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A Review: Pharmacological Actions of *Daucus carota*

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Jagdish Arun[2], B Shrivastava[2], SP Deshmukh[1]*, NS Bhajipale[1]

1. SGSPS Institute of Pharmacy, Akola, Maharashtra, India.

2. School of Pharmaceutical Sciences, Jaipur National University, Jaipur, Rajasthan, India

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ABSTRACT

The pharmacological studies revealed that the plant possessed cytotoxic, antioxidant, antidiabetic, antimicrobial, smooth muscle relaxant, hypotensive effect and decrease intraocular pressure, gastroprotective, nephroprotective, hepato-protective, cardio-protective antidepressant memory enhancement, anti-inflammatory, reproductive, wound healing and hear induction, and many other effects. The current review will highlight the chemical constituents, nutritional and pharmacological effects of *Daucus carota*. Carrots mainly contain four types of phytochemicals, *i.e.* phenolics, carotenoids, polyacetylenes, and ascorbic acid. Flavonols (quercetin, kaempferol, rutin or quercetin 3-rutinoside) and flavones (apigenin, luteolin and chrysin) were identified from different parts of carrot. Carrot gives appetite, astringent to the bowels, anti-dysentric, carminative, cardiotonic, aphrodisiac, expectorant, diuretic, stomachic, cure leprosy, pain, burning sensation, thirst, biliousness, tumours, good in inflammation and bronchitis, asthma, hiccough, corrects foul breath. Nephro Protection: *Daucus carota* is a scientific name of carrot belongs to family Apiaceae and it contains an array of chemical constituent. The plant probably originated in Persia and was originally cultivated for its leaves and seeds. The carrot is a biennial plant in the umbellifer family Apiaceae. The roots contain high quantities of alpha- and beta-carotene and are a good source of vitamin K and vitamin B6.

INTRODUCTION:

Daucus carota is a scientific name of carrot belongs to family Apiaceae and it contains an array of chemical constituent. The carrot (Daucus carota subsp. sativus) is a root vegetable, usually orange in colour, though purple, black, red, white, and yellow varieties exist. Carrots are a domesticated form of the wild carrot, *D. carota*, native to Europe and southwestern Asia. The plant probably originated in Persia and was originally cultivated for its leaves and seeds. The carrot is a biennial plant in the umbellifer family Apiaceae. The roots contain high quantities of alpha- and beta-carotene and are a good source of vitamin K and vitamin B6.[1]

The plant showed nutritional and therapeutic benefits including antimicrobial, antioxidant, anticancer, hypolipidemic, cardiovascular, central nervous, respiratory, immunological, anti-inflammatory, analgesic antipyretic, and many other pharmacological effects. Phytochemical analysis showed that the root of *D. carota* contained alkaloids, carbohydrates, chlorogenic acid, flavonoids, phenols, essential oil, terpenoid, and coumarin. The nutritional analysis of carrot juice showed that the juice contained: protein 1.067 ± 0.058%, crude fat 0.367 ± 0.089%, crude fibre 1.167 ± 0.153%, carbohydrates 6.100 ± 0.346%, many vitamins, and minerals. The pharmacological studies revealed that the plant possessed cytotoxic, antioxidant, antidiabetic, antimicrobial, smooth muscle relaxant, hypotensive effect and decrease intraocular pressure, gastroprotective, nephroprotective, hepato-protective, cardio-protective antidepressant memory enhancement, anti-inflammatory, reproductive, wound healing and hear induction, and many other effects. The current review will highlight the chemical constituents, nutritional and pharmacological effects of *D. carota*.

