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PHYTOCHEMISTRY AND THERAPEUTIC USES OF *CARDARIA DRABA* L. : A REVIEW

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Abstract

For past time *Cardaria draba* was used against wide range of ailments as one of the available traditional medicine such as anti-inflammatory, anticancer, antimicrobial, antioxidant, hypoglycemic and other uses; because of these activities of *C. draba* and the other species of the same family Brassicaceae different studies were applied to extract the active components in this plant that responsible for these activities between them the antimicrobial activity against fungi, gram negative and gram positive bacteria. This review concerns with the phytochemistry of the plant including the extraction process, identification and isolation of the active components also the pharmacological activities belong to *C. draba.* The aerial parts of *C. draba* was found to contain alkaloids, saponins, flavonoids, terpenoids, tannins, triterpenoids, and Leucoanthocyanins. Three flavonoids components were isolated from all *C. draba* parts which are complanatuside, genkwanin-4′-O-β D-glucoside and rhamnocitrin-3-O-β D-glucoside.

Keywords : Phytochemistry, Therapeutic, *Cardaria draba* L.

Introduction

Brassicaceae family is also known as mustard or Cabbage family and formerly called Cruciferae. This family contains about 385 genera and 3,700 species (Clarke DB, 2010). One of these genera is cardaria, its name means heart and belongs to a Greek word kardia, its named heart due to the shape of the fruit like heart, but not all the fruits shape is like the heart in this genus (Bobbi Campbell *et al.,* 2012). *Cardaria draba* (L.) Desv. was originally included in genus *Draba* (Fernald, 1950) and recently in genus *Lepidium* (as *Lepidium draba* L.) (Gleason, 1952). In North American *Cardaria draba* is a term referred to the weed, which actually consist of three European and Asian species: *C. draba* L.*, C. chalepensis* (L.) and *C. pubescens* (Sexsmith, 2017). *Cardaria* species are commonly called whiteweed or white-top and hoary cress. Common names for *C. draba* are white-top, heart-podded hoary cress (Fischer *et al.,* 1978) perennial peppergrass (Kummer, 1951) and Cransondravier (Mulligan and Frankton, 1962). In England it may be referred to as whitlow pepper wort or Thanet weed, (Robson, 1919) hoary pepperwort, chalk weed and devil's cabbage (Garrad, 1923). Common names for *C. chalepensis* are included Cransonrampant and lens-podded hoary cress. Common names for *C. pubescens* are included Cransonvelu and globe-podded hoary cress.

Botanical description

Cardaria draba (syn. *Lepidium draba* L.), which commonly known as hoary cress or white-top, is a perennial weed (Dixon, 2007), it reproduces by horizontal creeping roots and seeds and its stem is erect, hard, and branched, its tall was about 10 to 80 cm, covered sparsely to heavily with ash colored soft hairs (Agriculture Research Service, 1970). The mature leaves were mostly toothed, simple, and alternating, basal leaves are long about 4 to 10 cm length, also have petiole, and have flat, lance-shaped to spoon or egg shape, with a narrow end attached to the stalk with long 2-6.5 cm length (Robbins *et al.,* 1952).

C. draba has slightly domed, corymb-like flower clusters, each flower 2 mm width, in these clusters, each one of the flower stalks grow upward from different points of branch to approximately the same height. Each flower has about four petals with long, and narrow bases like spoon (Mulligan & Findlay, 1974). The petals are clawed, white, with length about 3 to 5 mm, and about twice as long as the green sepals which have length of about 1.5-2.5 mm, the flower has one pistil and six stamens like mustard species. The fruit length about 3 to 4mm and has inverted heart or egg shape. The fruits two chambers contain one or two seeds (Scurfield, 1962). The seeds has dark red brown color, with 2 to 3mm long, and 1 to 1.5 width; its shape is round or oval at one end and narrow to a blunt point at the other as shown in figure (1).

Fig.1: *Cardaria drabra* plant

Table 1: Comparison between *Cardaria* species (Miller and Callihan, 1991).

