



EVALUATING THE MAJOR CONSTITUENTS OF TWO COMMERCIAL CLOVE OIL (*Syzygium aromaticum* L.) BRANDS IN IRAQ

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ABSTRACT

Syzygium aromaticum L. is important medicinal plant belong to the family Myrtaceae. Scientific studies about flavor variety in clove oil from Iraq are still limited, the aim of this research is to mark significant varieties of bioactive constituents in clove oil originated from Hemani and AL-Emad companies. Clove oils were collected from local market, GC-MS analysis was used to count bioactive components in both companies, major constituents were detected such as eugenol, caryophyllene, humulene in both but eugenol acetate was limited to AL-Emad, minor constituents also detected such as caryophyllene oxide in Hemani. Tetratetracontane was detected in AL-Emad oil that indicate contaminated with other plant substances or may be insects. The differences of the flavor are due to the variation in the concentration of caryophyllene.

Keywords: *Syzygium aromaticum*; Clove oil; Eugenol; Caryophyllene; Humulene.

1 INTRODUCTION

Syzygium aromaticum L. belong to the family Myrtaceae, it is native Indonesia specifically in Maluku Islands [1]. The name "clove" refer to the flower buds after drying it, this plant is in high demand for its medicinal and culinary uses, while it was cultivated for commercial purposes in Europe during the middle ages, it is currently produced primarily in Indonesia, India, West Indies, Sri Lanka, Tanzania and Madagascar [2]. Tanzania currently produces about 80% of the world's production [3]. Approximately 110 volatile components have been identified in the plant *S. aromaticum*, the major components of the volatile oil are eugenol, eugenyl acetate, caryophyllene, and humulene that identified in the essential oil by GC-MS [4]. Eugenol is a volatile compound ranging in color from colorless to light yellow, characterized by insolubility to water and strong flavor. Its known biological activities include, antibacterial, insecticidal, antiphlogistic, wound recovery, effective against viruses, effective antioxidant agent and have anticancer properties [5-8]. Eugenyl acetate is a compound derivative from eugenol that exhibits antibacterial, effective antioxidant agent, active to virulence factors, anticancer and antimutagenic [9-12]. Caryophyllene is a sesquiterpene soluble in alcohol, it has showed antibacterial, antiphlogistic, reduces stress, antioxidant, anticarcinogenic, effects of local anesthesia and have antitumor properties against various types of cancer [6, 9] [13-15]. Humulene is a sesquiterpene which shown

antiphlogistic and anticancer activity for several types of cancerous diseases [6] [14] [16, 17]. Clove taste can be described as a piquancy, acrid, and aromatic taste with low bitterness [18]. Scientific studies about flavor variety in clove oil between brands widespread in Iraq are still limited, there is a noticeable difference in taste, as the flavor is very sharp in the clove oil of Hemani, the aim of this research is to mark significant differences of bioactive constituents in clove oil originated from Hemani and AL-Emad companies and comparing them with previous studies.

2 MATERIALS AND METHODS

The work was conducted at the corporation of research and industrial development laboratory within Ibn Al-Bitar research center affiliated to the Iraqi ministry of industry and minerals. Research employed an Agilent 7820A gas chromatograph interfaced with a detector Agilent 5977E Mass Spectrometry, we used column HP-5MS Ultra Inert capillary column (30 m length x 250 μ m inner diameter x 0.25 μ m film thickness). Oven temperature was 60°C then heated to 180°C at 7°C/min, then increased from 180 to 280 °C at rate 8 °C/min, then post run for 3 minutes in 300 °C. The carrier gas was He 99.99 % with a flow rate of 1 mL/min. Injector GC Inlet Line Temperature was 250 °C and detector Aux heaters temperature was 310 °C. GC-MS was done by injecting 1 μ L of sample and using scan mode range: m/z 25-1000 and split less. Operating in electron ionization (EI), the mass spectrometer had an ionizing energy of 70 eV. The Bioactive compounds of clove oil were identified by comparing the results of the chromatogram with reference retention time using Wiley spectral databases.

3 RESULTS AND DISCUSSION

The results showed a variation in the concentration of the major compounds between clove oils from the brands (table 1), caryophyllene percentage was higher in Hemani than AL-Emad, therefore it caused the sharp flavor, Eugenol acetate was limited to AL-Emad, spicy flavor contributed with constituents like caryophyllene [19].

