

PHARMACOLOGICAL HEALTH BENEFITS OF *DAUCUS CAROTA*: A REVIEW

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ABSTRACT

Carrot is one of the important root vegetables rich in bioactive compounds like carotenoids and dietary fibres with appreciable levels of several other functional components having significant health-promoting properties. It is rich in beta carotene, ascorbic acid, tocopherol and classified as vitaminized food. The consumption of carrot and its products is increasing steadily due to its recognition as an important source of natural antioxidants having anticancer activity. The paper reports on its pharmacological health benefits such as anti-diabetic, cholesterol and cardiovascular disease lowering, anti-hypertensive, hepatoprotective, renoprotective, and wound healing, nephroprotective, anti-ulcer properties and the health benefits of carrot seed extracts.

Keywords: *Daucus carota*, antioxidant, carotenoids, anthocyanin.

INTRODUCTION

Plants are richest source for phytochemicals and nutraceuticals. It plays a role as an alternative medicine for drugs. Phytochemicals are primary and secondary compounds found in plants. These active substances in plants have been used for medicinal purposes from the prehistoric time, as home remedies, an over-the-counter drug products, and dietary supplement. Chlorophyll, proteins and common sugars are the primary constituents and secondary compounds have terpenoids, alkaloids and phenolic compounds. The active phytoconstituents of plant have become keen interest in recent time due to its resourceful applications. Secondary metabolites present in smaller quantities in higher plants, include the alkaloids, steroids, flavonoids, terpenoids, tannins, and many others. Consumption of vegetables can lower the incidence and mortality rates of many ailments viz., cancer, cardiovascular and cerebrovascular diseases, which may be due to vegetable antioxidants. Phenolic compounds account for a major portion of the antioxidant capacity in many plants. Carrots have been ranked 10th in nutritional value among 39 fruits and vegetables.



Daucus carota Linn, common known as Carrot, belongs to the family (Apiaceae Umbelliferae) and is cultivated almost all over the world as a useful vegetable, carrot is widely consumed as an aphrodisiac and nervine tonic and its scarped root is used as a topical stimulant for indolent ulcers, the plant has undergone extensive phytochemical studies and large number of active ingredients have been isolated. These include volatile oils, steroids, tri terpenes, carbohydrates, glycosides, tannins, flavonoids, amino acid, carotene and hydro carotene. Carotenoids and anthocyanins are the major antioxidant pigments found in carrots. Its water extract has antioxidant properties and it could be a potential therapeutic for the pathologies linked with the breaking due to free radicals^{1,2}. The pharmacological studies revealed that the plant possessed cytotoxic, antioxidant, antidiabetic, antimicrobial, smooth muscle relaxant, hypotensive effect and decrease intraocular pressure, gastro-protective,

nephro-protective, hepato-protective, cardio-protective, antidepressant, memory enhancement, anti-inflammatory and reproductive, wound healing and hair induction and many other effects.



PHARMACOLOGICAL ACTIVITIES ANTI-OXIDANT

Carotenoids, polyphenols and vitamins present in carrot act as antioxidants which can neutralize the effect of free radicals. They have been shown to have inhibition mutagenesis activity contributing to decrease risk of some cancers. The flavonoids and phenolic derivatives present in carrot roots play also an important role as antioxidants. They also exert anti carcinogenic activities, reduce inflammatory insult, and modulate immune response^{3, 4}. The anthocyanin obtained from carrot showed an antioxidation activity⁵.

ANTI-CARCINOGEN

The anti-carcinogenic effect of carrot juice extracts on myeloid and lymphoid leukaemia cell lines. *In vitro* analysis was done on 72 hours incubation of carrot juice extracts in leukaemia cell lines and non-tumour control cells. It was observed that carrot juice extract possessed the ability to induce apoptosis and cause cell cycle arrest in leukaemia 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" leukaemia cells and inhibit their progression⁶.

