INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 19, No. 2, p. 160-169, 2021

RESEARCH PAPER OPEN ACCESS

Review Article Pharmacological and phytochemical overview of *Daucus carota* L. (Black carrot)

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Key words: Traditional medicine, Kanji, *Daucus carota*, Phytochemistry, pharmacological activities.

http://dx.doi.org/10.12692/ijb/19.2.160-169 Article published on August 22, 2021

Abstract

Daucus carota, or black carrot, belongs to the family Apiaceae. Globally, *Daucus carota* is widely using to treat different ailments. The objective of this study is to document previously established pharmacological activities and isolated phytochemicals of the black carrot. The data was searched in the English language without any year limit. Various electronic databases were used for the literature survey, including Web of Sciences, Pub Med, and Scopus. The phytochemical investigation of *Daucus carota* L. revealed that the plant contains lecithin, pectin, essential oils, volatile oils, provitamin, gluten, starch, extractine, malic acid, carotin, albumen, water, sugar, and trace elements like calcium, manganese, phosphorus, iron, potassium, molybdenum, etc. Anthocyanins and carotenoids are the essential antioxidant constituents present in carrots. Anthocyanin-rich carrots are purple. In addition, carrots have three unique flavonoids, namely quercetin, luteolin and kaempferol. Traditionally, *Daucus carota* is being utilized for its anti-inflammatory, anti-bacterial, anti-fungal and antioxidant activities. Many scientific studies have validated its wound healing, hepatoprotective, renal protective, gastric healing, anti-bacterial, anti-cancer, anti-fungal and anti-diabetic activities. However, more scientific studies are required to justify its pharmacological use in traditional medicine. Further, toxicity and clinical studies should perform to ensure its effective and safe use.

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Introduction

Black carrot is a sub-species having the scientific name *sativus* (Hoffin.) Arcang. Moreover, this sub-species has more varieties like purple (variety biossieerii Schweinf.), yellow (variety scharrovii Mazk.), black (variety vavilovii Mazk.), white (variety albus Alef.), pink (variety rosseus Mazk.), and orange (variety zhukovskii Setch.). The carrot is an herbaceous and biennial plant, about 30 - 120 cm tall, blossoming from June to August. Flowers are androgynous and are cross-fertilized by insects and flies. Fruits are 2-4 mm long and elliptical. Leaves are superbly parted, and sections are rectilinear to lanceolate and are 0.5-3.0 cm elongated. The stalk is striated or ribbed. The plant favors light (sandy), medium (loamy), and heavy (clay) soils and needs well-drained soil (Surbhi *et al.,* 2018). The seeds grow from August-September. *Daucus carota* seeds are small and protected with a fleshy, spiny, curved mericarp. Mericarp should be detached before seeding because it contains characteristic oil which prevents seed germination. Seeds are formed from ovules present in the carpels. Carrot seeds are dry fruits called schizocarps, so these are not true seeds botanically (Gomaa *et al.,* 2021).

Botanical description

The vernacular names of the plant are given as follows:

Botanical Name: *Daucus carota L.*

Sub-species: *sativus* (Hoffin.) Arcang.

Variety: vavilovii Mazk.

Common Name: Black carrot, Wild carrot, In Pakistan Kali Gajar

Arabic: gazar, English: carrot, German: Karotte, Möhre, Italian: carota.

Family: Apiaceae

Edible parts and habitat

Flowers and roots of *Daucus Carota L.* are eatable components. Flowers are stir-fried to make a unique dish and gourmet delight. A type of coffee can be made from the root. The root can also be utilized as a vegetable. Kanji is also made from the root, which is a self-fermented probiotic used in the early summer season. Seeds are employed for various purposes (Facciola, 1990). Carrots grow within a high range of temperatures and are grown worldwide with the exemption of the very warmest region.