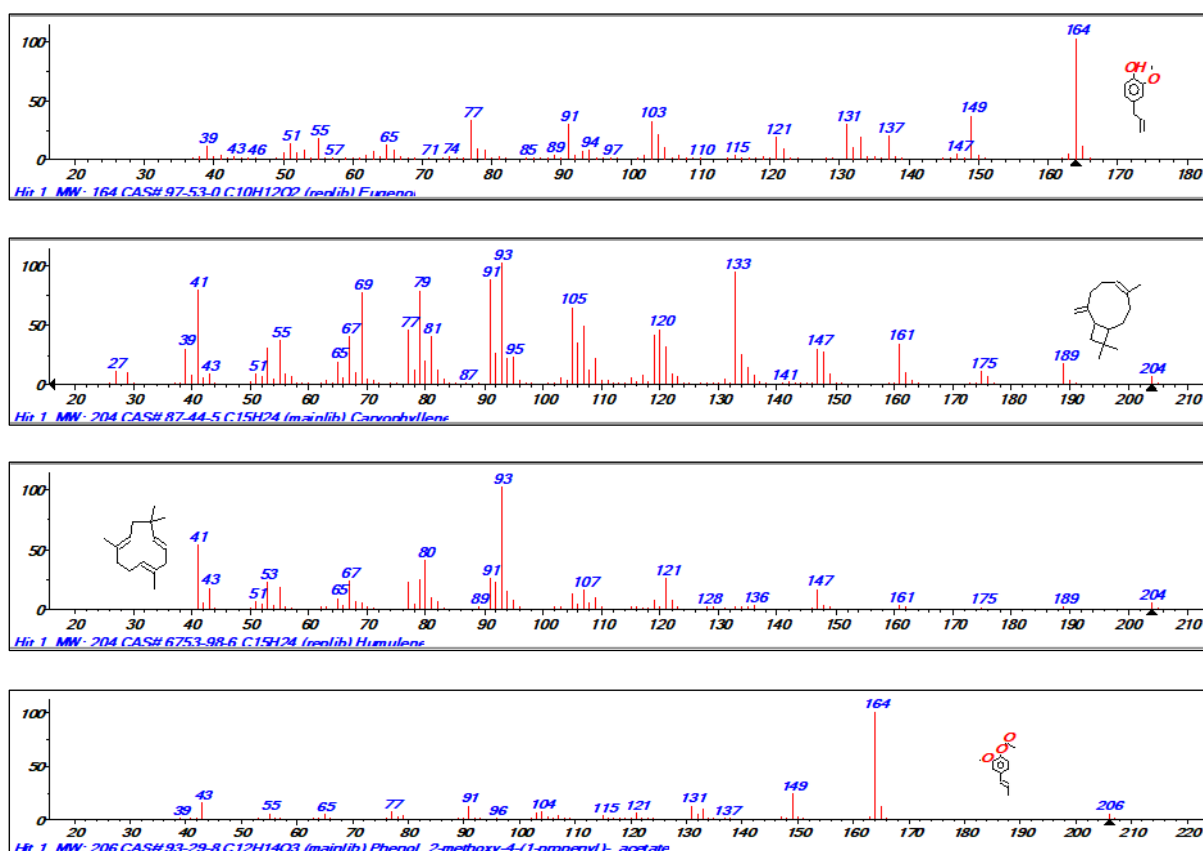


Figure 1: Mass spectrum of the major constituents of clove oil

Table 1: Major constituents of essential oils of clove

Constituents	RT (min)	Hemani	AL-Emad
Eugenol	14.526	70.50	74.35
Caryophyllene	15.776	23.83	10.21
Humulene	16.365	2.49	1.96
Eugenol acetate	17.603	-	2.22

Table 2: Major constituents of essential oil in clove from previous studies

Eugenol	Caryophyllene	Humulene	Eugenol acetate	Reference
87.00	3.56	0.40	8.01	[20]
60.50	7.50	1.70	7.00	[21]
46.53	43.03	4.61	2.54	[22]
51.51	36.20	4.26	2.64	
55.60	14.84	2.75	20.54	[23]
74.64	12.79	1.53	8.70	
60.95	2.74	0.33	34.44	[24]
56.69	2.45	0.37	39.05	
64.64	2.08	0.29	31.40	
66.01	19.88	3.75	4.55	[25]
84.63	2.31	0.32	11.37	[26]
63.79	10.43	-	8.48	[27]
96.25	1.66	0.16	1.88	[28]
68.51	16.93	-	10.35	[29]
59.11	5.51	0.79	33.73	[30]
41.40	10.42	2.73	7.21	[31]