No.	Species	Tall	Fruit shape	Seeds
1	*C. draba*	20-50cm	Heart or egg shape	2
2	*C. chalepensis*	20-40cm	Oval to lens shape	4
3	*C. pubescens*	20-50cm	Globe shape	4

Cultivation and Distribution of Cardaria

Although *C. draba* prefers alkaline conditions (Francis and Warwick, 2008), It could be found in a different types of soil where there is adequate moisture, its grows in a wide range of habitats, including un shade open place, meadows, fields, cultivated land, pastures, along roads idespastures, and waste places(AniRadonic´ *et al.,* 2011). *C. draba* weed can quickly forms pure colonies which are impossible to be invaded by other plant species and surrounded by an inhibition zone (Qasem, 2004). Its reproduce either vegetatively by creeping root or from seeds, made it difficult to control by control methods of the traditional weed (Scurfield, 1962). *C. draba* is native in Western Asia, including Iraq, Iran, Turkey, Armenia, and Syria, Eastern Europe, North America and Africa including Algeria (Chopra *et al.,* 1986). *C. pubescens* and *C. draba* are more common in the United States, while *C. chalepensis* is more common in Canada. *C. draba* is a common weed in Iraq, Lebanon, South Africa, Tunisia, Turkey, Germany, Canada, England, and Portugal; it is also present as a weed in Belgium, Argentina, New Zealand, Chile, Guatemala, Czechoslovakia, Tasmaniaa, The Netherlands, and former Rhodesia; it's a serious weed in Austria, Italy, Afghanistan, United States, the former Soviet Union, and Hungary; it is a principle weed in Jordan, the former Yugoslavia, Iran, and Greece (Holm *et al.,*1991).

Pharmacological uses of *C. draba*

C. draba used as carminative and has antiscorbutic activity (Fatemeh Benakashani *et al.,* 2017), antioxidant, laxative (A. Ghahreman, 2009), antibacterial activity against two gram (+) bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) and two gram (-) bacteria (*Pseudomonas aeruginosa* and *Escherechia coli*), anticancer (Amer Hakeem Chyad, 2017) and antifungal activity; infusion of *C. draba* seeds and leaves have expectorant and purgative effects (Nebras *et al.,* 2016). *C. draba* also has hypoglycemic effect by decrease the blood glucose level, hypocholesterolemic effect via inhibition of hydroxyl methylglutaryl COA reductase enzyme, decrease triglyceride level due to inhibit lipase enzyme, increase total protein level in blood, decrease blood urea level, increase erythrocytes and hemoglobin level and decrease white blood cell level.

Phytochemistry of *C. draba*

The aerial parts of *C. draba* contain alkaloids, saponins, flavonoids, terpenoids, tannins, triterpenoids, and Leucoanthocyanins. Three flavonoids components were isolated from all *C. draba* parts complanatuside, genkwanin-4′-O-β-D-glucoside and rhamnocitrin-3-O-β-D-glucoside (Abdolhossein Miri, *et al.,* 2013). Another study on *C. draba* have confirmed the presence these organic compounds, saponins, alkaloids, tannins, terpenoids, flavonoids, Leuco anthocyanin and triterpenoids, also the study were mentioned the necessity of these compounds for stabilizing and reducing Ag ions to Ag NPs (Mojab *et al.,* 2003). The reproductive and vegetative tissues of *C. draba* also contain two major types of glucosinolates, namely glucosinalbin and glucoraphanin (Powell *et al.,* 2005). An important type of isothiocyanate (4-[methylsulfinyl] butyl isothiocyanate) can be produced through hydrolysis of glucoraphanin via myrosinase activity (Fahey *et al.,*2001).This isothiocyanate has antibacterial effect on Helicobacter pylori (Fahey *et al.,* 2002) and antioxidant properties (Fahey *et al.,*1999).

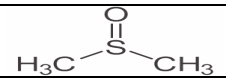
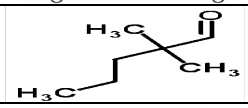
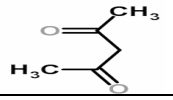
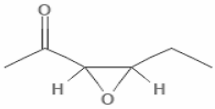
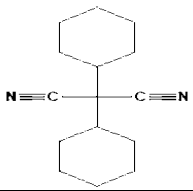
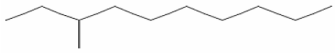
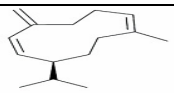
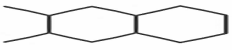
The present study carried out on the *C. draba* revealed the presence of many medicinal active compounds. The phytochemical active compounds of *C. draba* were analyzed qualitatively and the results were presented in Table 2. Based on the changes occurred in the color of chemical test, and the presence or absence of secondary metabolite. In this screening processes flavonoids, alkaloids and saponins gave positive results and tannin gave negative result (Nadaf *et al.,* 2015). There is another investigation of *C. drabra* leaves and seeds by HPLC to identify the phenolic compounds in the ethanolic extracts of leaves. Kaempferol, quercetin and isorhamnetin were the most abundant compounds in the ethanolic extract of leaves (11.5, 12.9 and 13.85% respectively) while the most abundant compounds in the ethanolic extract of seeds were ellagic acid, sinapic acid, p-coumaric acid and caffeic acid (7.9, 7.9, 7.9 and 13.3% respectively) (Sabrina Bicha, *et al.,* 2016).

