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Residual Waste of Boswellia Carterii Aromatic Oil Distillation as a Source of Natural Flavors

Lamiaa A. Gharb
Department of Biology, College of Science, Baghdad University, Baghdad, Iraq.

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Abstract

Nowadays, many researchers and industries prefer natural flavors over chemical ones. The main focus of the current research is to determine the flavoring compounds and terpenoids of by-products resulting from Boswellia carterii oleo-gum resin distillation, in addition to identifying active compounds in its essential oil. Aromatic oil was extracted from oleogum resin by using a Clevenger apparatus. In addition to the supernatant layer, which represents residual waste, was isolated by filtration. Both aromatic oil and residual waste were subjected to Gas chromatographic–mass spectral (GCMS) analysis. The results showed that B. carterii oil contains fourteen main active compounds, which include different terpenoid compounds. On the other hand, n-Octyl acetate (60.25%) represents the major components in this volatile oil. Residual waste analysis showed fifteen main active compounds, and the sesquiterpenoid compound 3,5,6,7,8,8a-Hexahydro-4,8a-dimethyl-6-(1-methylethenyl)-2(1H) naphthalenone was the major component with (17.23%) percent. The results indicated that both of essential oil and the upper layer of B. carterii (olibanum) residual waste were rich in valuable terpenoids and flavoring compounds, so waste could be used as an eco-friendly and natural source of these compounds with no cost.

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*Corresponding author: lamya.gharb@sc.uobaghdad.edu.iq

1. Introduction

Aromatic oils or volatile oils are considered as organic substances which derived from various plant areas: leaves, flowers, fruits, seeds, and resin. One of the traditionally important secondary metabolites in plants is aroma-active volatiles, which are employed for their flavors and fragrances in pharmaceutical, food, as well as perfumes sectors to enhance the quality [1]. Among the many biological applications of aromatic oils is their use in feed mixtures instead of growth-promoting antibiotics [2]; antibacterial activities [3, 4, 5]; antioxidant and antibiofilm [6]. However, a lot of waste material has emerged, and there are still a lot of active chemical compounds from the extraction of aromatic oils [7]. By-products from some medicinal plants were used for different purposes like insecticidal agent [8]; Plant growth promoter [9]; antibacterial [10]; and antioxidants [11]. *Boswellia,* a member of the Burseraceae family, contains olibanum or frankincense, which is a substance that the tree's trunk excretes. Terpenoids, gum, and essential oils make up this resin [12]. The main components of *B. carterii* are terpenoids and aromatic oils [13]. Terpenes are widely used as anti-microbial, anti-viral, anti-oxidant, and analgesic as well as to use these compounds as flavoring substances for food and as health factors that operation in fermented foods [14]. Sesquiterpenes represent a large and extremely important active compounds, both to peoples and to the plants themselves [15]. The volatile compounds in plants could serve as aroma and flavor particles because of their communication with human receptors. However, the demand for natural aroma chemicals by perfumers and flavor workers is growing fast [16]. The by-product wastes generated during the process of some essential oil distillation are still not well known. Therefore, this study aimed to determine the flavoring contents of waste materials resulted in the essential oils extraction process during *Boswellia carterii* oleo-gum resin distillation as well as identification the active compounds in its essential oil.

2. Materials and methods

2.1. Aromatic oil extraction

The aromatic oil was obtained by using a Clevenger apparatus. Hydro distillation was done according to the method mentioned in [17]. 250 gm from oleo-gum resin was kept in a refrigerator for a duration (1-12) hours. The gum resin was ground to have a fine powder and was mixed with 2.5 liters of distilled water for a duration (1-8) hours. The volatile oil was kept in a cold storage until used for chemical screening.

2.2. Preparation of residual waste

Olibanum hydro-distilled residue contains: An off-white mixture and a thin top layer of yellow resinous with oily drops. In this study only the supernatant layer was isolated by filtration and cooled and then was kept in a cold storage for a duration (1-24) hours. An appropriate amount from the top layer was dissolved in hexane and then subjected to GC-MS analysis.

2.3. Gas chromatographic–mass spectral (GC-MS) analysis of olibanum volatile oil and residual waste

Chemical components in *Boswellia carterii* aromatic oil and hexane extract of residual waste were identified by utilizing GC-MS (Shimadzu GC-MS-QP2010 Plus). Helium was the carrier gas at (13ml.min^{-1} flowing rate. The splitting ratio of samples injection was 5.0 and the temperature of injector was (280°C). The column flow was 1.69 ml.min^{-1} and total flow-rate was 13.1ml.min^{-1}. The temperature of column oven was 50°C and the hold time was 2-5 min. The running time was 30-50 minutes [2].