All major compounds in the brands are in the range comparing with previous studies (table 2) except eugenol acetate wasn't notified in Hemani brand. Eugenol higher percentage was 96.25 [28] whereas caryophyllene and humulene higher percentage was 43.03, 4.61 respectively [22] in Shahi oils, the environment and areas of occurrence have strongly effect on the constituents of essential oil, therefore there are a variety in the flavor and percentages of chemical compounds [32]. Eugenol acetate higher percentage was 39.05 in oil of fresh clove [24] while it not appears in Hemani brand, it is likely that the low level of eugenol acetate is inversely proportional to the increase in the clove drying time.

Caryophyllene oxide detected in Hemani brand as minor constituents in RT 19.005 with percentage 1.69%, it is in the range of previous studies that ranged between 0.06 in [28] and 5.80 in [25] while it not detected in AL-Emad brand such as [21] [26, 27] A high initial caryophyllene content is associated with an increase in caryophyllene oxide during storage, as the latter forms through the oxidation of caryophyllene. This oxidation process and the resulting conversion of caryophyllene into caryophyllene oxide can lead to a decline in the quality of the essential oil [33].

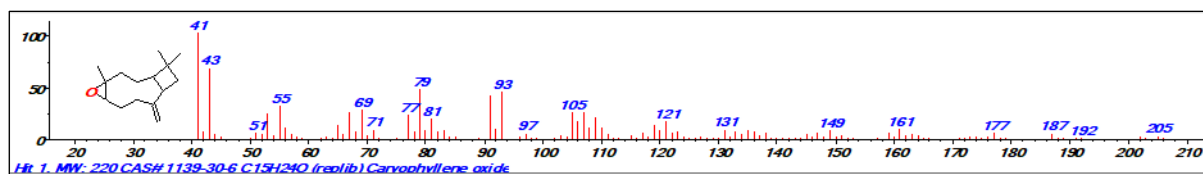


Figure 2: Mass spectrum of caryophyllene oxide

Tetratetracontane detected in AL-Emad brand as minor constituents in RT 27.947 with percentage 2.24%, all previous studies mentioned in (table 2) didn't showed this compound, so that indicate contaminated with other plant substances or may be insects.

