Journal of Medicinal Plants and By-products (2016) 1: 39-44

Original Article

Comparison of Essential Oils Compositions of *Boswellia carteri* Birdwood as a Food and Non-food in Different Distillation from Iranian Market

Azam Ranjbar Dounchaly[1*], Kamkar Jaimand[2] and Shahla Mozaffari[1]

[1]*Department of Chemistry, Payame Noor University, Tehran, Iran*
[2]*Phytochemistry Group, Department of Medicinal plants & By-products, Research Institute of Forests and Rangelands, Tehran, Iran*

Article History: Received: 21 September 2015/Accepted in revised form: 06 February 2016

Abstract

The genus *Boswellia* is one of the 17 genera belonging to Burseraceae family. In this study resin of *Boswellia carteri* birdwood collected or purchased from Tehram herbal Market as a food and non-food for chemical analysis. The essential oils of the resins of *Boswellia carteri* birdwood obtained by different methods of distillation (water distillation, steam distillation and hydro-steam distillation), the composition of essential oils was analyzed by gas chromatography (GC) and gas chromatography, coupled to mass spectrometry (GC-MS). The major components of the different methods of distillation oils of *Boswellia carteri* birdwood as a non-food by hydro-steam distillation were dihydro citronellol acetate (48%), 2-phenyl ethyl anthranilate (11.5%), α-santonine (7.7%), and with water distillation were dihydro citronellol acetate (48.2%), borneol (8.6%), methyl decanoate (7.9%), and with steam distillation were dihydro citronellol acetate (60.6%), borneol (9.7%), (Z)-β-ocimene (5.3%), respectively. Also the major components of *Boswellia carteri* birdwood as a food by hydro-steam distillation were dihydro citronellol acetate (55.6%), α-santonine (9%), 2-phenyl ethyl anthranilate (7.3%), and with water distillation were dihydro citronellol acetate (63.7%), borneol (9.1%), 2-phenyl ethyl anthranilate (3%), and with steam distillation were dihydro citronellol acetate (55.9%), (E)-phytol acetate (7.5%), borneol (7.3%), were the predominant major compounds respectively.

Keywords: *Boswellia carteri* birdwood, Distillation, Essential oil, Chemical composition

Introduction

From very early ages of history, plants and plant products have been the primary source of food, shelter and transport materials, clothing, fragrances, flavours and ingredients of medicinal substances for human kind. For at least 5000 years olibanum had been an important trade material for the civilizations located in North Africa and the Arabian Peninsula. It has been a precious commercial material even before Christian times because of the interest in this incense material of the old kings and queens like the Queen of Saba 700 B.C. With the dawn of Christianity, it was mentioned in the Bible as one of the presents which the three wise men had brought to Jesus on the night he was born, besides myrrh and gold. The wide useof this resin in religious ceremonies as incense material is still important in the Roman Catholic, Episcopal and eastern Orthodox churches that turn into an economical priority for countries like Somalia, Ethiopia, Oman, South Arabia and India in the production and import of olibanum, to western countries [1]. *Boswellia carteri* birdwood, is a decidious, gum-producing, multipurpose perennial tree, which is tapped on the stem for a kind of oleo-gum called "olibanum" (true frankincense) [1-4]. This gum resin is used in medicinal preparations for the treatment of amenorrhoea. It is also used in treatment of diarrhea, asthma, and bronchitis [5,6]. The

[*] Corresponding author: Department of chemistry, Payame Noor University, P.O. Box 19395-3697 Tehran, IRAN.
Email Address: shranjbar4@yahoo.com

Boswellia plants are known to contain several acidic triterpenes, some of which show analgesic, immunosuppressant, antileukemic, hepatoprotective, and anti-inflammatory activities. Most of these activities are based on the inhibition of the enzyme 5-lipoxygenase [7,8]. Incensole acetate, a novel anti-inflammatory compound isolated from *Boswellia* resin, inhibits nuclear factor-kappa B activation.