The root develops faster at 15 °C-18 °C. Seeds may be cultivated at low temperatures. Low temperatures induce flowering in Carrots. Carrot usually does not occur in recently abandoned fields because seeds do not stay alive for more than two years (Singh and Sethi, 2018).

Traditional uses of Daucus carota L.

In old-style treatment, various parts of the *Daucus Carota L.* are used in various countries to treat different diseases. It has been used in the past as a diuretic (Stanic *et al.*, 1998), antioxidant (Ahmad *et al.,* 2017; Shebaby *et al.,* 2013), anti-inflammatory (Porchezhian *et al.,* 2000), wound healer (Patil *et al.,* 2012), carminative, hepatoprotective (Bishayee *et al.,* 1995; Mills *et al.,* 2008), antimicrobial (Staniszewska *et al.,* 2005), antiseptic, ophthalmic tonic and uterine stimulant (Bown, 1995; ChevalIier, 1996).

Other Uses

Leaves have significant quantity of porphyrins, which helps to rise levels of sex hormones by exciting the pituitary gland (Chevallier, 1996). For the treatment of diabetes, a hot water tea of flowers is used. Grated fresh root is used for the treatment of threadworms (Chevallier, 1996; Foster and Duke, 1990). Patil *et al.*, 2012 in his study reported that when topical ointment of ethanol extract of the root of carrot was applied to animals, it showed a significant reduction in wound healing.

The root is also used traditionally to induce uterine contractions and to delay menstruation (Weiner, 1980) and roots are used to make a tea which is diuretic and is used to cure urinary stones (Foster and Duke, 1990; Encalada *et al.,* 2019). Bown (1995) reported that a root drink is employed as a part of the treatment of fart, dyspepsia, edema, and menstrual complications. Roots are likewise utilized as dressing in mammary gland, uterine and skin cancers.

Extracts of carrot seed and its essential oil have cardioprotective (Muralidharam *et al.*, 2008), hepatoprotective, cognitive dysfunction, cholesterol-lowering (Singh *et al.* 2012), and anti-parasitic actions. According to the studies, seeds are carminative, diuretic, anthelmintic and are also used as contraceptives and abortifacients (Duke and Ayensu, 1985; Foster and Duke, 1990; Chevallier, 1996). In a previous study, seed oil showed smooth muscle relaxant and vasodilatation properties and fresh seeds juice demonstrated potential for leukemia treatment (Gillani *et al.,* 2000; Rana *et al.,* 2011).

Review of chemical constituents

The phytochemical investigation of *Daucus carota* L. revealed that the plant contains lecithin, pectin, essential oils, volatile oils, provitamin, gluten, starch, extractine, malic acid, carotin, albumen, water, sugar, and trace elements like calcium, manganese, phosphorus, iron, potassium, molybdenum, etc. Anthocyanins and carotenoids are the most essential antioxidant constituents present in carrots. Anthocyanin-rich carrots are purple (Sun *et al.*, 2009; Pereira *et al.,* 2021).

The plant also has phytochemicals such as carotenoids, phenolics, polyacetylenes, isocoumarins and sesquiterpenes. Carrots have three unique flavonoids, namely quercetin, luteolin and kaempferol (Ching *et al.,* 2001; Lila, 2004; Horbowicz *et al.,* 2008). Many phytochemical studies (Table. 1) were carried out on this plant and many active ingredients were isolated that include triterpenes, volatile oils, tannins, carbohydrates, steroids, amino acids, glycerides, flavonoids, hydrocarotene and carotene (Mazzoni *et al.,* 1999).

Table 1. Isolated phytochemicals from *Daucus carota* L.