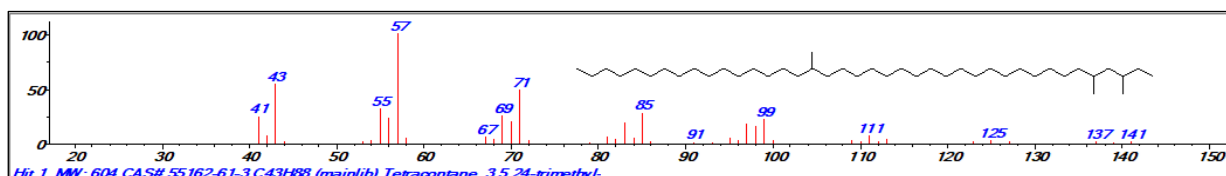


Figure 3: Mass spectrum of Tetratetracontane

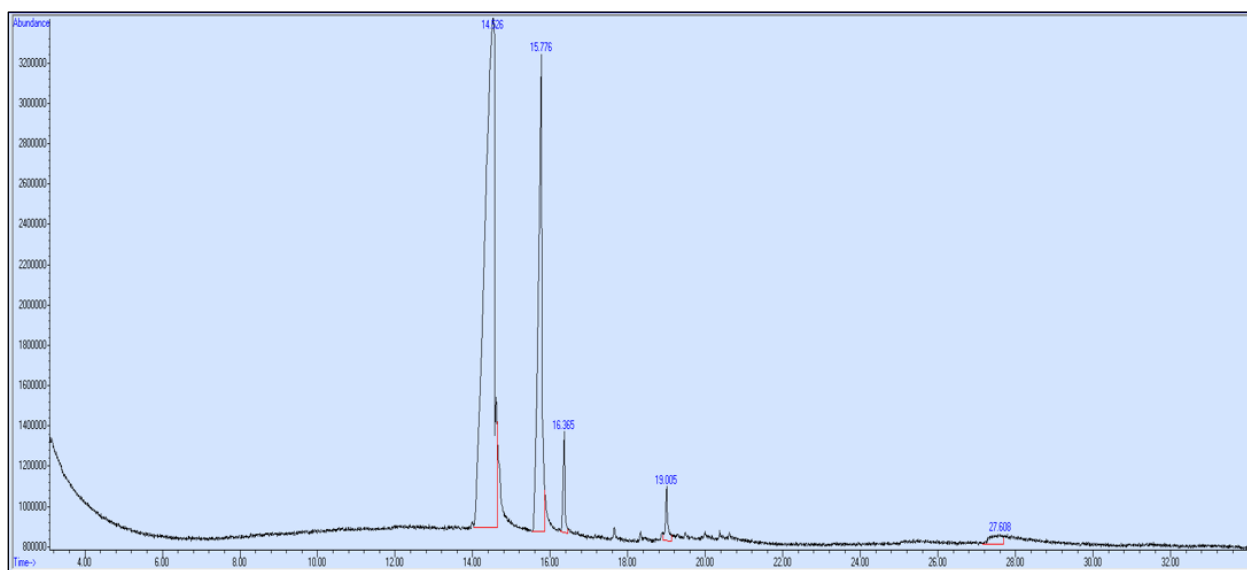


Figure 4: Gas chromatogram of clove oil from Hemani brand

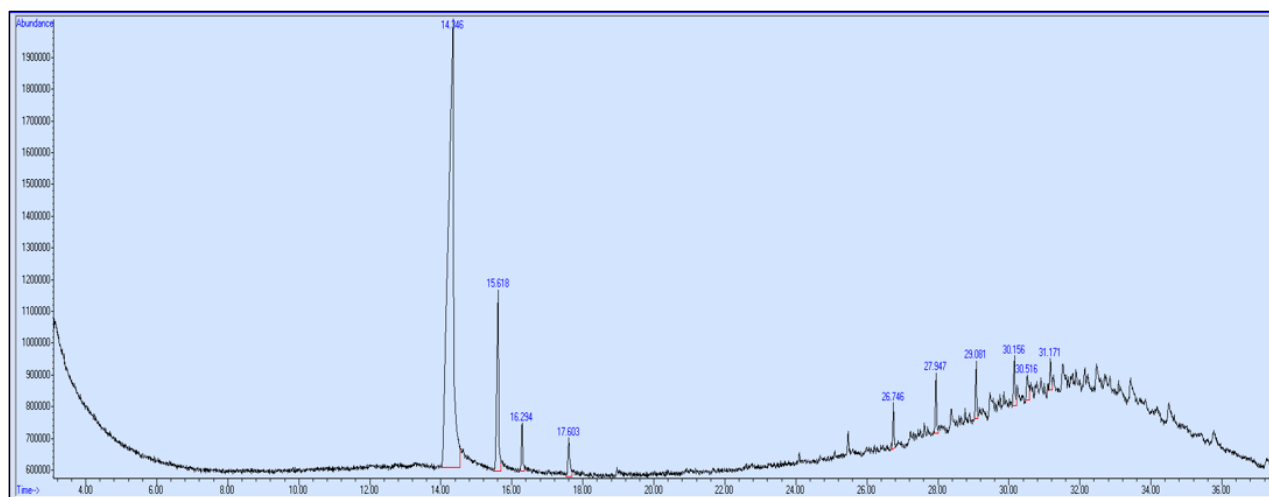


Figure 5: Gas chromatogram of clove oil from AL-Emad brand

4 CONCLUSION

Major constituent's percentages of clove essential oils are variety depend on the environment and areas of occurrence that affect the flavor. Occurrence of caryophyllene oxide is related to storage period. Presence of tetratetracontane indicate contaminated with other plant substances or may be insects.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