Being a natural product, frankincense varies greatly in its ingredients. These variations can also be found in different varieties of the *Boswellia* tree; whose botanical classification is:

Division: Spermatophyta
Sub-division: Angiospermae
Tribe: Rosopsida
Sub-tribe: Rosidae s. lat.
Super-class: Rutanae
Class: Anacardiales
Family: Burseraceae Genus *Boswellia*

The species are [9]: *B. sacra*, also known as *Boswellia* Roxo or B. carter Birdw; *B frereana*, also known as "Elenni frankincense"; *B. serrata*, also known as "Indian frankincense"; *B. papyrifera*, also known as: "Ethiopian frankincense" (syn: *Amyris papyrifera*); *B. rivae*; *B. neglecta*.; and about 10 more species.

It is interesting to note that some literature reports mention *B. sacra* Birdw. (synonym *B. carteri*) to be different species [2,10]. This may be explained by the fact that frankincense is cultivated in different countries by various means. Furthermore, the quality of frankincense is defined by geographical trade names and not by the botanical

classification [9,11]. Frankincense or olibanum is a plant product. It is an oleo-gum-resin produced by several species of tree belonging to the *Boswellia*, which is characterized by resin bearing ducts. To obtain frankincense, the bark of the tree is cut several times to allow a white milky resin to seep from the wounds. The resin is left on the tree to dry in the sun for a few days, after which the so called resin tears are scraped off. The color of the resin varies from light yellow to dark brown. The resin tears consist of [11] 60% resin (of which 50% are boswellic acids), 29% rubber, 6-8% bassorine, 5-15% essential oils, 0.5% bitter and nuciliage compounds.

Burseraceae is a family represented by 17 genera and 500-600 species, wide spread in all tropical regions and extended to sub-tropics. They are trees or shrubs often spiny, often with latex, resins or oils which are strongly aromatic. It is often a dominant constituent of the vegetation in dry lowland areas. In Ethiopia two genera (Boswellia and Commiphora) and 58 species are present. Today plant based products, essential oils, plant extracts, natural resins and their preparations have a wide range of applications mainly in perfume and cosmetic industry, in food technology, in aroma industry and in pharmaceutical industry. This large spectrum of uses stimulated the researcher to study on natural products [12-15].

Frankincense or olibanum is the oleo-gum resin harvested from several different trees belonging to the genus *Boswellia*. The word frankincense is derived from the old French name ''frank encense", meaning ''pure incense''. Frankincense is also known in Arabic as ''luban'', which means ''white'' or ''cream'', in Greek ''libanos'' and in Ethiopia ''etan'' [15-17]. *Boswellia carteri* birdwood is from the family Burseraceae. It is a small tree indigenous to northeast Africa and is found in southern Arabia and Iran. The oleo-gum-resin of this plant, which is called "morre-makki" has been used to treat and prevent infections (as antiseptic, in urinary disorders and skin diseases, for treatment of gonorrhea and for nasal catarrh and bronchitis) and to heal wounds. It is also used as aromatic for perfumes, in funerals, and as an insect repellent [18]. *Boswellia sacra* Flueck [Syn.: *B. carterii* Birdw., *B. bhaw-dajiana* Birdw. and *B. undulate crenata* (Engl.) Engl.] belongs to Burseraceae. The plant's oleo-gum-resin is called "kondor" in Persian and frankincense in English. It is routinely used in Persian folk medicine to heal wounds and treat infectious diseases (diarrhea, dysentery, urinary disorders, gonorrhea and bronchitis). It is burned with *Peganum harmala* to form smoke that acts as an air freshener and disinfectant. Reports have indicated that the oleo-gum-resin obtained from *B. sacra* (*B. carterii*) has neuroprotective, immunomodulatory [19], antioxidant [20] and anti-inflammatory [21] properties. Some studies have reported antimicrobial properties of the essential oils obtained from different species of *Boswellia genus*; there has been no study about the different fractions of this oleo-gum-resin. [22,23].

Frankincense has a wide use including incense in homes, formulation of a number of modern perfumes and as medicine. Its volatile oils have their own characteristic balsamic odors. Both resinoids (obtained by hydrocarbon extraction) and absolutes (obtained by alcoholic extraction) are used as fixatives and additives in perfumes [15].

