *2*, 9-20 (2019a).

Zaharia C., Dănilă A., Mureșan E.I., Șuteu D., *Emulsions of Beeswax - Lavender Oil: Characteristics and Preliminary Analysis for Use in Manufacturing of Value-Added Textiles in Aromatherapy and Skin Care Benefits*, Book of Abstracts, Proceeding of the 11th International Conference of Applied Sciences "Chemistry and Chemical Engineering" – CISA 2019, May 22-24, 2019, Bacău, Romania, 39 (2019b).

Zaharia C., Dănilă A., Mureșan E.I., Mureșan A., *Study of Quality and in-Time Stability of Some Emulsions Based on Vegetal Essential Oils Used in Manufacturing of Products for Skin Care Benefits and Aromatherapy*, Proceeding of the 13rd International Symposion of Cosmetics and Aromatizing Products (Cosmetology – Essence of Beauty and Health), June 4-7, 2029, Iaşi, Romania, 31-34, in press (2019c).

EMULSII CEARĂ DE ALBINE – ULEI DE LAVANDĂ: CARACTERISTICI ȘI ANALIZA PRELIMINARĂ ÎN VEDEREA FOLOSIRII LOR LA FABRICAREA UNOR PRODUSE TEXTILE CU VALOARE ADĂUGATĂ

(Rezumat)

Această lucrare de cercetare prezintă rezultatele de la prepararea și analiza preliminară a unor emulsii pe bază de ceară naturală (ceară de albine) și ulei esențial de lavandă pentru câteva caracteristici de calitate (*i.e*. pH, densitate, indicele de aciditate, indicele de peroxid, conținutul de diene și triene conjugate, polifenoli totali, flavonoide și acizi grași totali) precum și analiza senzorială considerând drept criterii de selecție următoarele: aderența, gradul de emulsifiere, uniformitatea, consistența și mirosul. Aceste cercetări au permis recomandarea celei mai adecvate emulsii pentru impregnare pe materialul textil și detalii preliminare de proiectare a produsului textil recomandabil pentru fabricarea materialului textil cu valoare adăugată.