3. Results and discussion

3.1. GC-MS analysis of Boswellia carterii (olibanum) volatile oil

The chromatogram (figure.1) of olibanum oil analysis showed the presence of 47 compounds.

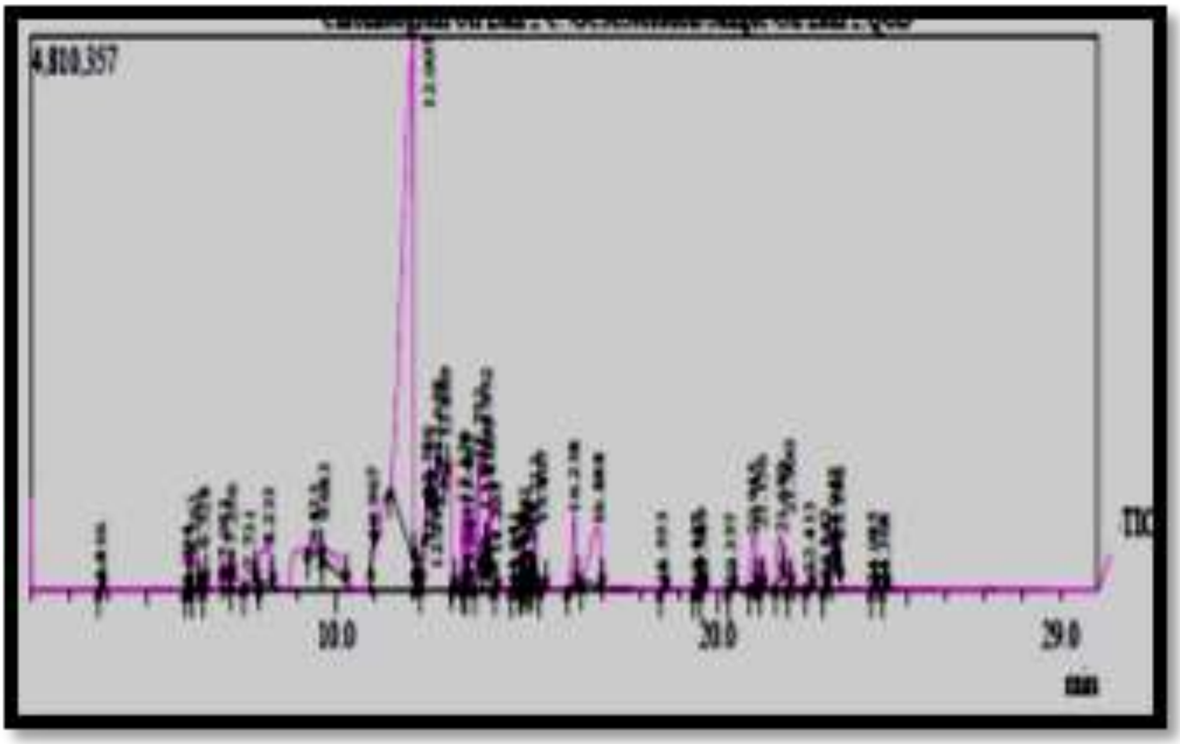

Figure 1: GC-MS Chromatogram of *Boswellia carterii* volatile oil

Fourteen active compounds with their percentage were listed in (Table 1). These compounds including different terpenoids compounds. On the other hand, n-Octyl acetate (60.25%) represent the major components in this volatile oil and it represent a flavor ester according to [18]. These results fall in with the finding of Huang *et al.* [19] which referred that aromatic oil from *B. carterii* includes monoterpenes, sesquiterpenes, and ester compounds.

Table 1: Active chemical compounds in Boswellia carterii volatile oil.