Olibanum is also used as components of adhesive plasters and fumigation powders, in chewing gums, ingredients for lotions, soaps, detergents and creams [15-17]. Frankincense is a complex mixture composed of about 5-9% highly aromatic essential oil (mono-and sesquiterpenes), 65-85% alcohol soluble resins (diterpenes, triterpenes), and the remaining water-soluble gums (polysaccharides) [15]. Mono-and sesquiterpenes are highly volatile compounds, diterpenes exhibit low volatility, triterpenes have very low volatility and polysaccharides are not volatile [15-17].

The major frankincense sources of the world today are Ethiopia, Somalia and northeast Kenya [24]. The principal frankincense producing species include *B. papyrifera* (Del.) Hochst, *B. neglecta* S.Moore, *B. microphylla* Chiov., *B. rivae* Engl. and *B. ogadenesis*occurring in Ethiopia [22]. *B. sacra* Birdw. and *B. frereana* Birdw.occurin Somalia, *B. serrata* Roxb.ex Coleber. occursin India and *B. dalzielii* Hutch occursin Nigeria. The resin of *B. papyrifera*is a raw material of the Ethiopian frankincense commonly called ‘‘etan’’ in Amharic and widely collected in north Ethiopia. It is known in commerce as ‘‘Tigray or Eritrean Type’’. It is widely used in Ethiopia and other countries as incense at home and during religious ceremonies. It is also exported to different parts of the world where it is used for making adhesives, chewing gum and fragrance oil. The resin of *B. papyrifera*is considered of poorer quality than the product obtained from the Arabian and Somalian species. *B. pirottae*is a rare endemic species only known from north and central low land regions of Ethiopia. The resin of *B. rivae*is known in commerce as ‘‘Ogaden etan’’ because it is obtained from Ogaden area, while that of *B. neglecta* originating from Borena is traded as ‘‘Borena etan’’ [16]. Olibanum which is an oleo gum resin exudes from incisions in the bark of Boswellia species. The interest of pharmaceutical companies created a third market for olibanum. Since ancient times it has been used in folk medicine for its antiseptic, anti-arthritic and anti-inflammatory effects. For this reason, in the last 20 years olibanum has gained increasing attention from scientists to better define its medical effects and identify the constituents responsible for these effects. In this work chemical investigation was performed on olibanum resins obtained from *Boswellia carteri* birdwood.

Materials and Methods

Plant Material

The plant material used in this study was collected or purchased from Tehram Market as a food and non-food for chemical analysis, which was collected in January 2015.

Extraction of Essential Oils of Boswellia Carteri Birdwood

The dry resin of *Boswellia carteri* birdwood (100 g) as a food type ground and with different methods of distillation (water distillation, steam distillation and hydro-steam distillation), for 3h at atmospheric pressure to yield the essential oil were hydro-steam distillation 0.84%, water distillation 1.12%, steam distillation 0.96%, respectively. Also for non-food type were hydro-steam distillation 1.01%, water distillation 1.26%, steam distillation 1.45%, respectively.

Gas Chromatography

GC analyses were performed using a gas chromatography, Ultera Fast Module–GC, made in Italia. Profile column machine brand Ph-5 capillary column, manufactured by Shimadzu with Length of 30 mm and an inner diameter of 1/0 mm thick 25/0 mm, the inner surface of the stationary phase material is covered Phenyl Dimethyl Siloxane 5%. Column temperature program: initial temperature 60 °C to start the final temperature of 210 °C. The initial 3 °C per minute to be added and then injected into the chamber to a temperature of 280 °C. The carrier gas inlet pressure to the column: helium with a purity of 99/99% of the inlet pressure to the column equal to 5/1 kilogram per square centimeter is set.

Gas Chromatography - Mass Spectrometry

The GC/MS unit consisted of a Varian Model 3400 gas chromatograph coupled to a Saturn II ion trap detector was used. The column was same as GC, and the GC conditions were as above. Mass spectrometer conditions were: ionization potential 70 eV; electron multiplier energy 2000 V.