ANTI-CLASTOGENIC

The anti-clastogenic activity of carrot on Chinese hamster ovary (CHO) cells and human lymphocytes. In pre-treated rats, fresh carrot juice was shown to attenuate the increase in the frequencies of sister-chromatid exchanges induced by cyclophosphamide in wild-type and mutant CHO cells⁷. Rats were assayed and treated with (azoxymethane)

AOM and fed with carrot and falcarinol isolated from carrot. The results showed that there was a significant reduction in tumours and aberrant crypt foci (ACF) in rats fed with carrot and falcarinol. The investigators concluded that this evidence indicates that dietary treatment with carrot and falcarinol has the potential to delay or retard the development of large ACF and colon tumors.¹⁰

IMMUNOENHANCER BENEFIT

The immunomodulatory effect of carrot-extracted carotenoids using 24 albino rats. The percentage variation in lymphocytes, eosinophils, monocytes and platelet count was evaluated. Interestingly, carotenoids administered rats showed a significant increase in lymphocytes, eosinophils, monocytes and platelet concentration. The beneficial effect was due to carrot's α - and β -carotenoids⁸.

ANTI-DIABETIC

Carrot and vitamin A-rich carotenoids might help diabetics to manage their condition, comparing the characteristics, properties and *in vitro* hypoglycaemic effects of various carrot water insoluble fibre-rich fractions, observed that dietary fibre-rich fractions, which contained not only water insoluble dietary fibre but also alcohol and water insoluble solids, isolated from carrot pomace exhibited glucose-adsorption capacity and amylase inhibition activity⁹. The enhanced glucose absorbance capacity and reduction of amylase activity of dietary fibre of carrot might help control post-prandial serum glucose level. This study confirmed the strong relationship between dietary fibre intake and lower risk of type 2 diabetes^{2, 3}.

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. The carrot intake may exert a protective effect against cardiovascular disease linked to atherosclerosis. The effect may be due to the synergistic action of dietary fibre and antioxidant polyphenols in carrot. The consumption of carrots has also been associated with lower risk of heart attacks in women¹⁰.

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 anaesthetized rats. The *in vitro* studies 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 action of coumarin glycosides (DC-2 and DC-3) from carrots¹².

HEPATOPROTECTIVE

The carrots extract help to protect liver from acute injury by the toxic effects of environmental chemicals. In its study the effect of carrot extract on carbon tetrachloride (CCl₄)-induced acute liver damage in mouse was evaluated. The increased serum enzyme levels by CCl₄-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 CCl₄ 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 CCl₄ were reversed by the carrot extract in a dose-responsive way. The investigators concluded that results of this study revealed that carrot could afford a significant protective action in the alleviation of CCl₄- induced hepatocellular acute injury¹².

RENOPROTECTIVE

The Renoprotective activity of carrot root extract on renal ischemia reperfusion acute injury in rats. Rats with renal reperfusion injury showed significantly decreased activity of superoxide dismutase, atalase and glutathione, and a significant increase in malondialdehyde level. The study revealed that carrot extract exerts Renoprotective activity against ischemia reperfusion induced kidney acute injury, by reducing free radical scavenging activity one of the mechanisms behind ischemia reperfusion damage of kidneys²³.

WOUND HEALING

The animals treated with topical cream of ethanolic extract of carrot root, formulated at different concentrations, showed significant decreases in wound area, epithelisation period and scar width when compared to control group animals in an excision wound model. Meanwhile, 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 derivates, 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 peroxides¹⁴.

NEPHROPROTECTIVE

The serum uric acid levels were found to be increased because of accumulation by the decrease in glomerular filtration rate in gentamicin-intoxicated rats, but with the supplementation of *Daucus Carota*, it dose dependently ameliorated the gentamicin-induced elevated serum levels of urea, BUN, uric acid, and creatinine in all groups. These results notified the improved renal function by the effective clearance of urea, BUN, creatinine, and uric acid. The increased wet kidney weight of gentamicin-treated rats due to edema induced by acute tubular necrosis was even normalized by the carrot treatment. Thus, the results notified that carrot may act by antagonizing the gentamicin-implicated acute renal tubular necrosis and acidosis to attenuate the nephrotoxicities. Polyphenolic compounds reported to possess nephroprotective property by promoting antioxidant enzyme system, thereby attenuating ROS generation and lipid peroxidation. The natural antioxidants such as β -carotene, a terpenoids constituent of the crude extract can ameliorate the nephrotoxicities by its free radical scavenging activity¹⁵.