REFERENCES

- [1] Batiha GE-S, Beshbishy AM, Tayebwa DS, Shaheen HM, Yokoyama N, Igarashi I. Inhibitory effects of *Syzygium aromaticum* and *Camellia sinensis* methanolic extracts on the growth of *Babesia* and *Theileria* parasites. *Ticks Tick Borne Dis.* 2019;10(5):949-58.
- [2] Kamatou GP, Vermaak I, Viljoen AM. Eugenol—from the remote Maluku Islands to the international market place: a review of a remarkable and versatile molecule. *Molecules.* 2012;17(6):6953-81.
- [3] Cortés-Rojas DF, De Souza CRF, Oliveira WP. Clove (*Syzygium aromaticum*): a precious spice. *Asian Pacific journal of tropical biomedicine.* 2014;4(2):90-6.
- [4] Xue Q, Xiang Z, Wang S, Cong Z, Gao P, Liu X. Recent advances in nutritional composition, phytochemistry, bioactive, and potential applications of *Syzygium aromaticum* L.(Myrtaceae). *Frontiers in Nutrition.* 2022;9:1002147.
- [5] Frohlich PC, Santos KA, Palu F, Cardozo-Filho L, da Silva C, da Silva EA. Evaluation of the effects of temperature and pressure on the extraction of eugenol from clove (*Syzygium aromaticum*) leaves using supercritical CO₂. *The Journal of Supercritical Fluids.* 2019;143:313-20.
- [6] Yang Y-C, Wei M-C, Hong S-J. Ultrasound-assisted extraction and quantitation of oils from *Syzygium aromaticum* flower bud (clove) with supercritical carbon dioxide. *Journal of Chromatography A.* 2014;1323:18-27.
- [7] Khalil AA, Rahman Uu, Khan MR, Sahar A, Mehmood T, Khan M. Essential oil eugenol: Sources, extraction techniques and nutraceutical perspectives. *RSC advances.* 2017;7(52):32669-81.
- [8] SUGIHARTINI N, Prabandari R, YUWONO T, RAHMAWATI DR. The anti-inflammatory activity of essential oil of clove (*Syzygium aromaticum*) in absorption base ointment with addition of oleic acid and propylene glycol as enhancer. *International Journal of Applied Pharmaceutics.* 2019:106-9.
- [9] Guan W, Li S, Yan R, Tang S, Quan C. Comparison of essential oils of clove buds extracted with supercritical carbon dioxide and other three traditional extraction methods. *Food Chemistry.* 2007;101(4):1558-64.
- [10] Banerjee K, Madhyastha H, Sandur R, NT M, Thiagarajan P. Anti-inflammatory and wound healing potential of a clove oil emulsion. *Colloids Surf B Biointerfaces.* 2020;193:111102.
- [11] Cansian R, Vanin A, Orlando T, Piazza S, Puton B, Cardoso R, et al. Toxicity of clove essential oil and its ester eugenyl acetate against *Artemia salina*. *Braz J Biol.* 2016;77(01):155-61.