Botanical Classification

Botanical name: *Daucus carrota*

Kingdom: Plantae

Class: Magnoliopsida

Order: Apiales

Family: Apiaceae

Genus: Daucus

Division: Magnoliophyta

D. carota L. is an aromatic plant used since old times in traditional medicine, due to recognized therapeutic properties, namely the antibacterial and antifungal activity of their essential oils (carrot oil). Although this plant has been subject to investigations some scientific reports do not refer to the subspecies, a crucial aspect of this polymorphic species presenting 11 interrelated subspecies. Extracts of wild *D. carota* were known to be antioxidative and iron-chelating. The composition of the *D. carota* L. essential oil was variable according to the area of harvest, the part of the plant, and the stage of development. However, it could be summarized from literature data that leaf, stem, and blooming umbel oils are dominated by monoterpenes or sesquiterpenes. Conversely, oils isolated from umbels in nest or seeds were dominated by β-bisabolene and β-asarone or by (E)-methyl isoeugenol accompanied by α-pinene and elemicin such as in commercial oils from Corsica, isolated from aerial parts harvested at the end of the flowering stage.

DESCRIPTION

D. carota is a biennial plant that grows a rosett of leaves in the spring and summer while building up the stout taproot that stores large amounts of sugars for the plant to flower in the second year. Soon after germination**,** carrot seedlings show a distinct demarcation between the taproot and the stem. The latter is thicker and lacks lateral roots. At the upper end of the stem is the seed leaf. The first true leaf appears about 10–15 days after germination. Subsequent leaves, produced from the stem nodes, are alternating (with a single leaf attached to a node, and the leaves growing in alternate directions) and compounds, and arranged in a spiral. The leaf blades are pinnate. As the plant grows, the bases of the seed leaves are pushed apart. The stem, located just above the ground, is compressed and the internodes are not distinct. When the seed stalk elongates, the tip of the stem narrows and becomes pointed, extends upward, and becomes a highly branched inflorescence. The stems grow to 60–200 cm (20–80 in) tall.[2]

D. carota L. (Apiaceae) is an aromatic plant used since olden times in traditional medicine, due to recognized therapeutic properties, namely the antibacterial and antifungal activity of their essential oils (carrot oil). [36]

Leaves: Triangular to oblong in outline, 2-3 pinnatisect into oblong-lanceolate, incised-dentate segments those of the upper leaves linear-lanceolate. **Flowers:** umbel with very numerous rays, at length, contracted into a nest-like form; bracts of the involucre, 3-fid or pinnate, of the involucre linear, white, margined, entire or 2-3 fid; petals radiating; central

flower sterile, purple. **Fruits:** 4 mm. long, 3 mm. broad, including the prickles. Prickles setaceous, as long as the diameter of the seed or longer with 1-3 recurved barbs.[3,4]

Figure No. 1: ***Daucus carota***

CHEMICAL CONSTITUENTS

D. carota contains many phytochemical constituents such as carbohydrates are sugars and dietary fibres. Fats, proteins, vitamins like vitamin A, beta-carotene, lutein zeaxanthin, riboflavin, niacin, pathetic acid, vitamin B6, foliate, vitamin C, vitamin K. Minerals like calcium, iron, magnesium, phosphorous, potassium, sodium, and zinc. Carrots mainly contain four types of phytochemicals, *i.e.* phenolics, carotenoids, polyacetylenes, and ascorbic acid.[5,6]

Flavonols (quercetin, kaempferol, rutin or quercetin 3-rutinoside) and flavones (apigenin, luteolin and chrysin) were identified from different parts of carrot[7,8,9,10]. Furanocoumarin, 8-methoxypsoralen, and 5-methoxypsoralen (0 .01-0.02 pg/g fresh weight) were isolated from the fresh plant. Their concentrations were increased in the diseased plant[11].*D. carota* essential oil yields 3% for seeds and 2.1% for leaves. A total of 48 compounds were identified in *D. carota* essential oil of leaves, 46 in seeds essential oil. The essential oil from seeds was predominantly composed of oxygenated monoterpene (66.08 %) and oxygenated sesquiterpenes (16.41%). The main components were geranyl acetate (52.45%), cedrone S (14.04%), and asarone (11.39%). The oil from leaves is mainly composed of hydrocarbon monoterpenes (64.59%) and hydrocarbon sesquiterpenes (22.18%), α-pinene (27.44%), sabinene (25.34%), germacrene D (16.33%). [12]