The identity of the oil components was established from their GC retention indices, relative to C7-C25 n-alkanes, by comparison of their MS spectra with those reported in the literature [25-27], and by computer matching with the Wiley 5 mass spectra library, whenever possible, by co-injection with standards available in the laboratories.

Results

Table 1 Comparison of essential oils compositions of *Boswellia carteri* birdwood in different Distillation from Iranian market

		Non- Food			Food		
		Distillation			Distillation		
Method of Distillation		hydro-steam	water	Steam	hydro-steam	water	Steam
Oil %	-	0.84	1.12	0.96	1.01	1.26	1.45
1,8-cineole	1033	0.3	-	0.3	-	0.2	0.3
β- phellandrene	1039	-	2.4		0.2	-	2.3
(Z)- β-ocimene	1042	6.0		5.3	1.9	2.0	-
(E)- β-ocimene	1056	0.6	0.3	0.6	-	0.7	0.7
γ-terpinene	1061	0.2	-	-	0.5	-	-
n-octanol	1079	0.4	-	0.5	-	-	0.6
Trans-linalool oxide	1083	0.4	-	0.5	0.4	0.5	0.5
Terpinolene	1086	-	-		0.3	0.5	-
Linalool	1093	0.4	0.3	0.4	0.4	0.6	0.7
Heptanol acetate	1112	0.4	0.4	0.6	0.3	0.5	0.5
Myrcenol	1117	-	0.3	-	-	-	-
3-octanol acetate	1124	1.2	0.5	0.9	-	0.3	0.3
2-ethyl hexanoic acid	1128	2.3	1.3	3.0	1.0	1.3	1.4
Limonene oxide	1130	0.5	0.6	1.1	0.4	0.9	0.8
Trans- verbenol	1142	0.3	0.3	0.5	2.0	1.7	3.1
Borneol	1161	5.8	8.6	9.7	4.8	9.1	7.3
α- terpineol	1180	-	1.9	-	-	-	-
Yerbenone	1201	1.0	-	1.7	1.4	2.7	1.9
Octanol acetate	1214	-	1.1	-	-	-	-
Isobornyl formate	1234	0.7	0.7	1.0	0.7	1.0	0.9
Carvone	1245	0.3	0.4	0.3	-	-	-
Piperitone	1251	0.3	0.4	0.3	-	-	-
n-decanol	1270	-	0.3	-	-	-	-
Bornyl acetate	1292	-	0.3	-	-	-	-
n-tridecane	1297	-	0.3	0.2	-	-	-
n-nonanol acetate	1312	-	-	-	-	0.3	
Dihydro citronellol acetate	1316-8	48.0	48.2	60.6	55.6	63.7	55.9
Methyl decanoate	1324	-	7.9	-	-	-	-
δ-elemene	1343	-	3.8	0.3	-	-	-
Neryl acetate	1369	1.0	1.1	1.1	1.4	1.7	1.2
β-acoradiene	1469	0.2	1.1	-	-	-	-
β- selinene	1485	-	-	-	0.2	0.3	0.2
cis- β-guaiene	1487	-	-	-	0.6	0.5	0.5
(E,E)- α- farnesene	1508	0.2	-	0.2	0.3	0.3	0.2
δ- cadinene	1522	-	-	0.3	-	-	-
Spathulenol	1578	-	0.3	-	-		-
Acorenone	1684	-	-	-	0.2	0.1	-
Germacrone	1694	-	1.1	-	-	-	-
n-pentadecanol	1781	-	0.5	-	-	-	-
Cembrene A	1960	-	0.7	-	-	-	-
Cembrene C	2002	-	3.1	-	-	-	-
Abietadiene	2079	3.0	1.1	1.2	3.7	1.9	2.9
n-heneicosane	2108	0.8	4.6	-	1.3	0.5	0.8
2-phenyl ethyl anthranilate	2119	11.5	-	5.0	7.3	3.0	5.0
Methyl octadecanoate	2123	0.8	-	-	0.5	-	-
Oroselone	2144	0.5	-	-	-	-	-
Incensole	2153	-	1.4	-	-	-	-
Incensole acetate	2185	0.5	-	-	0.5	-	0.5
n-docosane	2201	3.8	1.2	1.2	3.4	1.2	2.7
α-santonine	2204	7.7	-	-	9.0	3.4	-
(E)-phytol acetate	2216	-	2.4	2.5	-	-	7.5