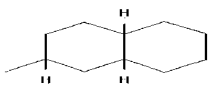
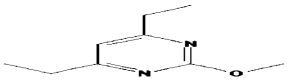
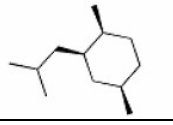
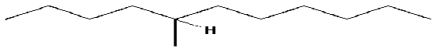
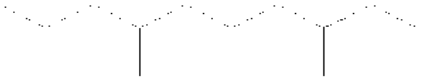
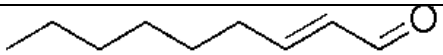
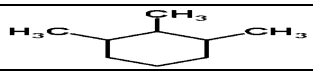
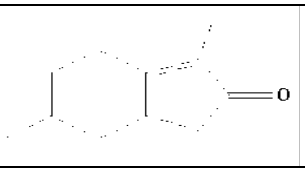
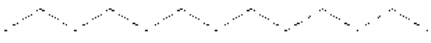
Table 2 : Phytochemical analysis of aerial parts of *Cardaria draba* (Javad Sharifi-Rad, *et al.,* 2015)

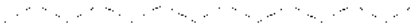
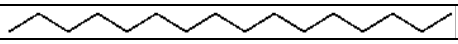
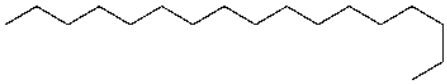
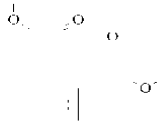
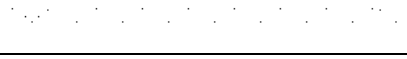
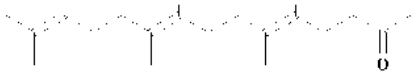
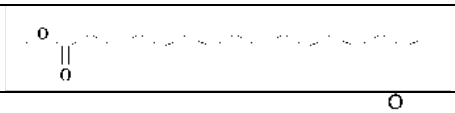
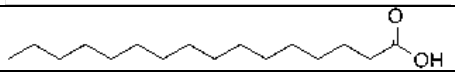
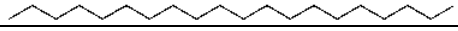
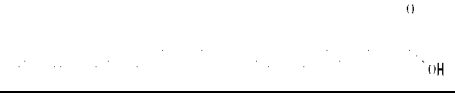
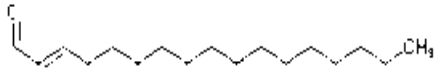
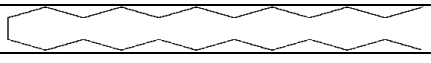
Phytochemical compounds	***C. draba***
Alkaloids	+
Flavonoids	++
Saponins	+
Tanins	-

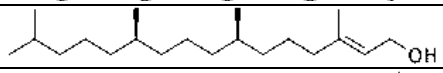
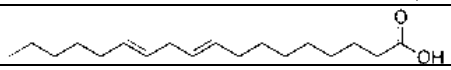
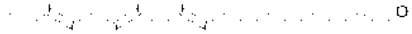
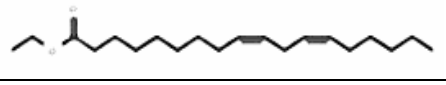
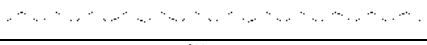
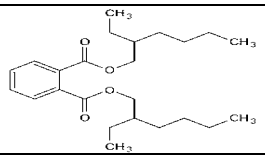
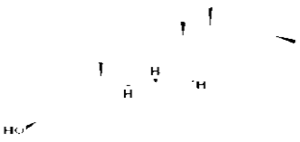
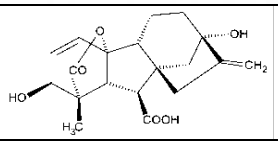
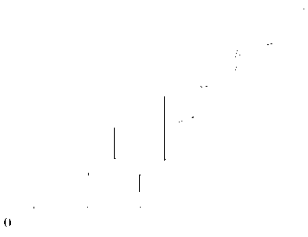
GC-MS analysis of *C. draba* n-hexane led to identify sixty two secondary metabolites. The identification of these phytochemical compounds is based on Kovats index and area under the peak. Percentage compositions of different compounds are listed in table 2 (Nadaf *et al.,* 2015).