Carrots are one of the best sources of β-carotene. The carotene content of carrots ranges from 60–120 mg/100 g, but some varieties can contain up to 300 mg/100 g.[35]

TRADITIONAL USES

Carrot gives appétit, astringent to the bowels, anti-dysentric, carminative, cardiotonic, aphrodisiac, expectorant, diuretic, stomachic, cure leprosy, pain, burning sensation, thirst, biliousness, tumours, good in inflammation and bronchitis, asthma, hiccough, corrects foul breath.[13] Nephro Protection: This improves kidney function in a significant way on renal ischemia-reperfusion injury in rats.[14] The essential oil was used to flavor liqueurs and perfumes. Seeds were aromatic, carminative, diuretic, emmenagogue, stimulant, and were used for dropsy, chronic dysentery, kidney ailments, worms, as an aphrodisiac, nervine tonic, and uterine pain. Roots were refrigerant and used in infusion for threadworm, as a diuretic, and eliminating uric acid.[15] The ethnobotanical uses of this species also included applications in the treatment of cough, diarrhea, dysentery, cancer, malaria, tumors, as an antiseptic, abortifacient, aphrodisiac, carminative, stimulant, stomachic, and tonic.[16] *D. carota* was used by the Ancient Egyptians as a stimulant, carminative, diuretic, anthelmintic, and decoction for infantile diarrhea.[17]Parts used: Roots, leaves, and seeds.[18]

MEDICINAL USES

1. IMMUNOENHANCER BENEFITS

The immunomodulatory effect of carrot-extracted carotenoid using 24 albino rats was studied. The percentage variation in lymphocytes, eosinophils, monocytes, and platelet count was evaluated. Interestingly, carotenoid administered rats showed a significant increase in lymphocytes, eosinophils, monocytes, and platelet concentration. The beneficial effect was due to carrot's α- and β-carotenoids. [20]

2. ANTICARCINOGEN

The anti-carcinogenic effect of carrot juice extracts on myeloid and lymphoid leukemia cell lines. *In vitro* analysis was done on 72 hours incubation of carrot juice extracts in leukemia cell lines and non-tumor control cells. It was observed that carrot juice extract possessed the ability to induce apoptosis and cause cell cycle arrest in leukemia cell lines. The effect was less prominent in myeloid and hematopoietic stem cells. Those investigators considered that

β-carotene and falcarinol present in the carrot juice extract may have been responsible for this beneficial effect of "kill" leukemia cells and inhibit their progression.[19]

Anti-cancer activity and other health benefits provided by β-carotene include the protection against cardiovascular disease or cataract prevention.

3. ANTI-HYPOGLYCEMIC

Recent research demonstrates a significant association between vitamin A-rich carotenoids and diabetes status. According to these investigators higher blood glucose levels, as well as higher fasting levels of insulin, were observed in study participants with lower levels of carotenoids. Carotenoid levels also decreased as the severity of glucose intolerance increased. These findings suggest that carrot and vitamin A-rich carotenoids might help diabetics to manage their condition.

Comparing the characteristics, properties, and *in-vitro* hypoglycemic effects of various carrot water-insoluble fiber-rich fractions, observed that dietary fiber-rich fractions, which contained not only water-insoluble dietary fiber but also alcohol and water-insoluble solids, isolated from carrot pomace exhibited glucose-adsorption capacity and amylase inhibition activity. Dietary fiber transports also a significant amount of polyphenols and carotenoids linked to the fiber matrix through the human gut and this research is concluded that the enhanced glucose absorbance capacity and reduction of amylase activity of dietary fiber of carrot might help control post-prandial serum glucose level. This study confirmed the strong relationship between dietary fiber intake and a lower risk of type 2 diabetes.[21,22]