Peak no.	Compound name	Composition%	Class of compound
3	alpha.-Pinene	1.80	Monoterpene
5	Sabinene	0.52	bicyclic monoterpene
7	Acetic acid, hexyl ester	1.13	Esters
8	D-Limonene	3.57	Monoterpene
10	2-methyl-5-prop-1-en-2-yl-7-oxabicyclo[4.1.0]heptan-2-ol	2.77	Alcohol
12	n-Octyl acetate	60.25	Esters
19	Citronellyl acetate	1.23	Monoterpene
21	Geranyl acetate	5.78	Monoterpene
24	1-Dodecanol acetate	1.28	Esters
30	Humulen-(v1)	1.33	Sesquiterpene
32	Octanoic acid, hexyl ester	1.95	Esters
33	2-hydroxy-2-(4-methoxyphenyl)-*N*-methylacetamide	6.64	Amide
38	Cyclohexane, 2,4-diisopropenyl-1-methyl-	2.02	Cyclohexane
40	Verticillol	2.29	Diterpene alcohol

α-Pinene is the most abundant terpene in nature. It utilizes in cosmetics and also as a flavoring agent [21]. It could be also used to treat various inflammatory diseases [22]. On the other hand, [23] referred that acetate of geranyl represents the typical and important geranyl ester, which has a lemon taste and the scent of some flowers, that used as significant flavor substance. Dabiri et al. [24] indicated that acetate of Citronellol is a liquid which neutral in color and has a lime fruit smell which represent an important section of the flavors and fragrances. Thus, acetate ester of citronellol is extensively employed in different industrial sectors. As well as to the use of Hexyl acetate that has a fruity odor as identical flavoring agent [25]. In the recent years plant natural products gained special interest to be used as an alternatives for artificial additives of pharmacological agents especially the essential oils from aromatic plants that are used as green alternatives in flavoring, pharmaceutical, agricultural and other fields [20].The structures of the active chemical compounds in *B. carterii* (olibanum) volatile oil illustrated in (figure 2).

3.2. GC-MS analysis of Boswellia carterii residual waste

The chromatogram (figure 3) of olibanum waste analysis showed the presence of thirty-seven compounds. Fifteen active compounds with their percentage were listed in (Table 2). The results showed that the sesquiterpenoids compound 3,5,6,7,8,8a-Hexahydro-4,8 dimethyl-6-(1-methylethenyl)- 2(1H) naphthalenone was the major components with (17.23%) percent, followed by the compound 1S,6R,9S)-5,5,9, tetramethyltricyclo [7.3.0.0(1,6)]dodec-10(11)-ene(16.59%) percent. The study outcomes demonstrated that the upper layer of *B. carterii* (olibanum) waste was rich in terpenoids especially sesquiterpens like caryophyllene oxide. β-caryophyllene is a natural compound was accepted by the administration of Food and Drug as well as to the Authority of European Food Safety and it is used to enhance flavors [26]. Terpenoids are a broad class of plant natural compounds which represented the main material of aromatic oils and are extensively used as fragrances and flavors [27]. On the other hand, according to the administration of Food and Drug: the compound n-Octyl acetate can be used as flavoring agent or adjuvant. The results also showed the presence of Viridiflorol which is an organic volatile that may work against cancer cells [28]. The structures of the active chemical compounds in *Boswellia carterii* (olibanum) residual waste illustrated in (figure 4).

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Table 2: Active chemical compounds in upper layer of Boswellia carterii waste.

Peak no.	Compound name	Composition%	Class of Compound
2	n-octyl acetate	6.47	Esters
8	alpha.-farnesen	0.78	Sesquiterpenoids
10	1,5,9-trimethyl cyclododecatriene	3.87	cyclic trienes
11	spiro[androst-5-ene-17,1'-cyclobutan]-2'-one, 3-hydroxy-, (3.beta.,17.beta.)-	2.90	Steroid compound
13	verticillol	5.44	diterpene alcohol
15	viridiflorol	11.60	Sesquiterpene
16	isoaromadendrene epoxide	1.46	Sesquiterpene
17	2,6,10-dodecatriene-1,12-diol, 2,6,10-trimethyl-, 12-acetate,	3.82	Esters
20	caryophyllene oxide	4.96	bicyclic sesquiterpene
22	1,1-dimethyl-2-allylcyclopropane	10.04	Cycloalkane
25	pregnan-3,11-diol-20-one	1.44	Steroid compound
33	1-octanol, 2-nitro-	6.35	
34	3,5,6,7,8,8a-hexahydro-4,8a-dimethyl6-(1-methylethenyl)-2(1h)naphthalenone	17.23	Sesquiterpenoids
35	1,1,4b,5-tetramethyl-h,h,1h,2h,3h,4h,4bh,7h,7bh-cyclopenta[d]indene	16.59	Organic compound
36	9,19-cycloergost-24(28)-en-3-ol, 4,14-dimethyl-,	1.03	Sterol

