

## **CHRYSANTHEMUM BALSAMITA (L.) BAILL.: A FORGOTTEN MEDICINAL PLANT**

**Mohammad-Bagher Hassanpouraghdam<sup>1</sup>, Seied-Jalal Tabatabaie<sup>2</sup>, Hossein Nazemiyeh<sup>3</sup>,  
Lamia Vojodi<sup>4</sup>, Mohammad-Ali Aazami<sup>1</sup>, Atefeh Mohajjel Shoja<sup>5</sup>**

<sup>1</sup>Department of Horticulture, Faculty of Agriculture, University of Maragheh, Iran.

<sup>2</sup>Department of Horticulture, Faculty of Agriculture, University of Tabriz, Iran.

<sup>3</sup>Drug Applied Research Center, Faculty of Pharmacy, Tabriz University of Medical Sciences, Iran.

<sup>4</sup>Department of Plant Sciences, Faculty of Natural Sciences, University of Tabriz, Iran

E-mail: hassanpouraghdam@gmail.com

**Summary.** Costmary (*Chrysanthemum balsamita* (L.) Baill. syn. *Tanacetum balsamita* L.) is one of the most important medicinal and aromatic plants of Azerbaijan provinces in Iran. This plant has been used for more than several centuries as flavor, carminative and cardiotoxic in traditional and folk medicine of Iran, and some parts of the world such as the Mediterranean, Balkan and South American countries, but there is scarce information about this plant. In most substances and, for majority of folk and medical applications, costmary is harvested from the natural habitats. This trend i.e. harvests from natural habitats and different ecological conditions lead to the production of different medicinal preparations because of the divergent intrinsic active principle profiles of different plant origins. In addition, harvest from natural habitats can cause deterioration of genetic resources of plant and, the result would be imposing of irreversible destructive effects on the ecological balance of flora and ecosystems. Taking into account the widespread uses of costmary and its preparations in most countries especially in North-West of Iran and Turkey, also because of limited scientific literature for *Chrysanthemum balsamita* (L.) Baill., this article will survey the literature for different characteristics of costmary and its essential oil for the first time.

**Key words:** *Chrysanthemum balsamita* (L.) Baill., Asteraceae, essential oil, carvone,  $\alpha$ -thujone,  $\beta$ -bisabolene

### **General Information About Costmary**

Outer morphology of costmary: Perennial, 60-120cm high, pubescent, rhizomatous. Stem: solitary, erect, loosely pubescent, and branched above. Leaf: basal leaves 12-20cm long, limb oval-elliptic, 1-1.5cm wide, crenate-dentate, acute, loosely pubescent, sessile, and sometimes pinnatisect; petiole 8-15cm long. Flower: yellow, capitulum homogamous, discoid, numerous; synflorescence lax- or densely corymbose; involucre hemispheric, 5-8mm in diam.; bracts 3-seriate, lanceolate or oblong, yellow or brown-scariose at the margin; inner bracts shorter than the outers; ligulate flowers few or absent; disc flowers tubular, 2mm long. Fruit: achene 5-10mm long, costate; pappus crown-like, 0.2-0.4mm long, entire or dentate. Flowering period: July-August. Root: shallow in depth, wire like, slender and branched (1,2).

Costmary is an invasive plant and most people prefer to raise it in cement blocks or pots. As cultural practices, costmary is easy to grow and fits better in a sun exposed, well drained dry soil but it thrives in most conditions. Optimum pH and planting distance in field conditions are 5-7.6 and 60×30 cm respectively (3,4). In the shade or low light conditions flowering will be

limited especially in the greenhouse conditions, but this condition is favorable for mass production of essential oil bearing material i.e. leaves (3,4). Propagation of this plant carries out by division or root and rhizome cuttings and propagation by seed is not satisfactory (5,6,7).