4. CHOLESTEROL

Carrot showed cholesterol absorption mitigating effects in experimental carrot-fed rats. Regulation in bile acid secretion and antioxidant status was also reported. A significant decrease in liver cholesterol and triglyceride levels was also observed by these investigators. Moreover, carrot consumption increased the vitamin E level in plasma and increased the ferric reducing ability of plasma. The results suggested that carrot intake may exert a protective effect against cardiovascular disease linked to atherosclerosis. The effect may be due to the synergistic action of dietary fiber and antioxidant polyphenols in carrots. The consumption of carrots has also been associated with a lower risk of heart attacks in women.[23]

5. ANTI-HYPERTENSIVE

The anti-hypertensive effect of two coumarin glycosides (DC-2 and DC-3) from carrots. Dose-dependent intravenous administration of these glycoside compounds caused a decrease in arterial blood pressure in normotensive anesthetized rats. Moreover, *in vitro* studies by the same investigators showed that the glycoside compounds caused inhibitory effects on spontaneously beating guinea-pig atria, as well as on the kt-induced contractions of rabbit aorta. The authors concluded that the decreased blood pressure observed *in vitro* studies may be due to the calcium channel blocking the action of coumarin glycosides (DC-2 and DC-3) from carrots.[24,25]

6. HEPATOPROTECTIVE

Carrot extract help to protect the liver from acute injury by the toxic effects of environmental chemicals. In its study, the effect of carrot extract on carbon tetrachloride (CCl_4)-induced acute liver damage in mouse was evaluated. The increased serum enzyme levels by CCL_4-induction were significantly lowered due to pre-treatment with the carrot extract. The carrot extract also decreased the elevated serum bilirubin and urea content due to CCl_4 administration. Increased activities of hepatic 5'-nucleotidase, acid phosphatase, acid ribonuclease, and decreased levels of succinic dehydrogenase, glucose-6-phosphatase, and cytochrome P-450 produced by CCl_4 were reversed by the carrot extract in a dose-responsive way. The investigators concluded that the results of this study revealed that carrots could afford a significant protective action in the alleviation of CCl4- induced hepatocellular acute injury.[26]

7. WOUND HEALING

Animals treated with topical cream of ethanolic extract of carrot root, formulated at different concentrations, showed significant decreases in the wound area, epithelization period, and scar width when compared to control group animals in an excision wound model. Meanwhile, the rate of wound contraction significantly increased. Moreover, there were also significant increases in wound tensile strength, hydroxyproline content, and protein content in animals treated with the topical cream formulation of ethanolic extract of carrot seeds. The antioxidant and anti-microbial activities of ethanolic extract of carrot root, mainly flavonoids and phenolic derivatives, may be involved in this increased curative property. Wound healing

effects may also be due to regulation of collagen expression and inhibition of elevated levels of lipid peroxides.[27]

8. MEMORY ENHANCER

The antidepressant potential of ethanol root extract of *Daucus carota* (DC) was studied in different animal models, forced swim test (FST), tail suspension test (TST).

D. carota seeds are a promising therapy to improve memory especially in the management of Alzheimer's patients.

9. ANTIINFLAMMATORY EFFECT

D. carota seeds were investigated for anti-inflammatory and analgesic activity at the doses of 100, 200, and 400 mg/kg bw, orally. Carrageenan-, histamine- and serotonin-induced paw edema were used to study the effect of the extract in the acute inflammatory model, while, formaldehyde-induced arthritis was employed as a chronic model in rats.[28]

10. ANTIFUNGAL EFFECT-

The chemical composition and the antifungal activity of the essential oil of *D. carota* subsp. halophilus were evaluated against yeasts, dermatophyte, and Aspergillus strains. Dermatomycoses are common infections caused by filamentous fungi (especially dermatophytes) and by some yeasts that can be severe in immunocompromised patients.[36]

SEED CARROT EXTRACTS

Seed carrot extracts and its essential oil have been reported in experimental studies to have cardio- and hepatoprotective, cognitive dysfunction, cholesterol-lowering, anti-bacterial, anti-fungal, anti-inflammatory, analgesic, and wound healing benefits.