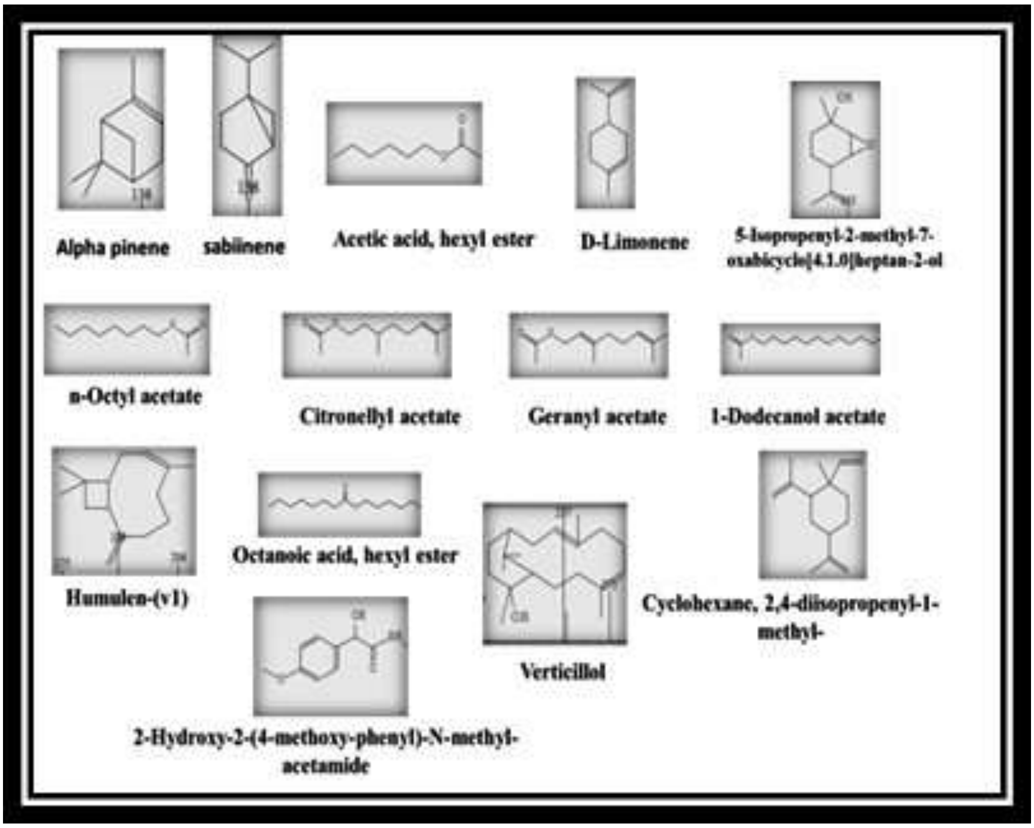

Figure 2: Structures of chemical compounds in *Boswellia carterii* volatile oil.