ANTI-ULCER

The antiulcer activity of fresh juice extract of the roots of carrot was assessed by the parameters i.e. volume of gastric section, pH, free acidity, total acidity, mucus content and ulcer index. The *Daucus carota* extract possesses gastro protective property and the results supported traditional use of the roots of this plant in the treatment of gastric ulcer and acidity¹⁶.

HEALTH BENEFITS OF 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 and

analgesic and wound healing, herbicidal, insecticidal, memory improvement, diuretic, muscle relaxant and lowering blood pressure, hypolipidemic benefits.

CARDIO-AND HEPATOPROTECTIVE BENEFITS

Carrot seed extract offers cardio protection 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 aspartate transaminase, alanine transaminase and lactate dehydrogenase were significantly lower in carrot seed extract fed rats¹⁷. The *invitro* antioxidant and hepatoprotective activity of methanolic extracts of carrot seeds. This study concluded that the hepatoprotective activity of the carrot seed extract was due to the antioxidant potential of carrot seed extract¹⁸.

COGNITIVE DYSFUNCTION AND CHOLESTEROL LOWERING BENEFITS

Cognitive impairment is the leading cause of neurodegenerative diseases such as Alzheimer's disease and dementia in elderly individuals. 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 acetyl cholinesterase 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 days¹⁹. 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.

ANTI-BACTERIAL AND ANTI-FUNGAL BENEFITS

Carrot seed oil extracts exhibited moderate inhibitory effects on mycelia growth of *Alternaria alternata* (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 from

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 extracts²⁰.

ANTI-INFLAMMATORY AND ANALGESIC BENEFITS

The anti-inflammatory and analgesic effects of carrot seed extract have been reported experimentally. 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, in order to assess the carrot's analgesic activity, writhing effect was induced by intra-peritoneal injection. There was a significant reduction in writhing effect after the administration of carrot seed extract²¹.

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 effect²².

HERBICIDAL

Carrot seed essential oil exhibited herbicidal properties. Whereas the water extracts from the carrot seed exhibited plant growth inhibitory properties against cress, cucumber, onion and carrot due to the action of low-and high-molecular components of the extract. Crotonic acid ((*E*)-2-butenic acid), low-molecular component with high level in seeds was also available after release to soil, might be considered as an allelopathic and autotoxic factor in the seeds²³.

INSECTICIDAL

Compounds isolated from the bioactive hexane extract of carrot seeds i.e. 2, 4, 5-trimethoxy benzaldehyde, oleic acid, trans-sarone, and geraniol were evaluated for their mosquitocidal activity. Larvicidal activity of the essential oil and the constituents from carrot plant was reported against *C. pipiens pallens* and *D. magna*. It was found that active components of carrot essential oil could be developed as control agents against mosquito larvae²⁴.

MEMORY IMPROVEMENT

A study on the effects of carrot seeds on memory in rats revealed that, the ethanolic extract was administered orally in three doses (100, 200 and 400mg/kg) for seven successive days to different groups of young and aged rats. Extracts (200 and 400 mg/ kg) showed significant improvement in memory of young and aged rats. Carrot extract also reversed the amnesia induced by scopolamine (0.4 mg/kg) and diazepam (1 mg/kg)²⁵.

MUSCLE RELAXANT AND LOWERING OF BLOOD PRESSURE

Ethanolic extract of *D. carota* exhibited Ca²⁺ channel blocking-like direct relaxant action on cardiac and smooth muscle preparations and lowered the blood pressure due to presence of two coumarin glycosides in aerial parts. The seed oil obtained from *D. carota* was reported to elicit CNS hypnotic effects in the rat, hypotension, direct depressant effect on cardiac muscle in the dog, leading to respiratory depression at higher doses, anticonvulsant activity in the frog, *in vitro* smooth muscle relaxant activity²⁶.