The extracts showed that they contained alkaloids, carbohydrates, chlorogenic acid, flavonoids, phenols, terpenoid, and coumarin. Flavonols (quercetin, kaempferol, rutin or quercetin 3-rutinoside) and flavones (apigenin, luteolin and chrysin) were identified from different parts of carrot.

Furanocoumarin, 8-Methoxypsoralen, and 5-methoxypsoralen (0 .01-0.02 pg/g fresh weight) were isolated from the fresh plant. Their concentrations were increased in the diseased plant

D. carota essential oil yields 3% for seeds and 2.1% for leaves. A total of 48 compounds were identified in *D. carota* essential oil of leaves, 46 in seeds essential oil. The essential oil from seeds was predominantly composed of oxygenated monoterpenes (66.08 %) and oxygenated sesquiterpenes (16.41%). The main components were geranyl acetate (52.45%), cedrone S (14.04%), and asarone (11.39%).

The oil from leaves is mainly composed of hydrocarbon monoterpenes (64.59%) and hydrocarbon sesquiterpenes (22.18%), α-pinene (27.44%), sabinene (25.34%), germacrene D (16.33%). Mojaba *et al*. mentioned that the leaves of carrot (*D. carota* L. subsp. sativus (Hoffman.) Arcang. from Iran gave 0.2 % (v/w) essential oil. Ninety-one compounds were identified in the essential oil. The main class of the compounds was monoterpenes (30.0 %), sesquiterpenes (27.8 %), and phenyl propane (26.4 %). The major constituents were trans-anethole (23.5 %) and myrcene (14.5 %). The changes occurring in the essential oil yield and chemical composition of *D. carota* L. subsp. sativus (Hoffm.) Arcang. during flowering and fruiting process were studied.

The essential oil yield varied from 0.7% to 1.8% (v/w) during umbel ontogeny. The resulted essential oils contained 34 constituents, forming 94.5–97.9% of the total compositions. The essential oil composition was characterized by high proportions of monoterpenoids (35.9–81.3%) and sesquiterpenoids (15.1–62.0%). [37]