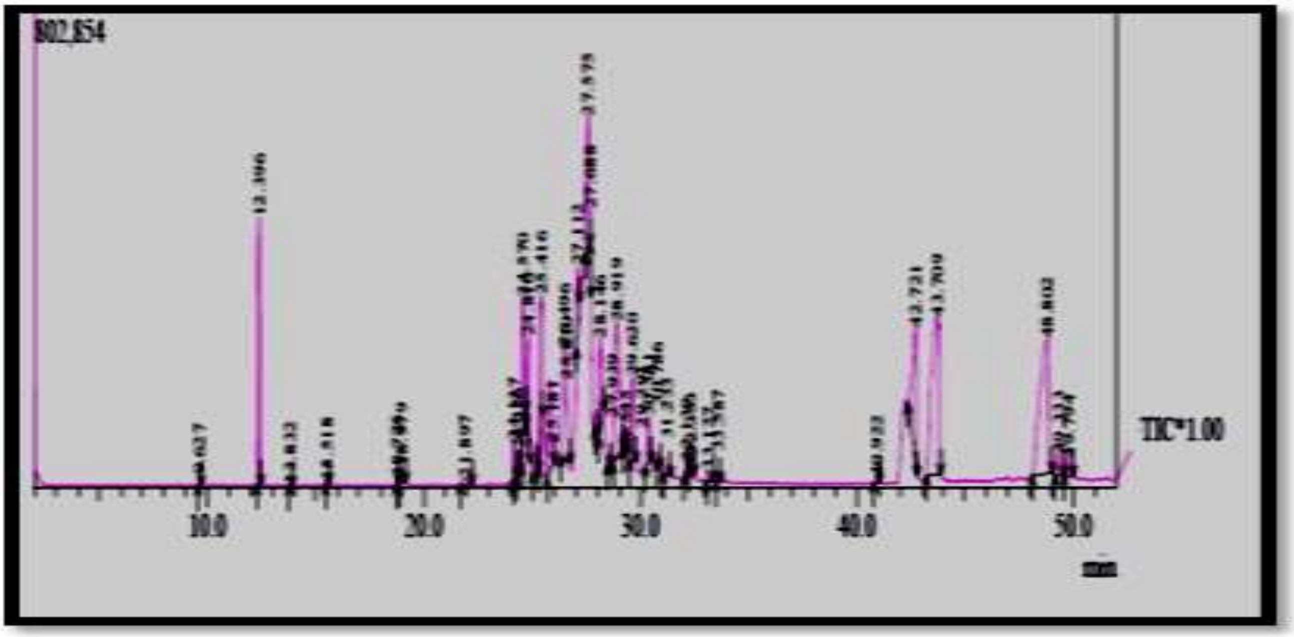

Figure 3: GC-MS Chromatogram of upper layer of *Boswellia carterii* waste.

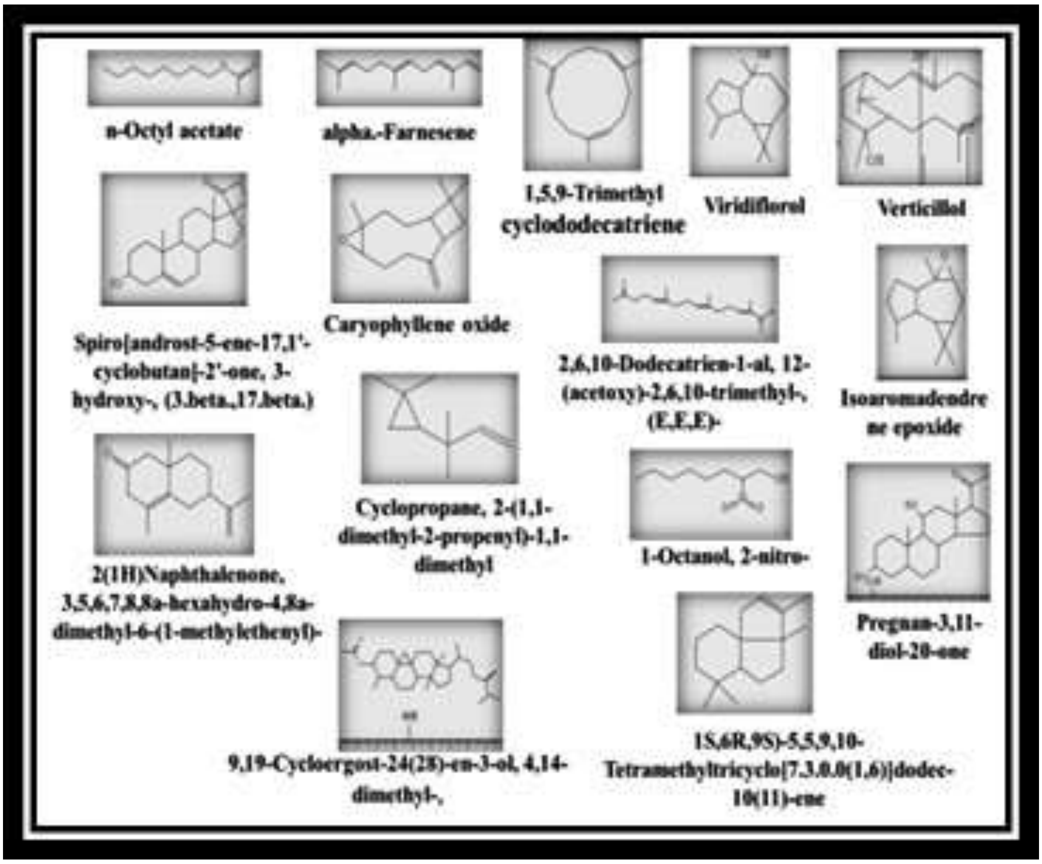

Figure 4: structures of chemical compounds in *Boswellia carterii* (olibanum) residual waste.

4. Conclusions

The results indicated that both of essential oil and upper layer of *B. carterii* (olibanum) residual waste were rich in valuable terpenoids and flavoring compounds, so waste could be used as eco- friendly, natural source of these compounds with no cost and it could be used as a food additive and preservative.

Conflict of interest: The author declares no conflict of interest

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