DIURETIC

Terpinen-4-ol, component of the carrot seed oil and juniper was considered to be the diuretic principle exerting its effect by causing renal irritation. The traditional use of wild carrot was as a diuretic and ethanolic extract of carrot produced an increased urine flow in dogs²⁷.

HYPOLIPIDEMIC

The hypolipidemic activity of carrot seeds in rats. It was observed that rats fed with carrot seeds showed a reduction in the total cholesterol and triglyceride HLD and VLDL as compared with the control group of rats²⁸.

CONCLUSION

Carrot has remarkable nutritional and health benefits. They are enriched with carotenoids, phenolic compounds, polyacetylenes, and vitamins and by this reason they may help

reduce the risk of some diseases. The present review reveals the active constituents, pharmacological health benefits of *Daucus carota*. The carrot has been studied for its various pharmacological health benefits like anti-diabetic, cholesterol and cardiovascular disease lowering, anti-hypertensive, hepatoprotective, renoprotective, and wound healing, nephroprotective, anti-ulcer properties. Cardio- and hepatoprotective, cognitive dysfunction, cholesterol lowering, anti-bacterial, anti-fungal, anti-inflammatory, analgesic and wound healing, herbicidal, insecticidal, memory improvement, diuretic, muscle relaxant and lowering blood pressure, hypolipidemic benefits of carrot seed extract also reported.

REFERENCES

1. Judita B, Petra K, Janette M, Alena V, Tomáš T, Marianna L. Carrot (*Daucus carota* L. ssp. *sativus* (Hoffm.) Arcang.) As source of antioxidants.
2. Antia BS, Okokon JE. Effect of juice of *Catharantus roseus* Linn on cholesterol, triglyceride and lipoproteins levels in normal rats, Indian J Pharmacol, 2005, 37, (6) :401-402.
3. Dias, J.S. Major Classes of Phytonutriceuticals in Veg and Health Benefits: A Review. J of Nutritional Therapeutics, 2012; 1, 31-62.
4. Dias, J.S. Nutritional Quality and Health Benefits of Veg: A Review. Food and Nutrition Sciences, 2012; 3, 1354-74.
5. Ravindra PV, Narayan MS. Antioxidant activity of the anthocyanin from carrot (*Daucus carota*) callus culture.
6. Zaini R, Clench MR, Maitre, CL. Bioactive Chemicals from Carrot (*Daucus carota*) Juice Extracts for the Treatment of Leukemia. J of medicinal food. 2011; 14, 1303-1312.
7. Darroudi F, Targa H, Natarajan AT. Influence of Dietary Carrot on Cytostatic Drug Activity of Cyclophosphamide and Its Main Directly Acting Metabolite: Induction of Sister-Chromatid Exchanges in Normal Human Lymphocytes, Chinese Hamster Ovary Cells, and Their DNA Repair-Deficient Cell Lines. *Mutation Research*. 1988; 198, 327-335.
8. Ekam VS, Udosen EO, Chighu AE. (2006) Comparative Effect of Carotenoid Complex from Goldenrod-Life Dynamite and Carrot Extracted