### **Origin of Costmary**

Costmary has Eurasian origin and there have been reported different habitats for this plant (8,9). It has been postulated that the Mediterranean is the primary origin of costmary and in the last three decades it has been naturalized and cultivated in different parts of the world (3,4). According to the literature review, costmary is under cultivation in Iran, Turkey, Romania, Germany, Italy, Spain and England (7,10-12). This plant is present in botanical gardens of most European countries (2). Costmary has long-time applications in Brazil but it has been introduced to Canadian flora in the last 15 years (3). Costmary has a long traditional usage as aromatic water in folk medicine of Iran. Finally we can claim that costmary is distributed in South and South-East of Europe and South-West of Asia but naturalized in most parts of the world.

## Taxonomy of Costmary

Costmary belongs to the Asteraceae family, Asterales order, Asteridae subclass and Anthemideae tribe. There are different documented scientific names (1,10, 11) for costmary such as:

<i>Balsamita major</i> (L.) Desf.	<i>Balsamita suaveolens</i> Pers.
<i>Balsamita vulgaris</i> Willd.	<i>Tanacetum balsamita</i> (L.)
<i>Pyrethrum tanacetum</i> DC.	<i>Tanacetum balsamitoides</i> Schultz Bip.
<i>Pyrethrum majus</i> (Desf.) Tzvel.	<i>Pyrethrum balsamita</i> (L.) Willd.
<i>Chrysanthemum balsamita</i> (L.) Baill.	

Furthermore, different common names referred to *Chrysanthemum balsamita* (L.) Baill. in English are balsam herb, alecost, costmary and bible leaf (4,10,11). Baily, a well known botanist, believes that costmary has two subspecies:

*Chrysanthemum balsamita* L. subsp. *balsamitoides*

With both white ray florets and yellow disk florets on capitulum and

*Chrysanthemum balsamita* L. subsp. *tanacetoides*

With only yellow disk florets, but no ray florets (4).

Aromatic flowers of costmary are hermaphrodite or bisexual and pollinated with insects (2,8).

## Chemical Composition and Active Principles of Costmary

Costmary has a rich secondary metabolites pool with diverse biological and therapeutical activities (7,9,12-15). These compounds consist of essential oil or volatile oil (monoterpenes and sesquiterpens), phenylpropane derivatives, flavonoids (Flavonols, apigenine derivatives, scutellareine derivatives and luteoline derivatives), tannins and oligo-elements. Essential oil derived from leaves and flowers is the most important active principle of this plant. Costmary essential oil is extracted by water and steam distillation of aerial parts and is a colorless to pale yellow liquid (3-6).

## Therapeutic Properties and Application of Costmary and its Preparations in Different Industries

Costmary has been used as spice for flavoring different types of food, cakes, drinks, as well as in confectionery from antiquity (10,11). Costmary leaves have been used as herbal tonic tea in different cultures (10, 15). Essential oil of costmary has long been used for beer flavoring in European countries, but in recent times, it has been replaced by hop (*Humulus lupulus* L.) extracts (10). Costmary leaves have been used in different salads and soups (10). For therapeutic purposes this plant and its essential oil have been used as hepatoprotective, antiallergic, tonic, sedative, and cardiotoxic (8,

10,15,17). Recently, essential oil derived from this plant has been used as insecticidal agent (17,18). This latter activity is due to the presence of thujones, carvone and pyrethrin1 in the essential oil. Sesquiterpene components of costmary essential oil have shown allelopathic effects in recent studies (18). It is noteworthy that, essential oil of costmary synthesizes and accumulates in the glandular trichomes occurring mostly at the adaxial surface of the leaves and for this reason touching the leaves causes rupture of these trichomes and intense balsamy odor of plant (8).

## Chemotaxonomy of Costmary

Essential oil composition of volatile oil bearing plants varies based on genetic, geographic and climatologic factors (19). This is true even when we discuss distinct species. This phenomenon is called chemical polymorphism (19). According to the predominant terpenes of essential oil, four chemotypes have been recorded for costmary:

- 1) Carvone type
- 2) Camphor type
- 3) Camphor- thujone type and recently
- 4) Carvone -  $\alpha$ - thujone chemotype (7,10).