Conclusion

Quality of frankincense for the purpose of trade varies with color, provenance and age of tree. This may be explained by the fact that frankincense is cultivated in different countries by various means. Furthermore, the quality of frankincense is defined by geographical trade names and not by the botanical classification [28-33].In our investigation major components of the different methods of distillation oils of *Boswellia carteri* birdwood as a non-food by hydro-steam distillation were dihydro citronellol acetate (48%), 2-phenyl ethyl anthranilate (11.5%), α-santonine (7.7%), and with water distillation were dihydro citronellol acetate (48.2%), borneol (8.6%), methyl decanoate (7.9%), and with steam distillation were dihydro citronellol acetate (60.6%), borneol (9.7%), (Z)-β-ocimene (5.3%), respectively. Also the major components of *Boswellia carteri* birdwood as a food by hydro-steam distillation were dihydro citronellol acetate (55.6%), α-santonine (9%), 2-phenyl ethyl anthranilate (7.3%), and with water distillation were dihydro citronellol acetate (63.7%), borneol (9.1%), 2-phenyl ethyl anthranilate (3%), and with steam distillation were dihydro citronellol acetate (55.9%), (E)-phytol acetate (7.5%), borneol (7.3%), were the predominant major compounds respectively.

WHO recommends the use of plant-based medicines as an alternative medicine, especially in developing countries [31]. Therefore, screening plants as potential sources for new drugs is rational approach. In this study, the oleogum resin of *Boswellia carteri* Birdw. (Bursearceae), known as olibanum, was evaluated as a prophylactic and as a therapy for cardiovascular diseases.