Phytochemicals	Authors	Year
Asaraldehyde	Chu and Lee	1953
Pyrrolidine, quinic acid, malic acid	Schramm	1961
Choline	Ghambir *et al.,*	1966
Ferulic acid	Sarkar and Phan	1974
Amylase	Neuman *et al.,*	2016
Anthocyanin	Alfermann *et al.,* and Montilla *et al.,*	1975,2011
Isobutyric acid, limonene	Cronin and Stanton	1976
Chlorogenic acid	Sarkar and Phan	1979
Quercetin	El-Maghazi *et al.,*	1980
Cinnamic acid	Noe	1983
Lupeol	Hooper and Chandler	1984
Amyrin	Hooper and Chandler	1984
Asarone	De Blasi *et al.,*	1990
Compesterol	Andhiwal *et al.,*	1990
Myricetin	Hertog *et al.,*	1992
Apigenin	Shaaban *et al.,*	1994
Carotene	Van Breeman	1996
Glycosides like peonidin and pelargonidin	Kammerer *et al.,*	2003
Crotinic acid, carotinic acid	Jasicka-Miaiak *et al.,*	2005
Polyacetylenes, sesquiterpenes, ducane esters and coumarin	Ahmed *et al.,*	2005
β-D-glucopyranosyl-(I, 6)- [β-D xylopyranosyl-(1, 2)]- β-D galactopyranosyl-(I, 3)-cyanidin, 6-0-acyl- β-D glucopyranosyl-(l, 6)- [β-D-xylopyranosyl-(1, 2)]-β-D galactopyranosyl-t l, 3)-cyanidin	llham *et al.,*	2006
Elemicin	Tavares *et al.,*	2008
Falcarindiol, falcarinol, falcarindiol 3-acetate	Purup *et al.,* and Metzger *et al.,*	2009,2008
Caffeic acid, carotenoids	Sun *et al.,*	2009

According to Lawrence (1999), seed oil of black carrot is composed of α-pinene, camphene, sabinene, myrcene, limonene, terpinolene, linalool, n-nonanal, trans-α-bergamotene, trans-pinocarveol, β-sesquiphellandrene, cis-α-bergamotene, trans-verbenas p-cymene-8-ol ,α-terpinol, β-caryophyllene, bicyclogermacrene, verbenone, β-bisabolene, crone ,daucene, cis-α-bergamotene, Z-α-farnesene, E-β-

farnesene ,Epi-β-santalene, (Z,Z)-α-farnesene, germacrene, Ar-curcumene ,β-selinene ,α-selinene, Z-γ-bisabolene ,copaenol ,carotid ,daucol ,α-eudesmol, alfa-cadinol, oleic acid and also contains linoleic acid, vaccenic acid, oleic acid, palmitic acid, stearic acid ,linoleic acid, palmitoleic acid, petroselinic acid and arachidic acids. Seed oil of black carrot also contains daucane-type sesquiterpenes (Mazzoni *et al.,* 1999), such as dauca-5,8-diene, trans-dauc-8-ene-4b-ol, acora-4,9-diene, acora-4,10-diene, trans-dauca-8,11-diene, daucol, furocoumarins, carotol (Ceska *et al.*1985), flavonoids (Gupta and Niranjan, 1982), fatty oil (Vesna *et al.,* 1989), polyacetylenes (Lund, 1992) and b-carotene (Almeida *et al.,* 1997).

Pharmacological activities

Based on the widespread utilization of plants in the ancient system of treatment, researchers investigate various pharmacological activities that are given as follows:

Antioxidant activity

Owing to vitamins, polyphenols and carotenoids carrots have antioxidant, immune enhancer and anti-carcinogen properties. Carotenoids have been shown to inhibit mutagenesis action and contribute to the lowest risk of some malignances (Dias, 2012).

Phenolic compounds and flavonoids, found in carrot roots act as antioxidants (Zhang and Hamauzuet, 2004). The methanolic extract of black carrot seeds has antioxidant action (Kumarasamy *et al.,* 2005; Shebaby *et al.*, 2013; Pereira *et al.,* 2021).

Anti-cancer effects

Carrot extracts comprising various quantities of falcarindiol, falcarinol, and falcarindiol 3-acetate had unique inhibitory properties on tumor cell propagation (Purup *et al.,* 2009). Furthermore, increased consumption of carotenoids found in carrots is associated with a substantial reduction in breast cancer after menopause (Swamy *et al.,* 2014).