Table 3 : Percentage compositions of essential Oil compounds obtained from the aerial parts of *Cardaria draba*

No.	**Compound**	**Retention index (RI[a])**	**Percentage**	**Structure**
1	Dimethyl sulfoxide	772	3.6	
2	2,2-dimethyl-pentanal	824	1.9	
3	2,4-Pentanedione	846	1.6	
4	1-(3-ethyloxiranyl)-Ethanone	855	1.6	
5	Dicyclohexyl-Propanedinitrile	864	7.4	
6	2,3,4,5-tetrahydro-Pyridine	886	0.6	
7	2,3,3-trimethyl-1-Butene	889	0.4	
8	Decane	897	0.3	
9	Dodecane	1051	6.3	
10	2-methyl-Decane	1061	0.2	
11	3-methyl-Decane	1073	0.1	
12	Germacrane D	1472	0.4	
13	Undecane	1090	2.7	
14	2,3-dimethyl decahydronaphthalene	1092	2.2	

15	2-Methyldecalin	1096	0.1	
16	4,6-diethyl-2-Methoxypyrimidine	1097	1.5	
17	1-isobutyl-2,5-dimethylcyclohexane	1098	0.4	
18	5-methyl-Undecane	1110	0.4	
19	3,7-dimethyl-Decane	1122	0.2	
20	2-Nonenal	1140	0.3	
21	1,2,3-trimethyl-Cyclohexane	1134	0.5	
22	Germacrane B	1147	0.2	
23	4-methylundecane	1163	0.2	
24	decahydro-1,6-dimethyl-Naphthalene	1166	4.6	
25	2-methylundecane	1169	0.5	
26	3-methylundecane	1177	1.0	
27	decahydro2,6-dimethyl-Naphthalene	1184	1.4	
28	Mint furanone	1211	2.6	
29	2,6-dimethylundecane	1202	0.7	
30	1-Tridecane	1230	0.4	

31	4-methyl-Dodecane	1248	0.5	
32	4-Methyltridecane	1347	0.2	
33	2-Methyltridecane	1352	0.2	
34	Tetradecane	1381	0.4	
35	Hexadecane	1587	0.3	
36	Tetradecanoic acid	1744	0.2	
37	Octadecane	1782	0.2	
38	6,10,14-trimethyl2-Pentadecanone	1827	0.7	
39	Bis(2-methylpropyl)1,2-benzenedi carboxylic acid	1851	0.4	
40	Nonadecane	1880	0.1	
41	Farnesyl acetone	1899	0.2	
42	Hexadecanoic acid methyl ester	1904	0.2	
43	Palmitic acid	1942	4.1	
44	Hexadecanoicacid,ethylester	1972	0.3	
45	Eicosane	1979	0.4	
46	Eicosanoic acid	2035	0.4	
47	2-Heptadecenal	2011	0.2	
48	Tetracosane	2071	0.1	

49	Heneicosane	2077	0.2	
50	Phytol	2098	0.3	
51	Linoelaidic acid	2111	0.8	
52	9,12,15-Octadecatriene-1-ol	2119	5.2	
53	Octadecanoic acid	2138	0.8	
54	Ethyl linoleolate	2146	0.2	
55	Tricosane	2274	0.3	
56	Pentacosane	2471	0.3	
57	Bis(2-ethylhexyl)phthalate	2525	12.5	
58	gamma-sitosterol	2569	0.9	
59	Tetracosane	2632	0.4	
60	Heptacosane	2668	1.0	
61	Gibberelin	2957	0.3	
62	Ergosta-4,6,22-trien-3.alpha.-ol	3088	1.0	

Other GC-MS Analysis of volatile oils revealed the presence of glucosinolate degradation products and other volatile compounds, e.g. fatty acid esters, carbonyl compounds, and fatty acids. These volatile compounds are sec-Butyl isothiocyanate, 5-Methylhexanenitrile, Isobutyl isothiocyanate, Benzaldehyde, Hexanoic acid (caproic acid), Heptanenitrile,(S)-Methyl methanethiosulfinate, 6-Methylhept-5-en-2-one, But-3-enylisothiocyanate, 2-Pentylfuran, (E,E)-Hepta-2,4-dienal(*E*)- Hex-2-enoic acid, (*S*)-Methylmethanethiosulfonate, 2-Phenylacetaldehyde, Acetophenone4-Methylphenol, (*E* ,*E*)-Octa-3,5-dien-2-one, Linalool, Nonanal, 2-PhenylacetonitrileOctanoic acid (caprylic acid), 2-Methylacetophenone, 5-(Methylsulfanyl)pentanenitrile, β-Cyclocitral, 3-Phenylpropanenitrile, Nonanoic acid(pelargonic acid)3-(Methylsulfanyl)propyl isothiocyanate, 2-Methoxy-4-vinylphenol, 6-(Methylsulfanyl)hexanenitrile, α-Ionone,