References

1. Lipp FJ, Kräuter Heilkunde, Heilung und Harmonie, Symbolik, Rituale und Folklore Östliche und Westliche Traditionen . Duncan Baird Publishers Ltd., 2001.
2. Springer V, Sandermann W, Naturharze, Terpentinol, Tallol, 1960.
3. Vollesen K, Burseraceae. In: The Flora of Ethiopia, Vol. 3. Hedberg, I.; Edward, S. (eds.), AddisAbaba University, Addis Ababa, 1989, pp. 442-478.
4. Tucker AO, Frankincense and myrrh. Econo Botany, 1986;40:425-433.
5. Dekebo A, Phytochemical Studies on the Resin of some Commiphora and Boswelliaspp. Ph. D.Thesis, Addis Ababa University, Addis Ababa, Ethiopia, 2001.
6. Kindeya GH, Ecology and Management of *Boswellia papyrifera* (Del.) Hochst. Dry Forest in Tigray, Northern Ethiopia. Ph. D. Thesis, Culvillier Verlag, Gottingen, Germany, 2003.
7. Hamm A, Bleton J, Connan J, Tchapla A, chemical investigation by headspace SPME and GC-MS of volatile and semi volatile terpenes in various olibanum samples. Phytochem. 2005;66:1499-1514.
8. Proyan GJI, Alexander WPG, Monoterpenerich resins from someKenyan *Burseraceae*. J. Flavour Frag. 1987; *2*:115-119.
9. Keller JC, Clark PH, Lofgren CS, Susceptibility of insecticide-resistant cockroachesto pyrethrins. Pest Control. 1956;24:14-15.
10. Kang HY, Matsushima N, Sameshima K, Takamura N. Termite resistance tests of hardwoods of Kochi growth: The strong termiticidal activity of kagonoki (*Litsea coreana*L). Mokuzai Gakkaishi, 1990, *36*: 78-84.
11. Kalemba D, Kunicka A, Antibacterial and antifungal properties of essential oils. Curr. Med. Chem. 2003, 10: 813-829.
12. Sandermann W, Chemie und Technologie, Springer-Verlag, Berlin, Gottingen, Heidel. Terpentinol, Tallol. 1960;118-122.
13. Vollesen K, Burseraceae. In: The Flora of Ethiopia, Vol. 3.Hedberg, I.;Edward,S. (eds.), AddisAbaba University, Addis Ababa, 1989, pp. 442-478.
14. Gamarda L, Dayton T, Di Stefano V, Pitonzo R, & Schillaci D, Chemical composition and antimicrobial activity of some oelegum resin essential oils from Boswellia spp. Annali di Chimica, 2007;97:837-844.
15. Hasson SS, Al-Balushi MS, Sallam TA, Idris MA, Habbal O, & Al-Jabri A, In vitro antibacterial activity of three medicinal plants-Boswellia (Luban) species. Asian Pacific J of Tropical Biomed, 2011;1:S178-S182.
16. Miller GA, & Morris M, Ethnoflora of the Soqotra Archipelago. Edinburgh, UK/Huddersfield, UK: The Royal Botanic Garden/Charlesworth Group.2004.
17. Tucker AO, Frankincense and myrrh. Economic Botany1986;40:425-433.
18. Dekebo A, Phytochemical Studies on the Resin of some Commiphora and *Boswelliaspp*. Ph. D. Thesis, Addis Ababa University, Addis Ababa, Ethiopia, 2001.
19. Kindeya GH, Ecology and Management of *Boswellia papyrifera* (Del.) Hochst. Dry Forest in Tigray, Northern Ethiopia. Ph. D. Thesis, Culvillier Verlag, Gottingen, Germany, 2003.
20. Al-Howiriny T, Alsheikh A, Alqasoumi S, Aghili Shirazi MH. Tehran*:* Tehran University of Medical Sciences*;* 2009. Makhzan-al-advia (Persian) pp. 105-801.
21. Badria FA, Mikhaeil BR, Maatooq GT, Amer MM. Immunomodulatory triterpenoids from the oleogum resin of *Boswellia carterii* Birdwood. *Z* Naturforsch C. 2003; 58: 505-516.
22. Yoshikawa M, Morikawa T, Oominami H, Matsuda H. Absolute stereostructures of olibanumols A, B, C, H, I, and J from olibanum, gum-resin of *Boswellia carterii*, and inhibitors of nitric oxide production in

lipopolysaccharide-activated mouse peritoneal macrophages. Chem Pharm Bull. 2009;57: 957-964.
23. Chevrier MR, Ryan AE, Lee DY-W, Zhongze M, Wu-Yan Z, Via CS. *Boswellia carterii* extract inhibits TH1 cytokines and promotes TH2 cytokines in vitro. Clin Diagn Lab Immun. 2005;12:575-580.
24. Mothana RA, Hasson SS, Schultze W, Mowitz A, Lindequist U. Phytochemical composition and *in vitro* antimicrobial and antioxidant activities of essential oils of three endemic Soqotraen *Boswellia* species. Food Chem. 2011; 126:1149-1154.
25. Adams RP, Identification of essential oils by ion trap mass spectroscopy. Academic Press: New York. 1989.
26. Shibamoto T, Retention indices in Essential oil analysis. In: Capillary Gas Chromatography in Essential oils analysis.Edits., Sandra P, and Bicchi C, , Dr. Alferd Huethig Verlag,New York. 1987. p. 259-274.
27. Davies NW, Gas chromatographic retention index of monoterpenes and sesquiterpenes on methyl silicon and carbowax 20M phases., Chromatogr.,1990. 503, 1-24.
28. Jauch J, In Weinrauchsymposium der DPhG: Phytomedicine, Tubingen, 2008.
29. Koch A, Basar S, Richter R, In Preparative Layer Chromatography (Kowalska T. and Sherma, J. Eds), CRC Press, Boca Raton, 2006; 391.
30. Mertens M, A Buettner; E Kirchhoff. Flavour Fragr. J., 2009;24:279.
31.World Health Organization. World Health Statistics [M]. 2010:64.