## Information About Costmary Essential Oil

**A) Essential oil contents:** Bylaite *et al.* reported that essential oil content of costmary leaves was between 0.31-1.25 % (10). Juknevicine *et al.* studied the essential oil content of different organs of costmary at different growth phases and reported that essential oil content ranged from 0.06-2.2 % based on dry weight (20). Jaimand and Rezaii noted that essential oil content of leaves, flowers and stem of costmary was 0.25, 0.15 and 0.05 % respectively (21). Hassanpouraghdam *et al.* studied the effects of different concentrations of N and K as well as different concentrations of nutrient solution on costmary and, mentioned that, essential oil content of leaves (medicinal material of plant) was 0.54 and 0.48 % respectively (3,4).

**B) Essential oil constituents:** Until now ~200 components have been identified in the essential oil of Costmary (10,11,13,17,18,21,22,24,25). Bylaite *et al.* reported carvone (56-80%) as major component of costmary essential oil from Lithuania (10). Gallori *et al.* reported that carvone, camphor and  $\alpha$ -thujone were the predominant components of costmary essential oil from Romania, Poland, Germany and Russia (11). In a recent study, bornyl acetate, pinocarvone, camphor and terpineol were reported as major constituents of costmary essential oil from Iran (21). It should be noted that, in order to high quality essential oil from costmary, this plant must be cut at the early stages of flowering period (3,4,10,11). Husnucan Basher *et al.* and Perez Alonso *et al.* reported that carvone (52 and 57%) was the most important component of costmary volatile oil from Turkey and Spain (17,22). Strobel *et al.* identified 29 components in the essential oil of costmary with carvone

Table 1. Essential oil constituents of costmary (*Chrysanthemum balsamita* (L.) Baill.)