Benzyl isothiocyanate, Decanoic acid (capric acid), 4-Hydroxybenzaldehyde, 4-Hydroxy-3-methoxybenzaldehyde, 4-(Methylsulfanyl) butyl isothiocyanate, Geranyl acetone, b-Ionone, (4-Hydroxyphenyl) acetonitrile, 5-(Methylsulfinyl) pentanenitrile, 5-(Methylsulfanyl)pentylisothiocyanate, 5,6,7,7a-Tetrahydro-4,4,7a-trimethyl-2(4H)-benzofuranone, Dodecanoic acid (lauric acid), Tetradecanoic acid (myristic acid), 4-(Methylsulfinyl) butyl isothiocyanate, 4-(Methylsulfonyl)butyl isothiocyanate, 6,10,14-Trimethylpentadecan-2-one, Dibutyl phthalate, Farnesyl acetone, Methyl linolenate, Hexadecanoic acid (palmitic acid), Phytol, Octadeca-9,12-dienoic acid (linoleic acid), Ethyl linolenate (AniRadonic´, *et al.,*2011).

Other secondary metabolites were identified by GC-MS from the methanolic extract of *C. draba* included different classes of phytochemical compounds such as alkaloids, essential oil, fatty acid, triterpene, phenolic, sugar and sulfur derivatives, organophosphorous compounds and others. Alkaloid included; Dipyrrolidinomethane; N-(4-Aminobutyl)aziridine; N-[3-[NAziridyl] propylidene] tetrahydrofurfurylamine; N-Propenylpiperidine; (2E)-3-(2-amino-1H-imidazol-5-yl)prop-2-enoic acid; S-Benzyl-l-cysteinyl-S- tetrahydropyranyl-l-cysteinylhydrazide; N-methyl-N-(4-pyrrolidin-1-ylbut-2-ynyl)formamide; Methyl-3,5-dioxohexahydro-1H-pyrrolizine-2-carboxylate; 2,4-dichloro-6-[(1Hindazol-7-ylamino)methyl]phenol; (3,3-Dimethyl-5-methylthio-3,4-(2H)-dihydro pyrrol-2-ylidene)acetonitril; Folic acid; N-(2-isothiocyanatophenethyl)-N-methyl-2-(pyrrolidin-1-yl)cyclohexanamine; 2,6-bis[2-(2-sulfosulfanylethylamino)ethoxy]pyrazine;Dasycarpidan-1-methanol, acetate (ester)**;** 2,7-Diphenyl-3,7-dihydro-1H-pyridazino[4',5':4,5]pyrrolo [2,3-d]pyridazine-1,6(2H)-dione; Fatty acid include; Cis-5,8,11,14,17-Eicosapentaoic acid; cis-methyl-11-(3-pentyloxiran-2-yl)undecanoate; (2-hexadecanoyloxy-3-hydroxypropyl) hexadecanoate; Ascorbic acid dipalmitate; (Z,Z,Z)-9,12,15-octadecatrienoic acid. Triterpenes includeEthyliso-allocholate; Amino Sugar, Paromomycine. Phenolic compounds include: Durohydroquinone; Corymbolone; 1,3-Heptadecyn-1-ol. Sulfur derivatives include 1,5-Bis(3-sulfosulfanyl propylamino)pentane and other thio-sugar. Essential oil include: Naphthalene,1,2-dihydro-2,5,8-trimethyl-; o-Cymene; 9-Oxabicyclo[3.3.1]nonane-2,6-diol; organophosphorus compounds include: Phosphorothioic acid, Others include Hydroxy-2-octanone; 1,13-tetradecadiene-3-one; 5-octadecenal; (E,Z)-2,6-Nonadienal (Haider, 2016).

Conclusion

C. draba aerial parts are very rich in bioactive components so its roots may contain a lot of these chemical compounds. Investigation of these components by GC-MS analysis and HPLC give explanation that these identified compounds were responsible for different clinical uses like carminative, antiscorbutic activity, antioxidant, laxative, antibacterial, anticancer, and antifungal activity, also has expectorant and hypoglycemic effect.

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