- [12] Musthafa KS, Hmoteh J, Thamjarungwong B, Voravuthikunchai SP. Antifungal potential of eugenyl acetate against clinical isolates of *Candida* species. *Microbial pathogenesis*. 2016;99:19-29.
- [13] Kennouche A, Benkaci-Ali F, Scholl G, Eppe G. Chemical composition and antimicrobial activity of the essential oil of *Eugenia caryophyllata* cloves extracted by conventional and microwave techniques. *Journal of Biologically Active Products from Nature*. 2015;5(1):1-11.
- [14] Lesgards JF, Baldovini N, Vidal N, Pietri S. Anticancer activities of essential oils constituents and synergy with conventional therapies: a review. *Phytotherapy Research*. 2014;28(10):1423-46.
- [15] Zhou L, Zhan M-L, Tang Y, Xiao M, Li M, Li Q-S, et al. Effects of β -caryophyllene on arginine ADP-ribosyltransferase 1-mediated regulation of glycolysis in colorectal cancer under high-glucose conditions. *Int J Oncol*. 2018;53(4):1613-24.
- [16] Ambrož M, Šmatová M, Šadibolová M, Pospíšilová E, Hadravská P, Kašparová M, et al. Sesquiterpenes α -humulene and β -caryophyllene oxide enhance the efficacy of 5-fluorouracil and oxaliplatin in colon cancer cells. *Acta Pharmaceutica*. 2019;69(1):121-8.
- [17] Langhasova L, Hanusova V, Rezek J, Stohanslova B, Ambroz M, Kralova V, et al. Essential oil from *Myrica rubra* leaves inhibits cancer cell proliferation and induces apoptosis in several human intestinal lines. *Industrial Crops and Products*. 2014;59:20-6.
- [18] Begum A, Sain M, Singh A. Bioactive Compounds in Clove. *Spice bioactive compounds: CRC Press*; 2022. p. 137-64.
- [19] Sukandar D, Radiastuti N, Khoeriyah K. Karakterisasi Senyawa Aktif Anti Bakteri Minyak Atsiri Bunga Cengkeh (*Syzygium Arimaticum*). *Indonesian Journal of Applied Chemistry*. 2010;12(1):107667.
- [20] Alma MH, Ertas M, Nitz S, Kollmannsberger H. Chemical composition and content of essential oil from the bud of cultivated Turkish clove. 2007.
- [21] Merchán Arenas DR, Muñoz Acevedo A, Vargas Méndez LY, Kouznetsov VV. Scavenger activity evaluation of the clove bud essential oil (*Eugenia caryophyllus*) and eugenol derivatives employing ABTS+• decolorization. 2011.
- [22] Hossain MA, Al-Hashmi RA, Weli AM, Al-Riyami Q, Al-Sabahib JN. Constituents of the essential oil from different brands of *Syzygium caryophyllatum* L by gas chromatography–mass spectrometry. *Asian Pacific Journal of Tropical Biomedicine*. 2012;2(3):S1446-S9.
- [23] Amelia B, Saepudin E, Cahyana AH, Rahayu D, Sulistyoningrum A, Haib J, editors. GC-MS analysis of clove (*Syzygium aromaticum*) bud essential oil from Java and Manado. *AIP conference Proceedings*; 2017: AIP Publishing LLC.
- [24] Hastuti L, Saepudin E, Cahyana AH, Rahayu D, Murni V, Haib J, editors. The influence of sun drying process and prolonged storage on composition of essential oil from clove buds (*Syzygium aromaticum*). *AIP Conference Proceedings*; 2017: AIP Publishing LLC.
- [25] G. Al-Hashimi A, Ammar AB, G L, Cacciola F, Lakhssassi N. Development of a millet starch edible film containing clove essential oil. *Foods*. 2020;9(2):184.
- [26] Uchôa Lopes CM, Saturnino de Oliveira JR, Holanda VN, Rodrigues AYT, Martins da Fonseca CS, Galvão Rodrigues FF, et al. GC-MS analysis and hemolytic, antipyretic and antidiarrheal potential of *Syzygium aromaticum* (Clove) essential oil. *Separations*. 2020;7(2):35.
- [27] Kiromah NZW, Sugihartini N, Nurani LH. Development and characterization of clove oil microemulsion. *Pharmacia*. 2023;70:233-41.
- [28] Sarraimi S, Akrami Mohajeri F, Sadeghizadeh-Yazdi J, Jambarsang S, Khalili Sadrabad E. Chemical composition and antioxidant activity of clove essential oil and its effect on stability of sesame oil under accelerated condition. *Journal of Nutrition and Food Security*. 2023;8(3):343-52.
- [29] Abdou A, Ennaji H, Maaghloud FE, El Azhary K, Badou A, Elmakssoudi A, et al. In silico and in vivo anti-inflammatory effect of eugenol and acetyleugenol. *Scientific African*. 2024;24:e02205.
- [30] Akotowanou OC, Adjou ES, Aboudou K, Olubi AB, Sessou P, Michels F, et al. GC-MS Analysis of Clove Essential Oil (*Syzygium aromaticum* L.) as Effective Source of Biomolecules for Traditional Tomato Puree Quality Improvement. *Advances in Molecular Imaging*. 2024;13(4):39-49.
- [31] Abdelmuhsin AA, Sulieman AME, Salih ZA, Al-Azmi M, Alanaizi NA, Goniem AE, et al. Clove (*Syzygium aromaticum*) pods: revealing their antioxidant potential via GC-MS analysis and computational insights. *Pharmaceutics*. 2025;18(4):504.
- [32] Surburg H, Panten J. Common fragrance and flavor materials: preparation, properties and uses: John Wiley & Sons; 2016.
- [33] Argyropoulos D, Müller J. Changes of essential oil content and composition during convective drying of lemon balm (*Melissa officinalis* L.). *Industrial Crops and Products*. 2014;52:118-24.