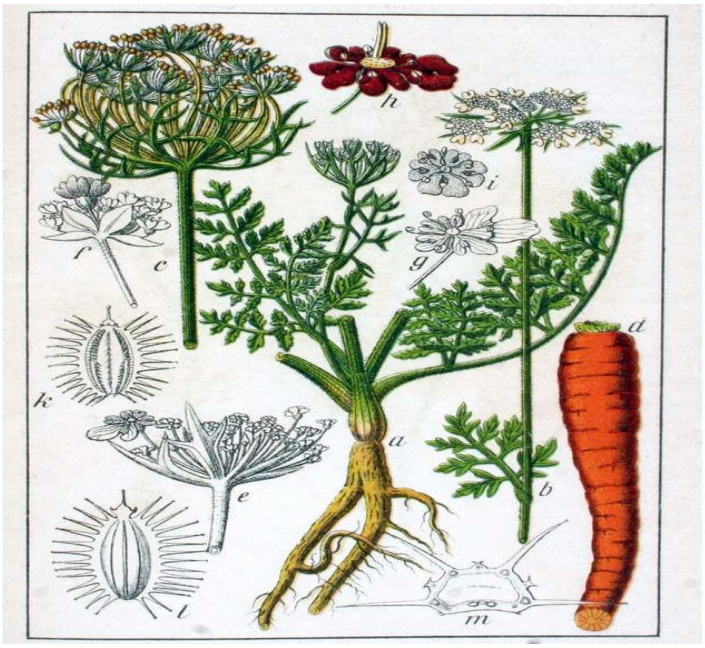

Figure No. 2: Seeds of *D. carota*

PHARMACOLOGICAL USES

11. CARDIO- AND HEPATOPROTECTIVE BENEFITS

Carrot seed extract offers cardioprotection and muscle contraction regulation in isoproterenol-induced myocardial infarction in rats by maintaining membrane-bound enzymes. From these results, investigators concluded that the carrot seed extract might have inotropic effects. Notably, levels of serum aspartame transaminase, alanine transaminase, and lactate dehydrogenase were significantly lower in carrot seed extract-fed rats.[29]

12. COGNITIVE DYSFUNCTION AND CHOLESTEROL-LOWERING

Cognition includes all aspects of perceiving, learning, thinking, and remembering. The cognitive dysfunctions include delirium, behavioral disorders, and dementia. Cognitive impairment is the leading cause of neurodegenerative diseases such as Alzheimer's disease and dementia in elderly individuals. It is characterized by progressive memory loss and personality defects accompanied by structural abnormalities in the brain like speech disorder and loss of space orientation. Carrot seed extract reversed the memory deficits in scopolamine (or diazepam)-induced amnesia in young mice. These investigators concluded that administration of carrot seed extract reduced brain acetylcholinesterase activity and cholesterol levels in mice (acetylcholine synthesis is mediated by choline and acetyl coenzyme A in the presence of the enzyme choline acetyltransferase). Furthermore, they observed that the ethanolic extract of carrot seeds improved the retention capacity of aged mice when administrated orally for 7 days.17 And it resulted that enhanced cholinergic transmission resulted from increased acetylcholine synthesis in the brain due to abundant availability of choline and reduction of brain cholinesterase activity.[30]

13. ANTI-BACTERIAL AND ANTI-FUNGAL BENEFITS

Carrot seed oil extracts exhibited moderate inhibitory effects on mycelia growth of *Alternaria alternate* (one of the most popular phytotoxic fungi infesting the carrot plant), isolated from the surface of carrot seeds cultivar Perfekcja. Experiments, namely with the chemical compounds, carotol, *β*-caryophyllene, and daucol were carried out to find out whether the observed activity was derived from the action of carotol alone or a synergistic action. Carotol significantly inhibited the growth of the fungi and reduced the colony radial size. Meanwhile, the inhibitory effect produced by daucol was comparatively less than carotol. No effect was

exerted by β-caryophyllene. The results suggested that carotol is the main agent responsible for the anti-fungal activity of carrot seed oil extracts. [31]

14. ANTI-INFLAMMATORY AND ANALGESIC BENEFITS

The anti-inflammatory and analgesic effects of carrot seed extract have been reported experimentally. The carrot seeds possess an anti-inflammatory effect. In their research paw edema was induced in rats using carrageenan histamine, and serotonin; and arthritis was induced using formaldehyde. Surprisingly, the disease condition decreased in rats fed with a high dose of carrot seed extract. Furthermore, to assess the carrot's analgesic activity, the writing effect was induced by intraperitoneal injection. There was a significant reduction in the writhing effect after the administration of carrot seed extract.[32]

15. FERTILITY BENEFITS

The fertility effect of carrot seed extract is gender-dependent. Pharmacological studies showed that carrot seeds exhibit anti-fertility properties in females. The carrot seed extract induces spermatogenesis in male rats. They observed that rats fed with carrot seed extract recovered from gentamicin-induced reproductive toxicity and displayed enhanced spermatogenesis. Thus, carrot seed extract was able to induce spermatogenesis and cauda epididymal sperm reserves. The probable biochemical mechanism behind the effect is through the elevation of testosterone levels in male rats. Besides carrot seed extracts are rich in antioxidants and therefore the elevation in cauda epididymal sperm reserves may be also attributed to its antioxidant effect. [33,34]

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