$\beta$ -Gurjunene	$\alpha$ -Cadinol	$\beta$ -Gurjunene
Cis-Muuroala-3,5-dien	Selin-11-en-4 $\alpha$ -ol	Cis-Muuroala-3,5-dien
(E)- $\beta$ -Farnesene	Hexadecanol	(E)- $\beta$ -Farnesene
$\alpha$ -Humulene	Pentacosane	$\alpha$ -Humulene
$\alpha$ -Patchulene	Phytol	$\alpha$ -Patchulene
Alloaromadendrene	Heptacosane	Alloaromadendrene
$\beta$ -Cadinene	Nonacosane	$\beta$ -Cadinene
$\gamma$ -Muuroolene	Hexadecanoic acid	$\gamma$ -Muuroolene
Germacrane-D	(E)-3-Hexenol	Germacrane-D
epi-Cubebol	Isopentylacetate	epi-Cubebol
Bicyclogermacrene	$\alpha$ - Thujone	Bicyclogermacrene
$\alpha$ -Muuroolene	S-Ethylpentanethioate	$\alpha$ -Muuroolene
$\beta$ -Himachalene	$\alpha$ -Pinene	$\beta$ -Himachalene
$\beta$ -Bisabolene	Camphene	$\beta$ -Bisabolene
trans- $\gamma$ -Cadinene	Thuja-2,4(10)-dien	trans- $\gamma$ -Cadinene
$\delta$ -Cadinene	$\beta$ -Pinene	$\delta$ -Cadinene
$\beta$ -Sesquiphellandrene	6-Methyl-5-hepten-2-one	$\beta$ -Sesquiphellandrene
trans-Calamenene	Myrcene	trans-Calamenene
(E)- $\gamma$ -Bisabolene	Ethylhexanoate	(E)- $\gamma$ -Bisabolene
Cadina-1,4-dien	(E)-3-Hexenol acetate	Cadina-1,4-dien
Spathulenol	$\alpha$ -Phellandrene	Spathulenol
Globulol	$\Delta^3$ -Carene	Globulol
Globulol	3-Methylbutylbutanoate	Globulol
1-epi-Cubenol	Methylcostate	1-epi-Cubenol
s-Methylpentanethioate	1,4-Cineol	s-Methylpentanethioate
2,3-Dehydro-1,8-cineole	$\alpha$ -Terpinene	2,3-Dehydro-1,8-cineole
Isobutyl-2-methylbutanoate	$\beta$ -Phellandrene	Isobutyl-2-methylbutanoate
$\rho$ -Mentha-1,3,8-triene	Butyl-2-methylbutanoate	$\rho$ -Mentha-1,3,8-triene
3-Methylbutylbutanoate	(E)-Ocimene	3-Methylbutylbutanoate
2-Methylbutyl-2-methylpropanoate	$\gamma$ -Terpinene	2-Methylbutyl-2-methylpropanoate
Butyl-2-methylbutanoate	Terpinolene	Butyl-2-methylbutanoate
3-Methylbutyl-2-methyl butanoate	$\rho$ -Cymenene	3-Methylbutyl-2-methyl butanoate
2-Methylbutyl-2-methylbutanoate	Linalool	2-Methylbutyl-2-methylbutanoate
3-Methyl-3-butenyl-2-methylbutanoate	Nonanal	3-Methyl-3-butenyl-2-methylbutanoate
$\rho$ -Mentha-1,5-dien-8-ol	Isopentyl isovalerate	$\rho$ -Mentha-1,5-dien-8-ol
$\alpha$ -Terpineol	1,3,8- $\rho$ -Metha-1,3,8-triene	$\alpha$ -Terpineol
$\rho$ -Cymene-8-ol	Chrysanthemone	$\rho$ -Cymene-8-ol
cis-Piperitol	trans-Sabinol	cis-Piperitol
2-Phenylethylacetate	Sabinaketone	2-Phenylethylacetate
$\alpha$ -Terpinylacetate	Isopinocampone	$\alpha$ -Terpinylacetate
$\gamma$ -Elemene	4-Terpineol	$\gamma$ -Elemene
cis-Carvylacetate	$\alpha$ -Thujnal	cis-Carvylacetate
cis-Jasmone	$\rho$ -Mentha-1(7),5-dien-2-ol	cis-Jasmone
4-epi-Cubebol	cis-Dihydrocarvone	4-epi-Cubebol
cis-Calamenene	Dihydrocarveol	cis-Calamenene
trans-Calamenene	trans-Dihydrocarvone	trans-Calamenene
Cadina-1,4-dien	Verbenone	Cadina-1,4-dien
trans-Nerolidol	Carvenone	trans-Nerolidol
1-epi-Cubenol	cis-Chrysanthenylacetate	1-epi-Cubenol
Sesquilandulol	cis-Carvoneoxide	Sesquilandulol
$\beta$ -Eudesmol	trans-Carvoneoxide	$\beta$ -Eudesmol
Sesquilandulylacetate(E)	Isobornylacetate	Sesquilandulylacetate(E)
Methylisocostate	Bornylacetate	Methylisocostate
6,10,14-Trimethyl-2-pentadecanone	1-Tridecane	6,10,14-Trimethyl-2-pentadecanone
4-Hydroxy-4,5-dihydroisocoscate	Carvacrol	4-Hydroxy-4,5-dihydroisocoscate
3-Methylbutyl-2-methylpropanoate	Isodihydrocarveol acetate	3-Methylbutyl-2-methylpropanoate
T-Muurolol	trans-Carvyl acetate	T-Muurolol
$\beta$ -Cubebene	$\alpha$ -Cubebene	$\beta$ -Cubebene
$\delta$ -Cadinol	cis-Carvylacetate	$\delta$ -Cadinol
$\alpha$ - Gurjunene	Cyclosativene	$\alpha$ - Gurjunene
trans- $\alpha$ -Bergamotol	$\alpha$ -Copaene	trans- $\alpha$ -Bergamotol
$\beta$ -Caryophyllene	$\beta$ -Burbonene	$\beta$ -Caryophyllene

(10, 11, 13, 17, 18, 21, 22, 24, 25).