- Carotenoids on Immune Parameters in Albino Wistar Rats. *Nigerian J Phys Sci.*2006; 21, 1-4.
9. Chau CF, Chen CH, Lee MH. Comparison of the Characteristics, Functional Properties, and *in Vitro* Hypoglycaemic Effects of Various Carrot Insoluble Fibre-Rich Fractions. *Lebensmittel-Wissenschaft und Technologie.*2004; 37, 155-160.
 10. Nicolle C, Cardinaul, N, Aprikian O, Busserolles J, Grolier P, Rock E *et al.* Effect of Carrot Intake on Cholesterol Metabolism and on Antioxidant Status in Cholesterol-Fed Rat. *Euro J Nutri.*2003; 42, 254-261.
 11. Gilani AH, Shaheer F, Saeed SA, Bibi S, Irfamilah-Sadiq M Faiz S. Hypotensive Action of Coumarin Glycoside from *Daucus carot.* *Phytomedicine.*2000;7, 423-426.
 12. Bishayee A, Sarkar A, Chatterjee M. Hepatoprotective Activity of Carrot (*Daucus carota* L.) against Carbon Tetrachloride Intoxication in Mouse Liver. *J Ethno pharmacology.* 1995;47, 69-74.
 13. Mital PR, Laxman PJ, Ramesshvar PK. Protective Effect of *Daucus carota* Root Extract against Ischemia Reperfusion Injury in Rats. *Pharmacology.* 2011; 1, 432-439.
 14. Patil MV, Kandhare AD, Bhise SD. Pharmacological Evaluation of Ethanolic Extract of *Daucus carota* Linn Root Formulated Cream on Wound Healing Using Excision and Incision Wound Model. *Asian Pacific J Tropical Biomed.* 2012;2, S646-S655.
 15. Vamsi S, Latha P, Raviteja M, Saisudheer M. Carrot (*Daucus carota* L.): Nephroprotective against gentamicin-induced nephrotoxicity in rats .2016;48(2):122-127
 16. Nayeem K, Godad A, Hashilkar N and Joshi R. Gastroprotective activity of the aqueous extract from the roots of *Daucus carota* L in rats *IJRAP.*2010;1 112-119
 17. Muralidharan P, Balamurugan G Kumar P. Inotropic and Cardioprotective Effects of *Daucus carota* Linn. On Isoproterenol-Induced Myocardial Infarction. *Bangladesh J Pharmacology.*2008; 3, 74-79.
 18. Singh K, Singh N, Chandy A, Maniganha A. *In Vivo* Antioxidant and Hepatoprotective Activity of Methanolic Extracts of *Daucus carota* Seeds in Experimental Animals. *Asian Pacific J Tropical Biomed.* 2012; 2,385-388.
 19. Vasudevan M, Parle M. Pharmacological Evidence for Potential of *Daucus carota* in the Management of Cognitive Dysfunctions. *Biolog and Pharmaceu Bulletin.*2016; 29, 1154-1161.
 20. Misiaka IJ, Lipoka J, Nowakowska EM, Wieczorek PP, Mlynarz P, Kafarski P. Antifungal Activity of Carrot Seed Oil and Its Major Sesquiterpene Compounds. *Zeitschrift Fur Naturforschung.*2004; 59, 791-796.
 21. Vasudevan M, Gunnam KK, Parle M. Anticonceptive and Anti-Inflammatory Properties of *Daucus carota* Seeds Extract. *J Health Sci.* 2006; 52, 598-606.
 22. Nouri M, Khaki A, Azar FF , Rashidi MR. The Protective Effects of Carrot Seed Extract on Spermatogenesis and Cauda Epididymal Sperm Reserves in Gentamicin Treated Rats. *Yakhteh Medi J.*2009; 11, 327-333.
 23. Jasicka-Misiak I, Wieczorek PP, Kafarski P . Crotonic acid as a bioactive factor in carrot seeds (*Daucus carota* L.) *Phtyochem.*2005; 66, 1485-1491.
 24. Dalvir K, Khushminder KC, Pavneet K, Ramandeer K. Carrot Plant-A Potential Source of High Value Compounds and Biological Activities: A Review
 25. Vasudevan M, Milind P, Kalavathy R, Abu B, Abdul M. Anti-dementia potential of *Daucus carota* seed extract in rats *Pharmacology Online.*2010; 1; 552-565
 26. Gambhir SS. Studies on *Daucus carota*, Linn. Part I Pharmacological studies with the water soluble fraction of the alcoholic extract of the seeds : A preliminary report *IJMR.*1966;, 54 178-187
 27. Stanic G, Samarzija I and Blazevic N. Time-dependent diuretic response in rats treated with Juniper berry preparations *Phytother Res.*1988;12, 494-497
 28. Sing K, Dhongade H, Sing N, Kashyap P. Hypolipidemic Activity of Ethanolic Extract of *Daucus carota* Seeds in Normal Rats. *Int J Biomed Adv Res.*2018; 1, 73-80.