In addition, black carrot seeds have anti-cancer effects (Shebaby *et al.,* 2013).

Immunoenhancer effects

Daucus carota comprises of different vitamins, for example, thiamin (B1), riboflavin (B2), vitamin C, vitamin K, vitamin B2, vitamin B6 and vitamin B9, which are required for uptake of proteins, sugars and strong development (Dias, 2012), hence play an important role in enhancing immunity.

Anti-diabetic activity

Nutritionist generally recommends that we eat carrots in moderation because they have a large amount of sugar than any other vegetable. However, more recent research demonstrates a significant relationship between diabetes and vitamin A-rich carotenoids (Coyne *et al.,* 2005; Akhtar *et al.,* 2017). Furthermore, the improved glucose absorbance limit and decrease of amylase action of carrot's dietary fiber may aid in regulating post-prandial serum glucose level (Chau *et al.,* 2004). These outcomes recommend that vitamin A-rich carotenoids and carrots can support diabetic patients to improve their ailment.

Cardiovascular and cholesterol-lowering effect

Carrot showed a significant decrease in triglyceride and liver cholesterol levels and carrot utilization improved the ferric reducing capacity of plasma. The results proposed that carrot consumption might shield against cardiac ailment related to atherosclerosis (Nicolle *et al.,* 2003). This outcome could be attributed to the dietary fiber's additive effect and antioxidant polyphenols present in carrot—Gramenzi (1990) associated the consumption of carrots with lesser chances of heart attacks in females.

Hepatoprotective and Renal protective actions

The possible consequences of bioactive compounds on the β-carotene bio-efficacy and antioxidant activity on rats' liver were observed in four types of bio-fortified carrots (Mills *et al.,* 2008). The properties of carrot seed extract upon the strong hepatotoxic amide (thioacetamide), were observed by Aydin *et al.* (2010). The effect of methanolic carrot seed extract on hepatic cells and antioxidant activity was also studied. The methanolic seed extract showed

hepatoprotective action and this activity was because of the antioxidant capacity of seed extract (Rezaei-Maghadam *et al.,* 2012; Singh *et al.,* 2012).

Wound healing effects

When a topical ointment of ethanolic root extract of black carrot was applied to animals at various concentrations, it exhibited many wound healing (Patil *et al.*, 2012).

Effect on cognitive functions

The ethanolic seed extract of *Daucus carota* L. reversed the hyoscine or diazepam-induced loss of memory in young mice.

In addition, the cholesterol level and acetylcholinesterase activity in the brain of mice was minimized by the administration of carrot seed extract (Vasudevan and Parle, 2006).

Anti-bacterial and Anti-fungal activity

Essential oils of the plant and seed have shown cytotoxicity, anti-fungal and antimicrobial activities (Tavares *et al.,* 2008). The essential oil gained from upper fragments of the black carrot exhibited antimicrobial action against the pathogen *Campylobacter jejuni* (Rossi *et al.,* 2007). An earlier study showed that oily extract of carrot seed demonstrated reasonable inhibitory properties on mycelia development of *Alternaria alternate*, a common phytotoxic fungus invading the carrot plant (Misiaka *et al.,* 2004).

Role in fertility

The effect of carrot seed extract in fertility is dependent on gender. The antifertility actions of carrot seeds are more prominent in females, as revealed from previous pharmacological studies (Bhatnagar 1995; Mujumdar *et al.,* 1997). In addition, when ethanolic seed extract of carrot was given orally to rats, they showed improved spermatogenesis (Nouri *et al.,* 2009).

Conclusion

Globally, *Daucus carota* is using to treat different ailments, while in traditional medicine, it is acceptable for its therapeutic properties. In the future, more research should perform to validate its therapeutic efficacy, toxicity, and safety.

Conflict of interest

None

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