and  $\alpha$ -thujone as the main ones (23). Bylaite *et al.* mentioned that the content of essential oil was higher in flowers than in leaves. However, carvone was the major component of both organs (10). Furthermore, percentage differences between leaves and flowers essential oil components were not significant except for some sesquiterpenoidal compounds such as T-muurolol (10). The researchers noted that the content of sesquiterpene components of essential oil increased in harvesting time. However, their increase was not comparable with carvone content of essential oil (69% versus ~10%). Gallori *et al.* analyzed essential oil and n-hexane extract of costmary aromatic water and reported that these two materials had different GC profiles. Furthermore, SPME followed by GC/MS analysis of fresh leaves and aromatic volatile components of costmary revealed that there was a qualitative and quantitative difference between them. In total 85 constituents identified in the essential oil, n-hexane extract of aromatic water and fresh leaves aroma of costmary with carvone (up to 46.2%) and  $\alpha$ -thujone (up to 15.93%) as main components (11). It is noteworthy that in the most studies conducted on the essential oil analysis of costmary,  $\alpha$ -thujone and  $\beta$ -thujone as two potent toxic monoterpenes had high share in essential oil and there must be great

consideration in regard to the internal use of  $\alpha$ -thujone and  $\beta$ -thujone rich essential oils of costmary (10,24). In a series of studies on the essential oil composition of wild and hydroponically grown costmary we identified carvone,  $\alpha$ -thujone and  $\beta$ -bisabolene as major components of costmary essential oil from Iran (24,25). As mentioned above, until now ~200 components were identified in the essential oil of costmary (Table 1). Some of these components possess unique biological and therapeutic properties (Table 2).

## Conclusion

Costmary is a potential medicinal and aromatic plant grown commonly in most of wild habitats in Iran, Turkey and several other countries. Its essential oil is currently used in medicine and pharmacology (cardiotonic, hepatoprotective, carminative and tonic) and several other industries such as food, perfumery and confectionery. Unfortunately there is very little tendency to the large scale production of this valuable plant. There are very limited literature and research works on costmary as well. In spite of this, costmary can be used as a rich source of monoterpenes such as carvone along with carvone bearing plants such as spearmint (*Mentha spicata*

Table 2. Biological and therapeutic activity of some major components of costmary (*Chrysanthemum balsamita* (L.) Baill.) essential oil.

Compound	Bioactivity(ies)
Carvone	Allergenic; antiacetylcholinesterase; antiseptic; CNS-stimulant; cancer-preventive; carminative; flavor; insecticide; insectifuge; motor-depressant; nematicide; perfumery; pesticide; sedative; trichomonocidic; vermicide
Camphor	Allelopathic; analgesic; anesthetic; antiacne; antidiarrheic; antidysenteric; antiemetic; antifeedant; antifibrositic; antineuralgic; antioxidative, antipruritic; antiseptic; antispasmodic; CNS-stimulant; cancer-preventive; carminative; convulsant; cosmetic; counterirritant; decongestant; deliriant; ecbolic; emetic; epileptogenic; expectorant; fungicide; herbicide; insect-repellent; insectifuge; irritant; nematicide; ocuolirritant; P450-2B1-inhibitor; pesticide; respirainhibitor; respirastimulant; rubefacient; stimulant; transdermal; verrucolytic; vibriocidic
$\alpha$ -thujone	Abortifacient; antibacterial; emmenagogue; epileptogenic/convulsant; insecticide; larvicidic; pesticide
$\beta$ -thujone	Abortifacient; antibacterial; emmenagogue; epileptogenic/convulsant; insectifuge; pesticide
1,8-cineole	Chronotropic; inotropic; acaricide; allelopathic; allergenic; anesthetic; anthelmintic; antiacetylcholinesterase; antiallergic; antibacterial; antibronchitic; anticariogenic; anticatarrh; anticholinesterase; antifatigue; antihalitotic; anti-inflammatory; antilarlyngitic; antinociceptive; antipharyngitic; antirheumatic; antirhinitic; antiseptic; antisinusitic; antispasmodic; antistaphylococcic; antitussive; antiulcer; CNS-stimulant; candidicide; carcinogenic; choleric; convulsant; counterirritant; cytochrome-P450-inducer; decongestant; degranulant; dentifrice; edemagenic; expectorant; flavor; fungicide; gastroprotective; Gram(+/-)icide; hepatotonic; herbicide; hypotensive; inflammatory; insectifuge; irritant; myorelaxant; nematicide; neurotoxic; P450-inducer; perfume; pesticide; rubefacient; secretagogue; sedative; spasmogenic; surfactant; testosterone-hydroxylase-inducer; trichomonocidic
$\beta$ -caryophyllene	Aldose-reductase-inhibitor; antiacne; antiasthmatic; antibacterial; anticariogenic; antiedemic; antifeedant; anti-inflammatory; antispasmodic; antistaphylococcic; antistreptococcic; antitumor; candidicide; flavor; fungicide; insectifuge; irritant; perfumery; pesticide; sedative; termitifuge
Sabinene	Perfumery

L.), caraway (*Carum carvi* L.) and dill (*Anethum graveolens* L.). We hope that our works will begin to encourage scientists and producers of this plant to meet industry's demand for main monoterpenoids of costmary besides above mentioned counterparts (3-6,24,25). To do this, contribution of research groups, as well as private and government organizations is appreciable. The first step will be prevention of natural habitats destruc-

tion, and the second would be preliminary study of cultural requirements of costmary and subsequently release of new lines and cultivars with appreciable amounts of secondary metabolites without depending on natural habitats.

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**Mohammad-Bagher Hassanpouraghdam<sup>1</sup>, Seied-Jalal Tabatabaie<sup>2</sup>, Hossein Nazemiyeh<sup>3</sup>,  
Lamia Vojodi<sup>4</sup>, Mohammad-Ali Aazami<sup>5</sup>, Atefeh Mohajjel Shoja<sup>6</sup>**

<sup>1</sup>Poljoprivredni fakultet, Departman hortikulture, Maragheh univerzitet, Iran

<sup>2</sup>Poljoprivredni fakultet, Departman hortikulture, Tabriz univerzitet, Iran

<sup>3</sup>Istraživački centar za primenu lekova, Farmaceutski fakultet, Univerzitet Medicinskih nauka Tabriz, Iran

<sup>4</sup>Fakultet prirodnih nauka, Departman botanike, Tabriz univerzitet, Iran

E-mail: hassanpouraghdam@gmail.com

Kratak sadržaj: *Matičnjak (Chrysanthemum balsamita (L.) Baill. syn. Tanacetum balsamita L.) je jedna od najvažnijih lekovitih i aromatičnih biljaka azerbejdžanskih provincija u Iranu. Vekovima se koristila kao začim, karminativ i kardiotonik u tradicionalnoj i narodnoj medicini Irana, kao i u pojedinim delovima sveta kao što su Mediteran, Balkan i zemlje Južne Amerike. Međutim, o ovoj biljci postoji veoma malo podataka. Kod većine supstanci i narodnih i medicinskih preparata, matičnjak se ubire iz prirodnih staništa. Ovakav pojava, tj. ubiranje u prirodnom staništu i različita ekološka okruženja, uslovljavaju proizvodnju raznovrsnih lekovitih preparata što je rezultat raznolikih urodjenih aktivnih principa u profilu iste biljke sa različitim poreklom. Takođe, ubiranje iz prirodnih staništa može da dovede do slabljenja genetskih resursa biljke a kao rezultat toga dolazi do nepovratnog destruktivnog uticaja na ekološku ravnotežu flore i ekosistema. Imajući u vidu široku primenu matičnjaka i njegovih preparata u većini zemalja, naročito na severo-zapadu Irana i u Turskoj, kao i nedovoljno naučne literature koja izučava Chrysanthemum balsamita (L.) Baill, ovaj članak bavi se pregledom literature u cilju pronalaska različitih karakteristika matičnjaka i njegovih eteričnih ulja.*

Ključne reči: *Chrysanthemum balsamita (L.) Baill, Asteraceae, eterična ulja, karvon,  $\alpha$ -tujon,  $\beta$ -bisabolen*