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Carum Carvi- An Updated Review

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Abstract
Carum carvi (Caraway) is a biennial plant (Family Apiaceae), native to western Asia, Europe and North Africa. It is reputed and extensively ayurvedic plant used for various therapeutic purposes. It contained a wide range of chemical constituents like essential oils, volatile oils, flavonoids, proteins, carbohydrates, vitamins and trace elements. The previous studies showed that its chemical constituents exerted anti-diabetic, antioxidant, hepatoprotective, antiulcerogenic, antimicrobial, Insecticidal, diuretic, analgesic, renoprotective, molluscicidal, endocrine, anti-cholinesterases, Immunomodulatory properties. This review is a step to open insight for therapeutic efficacy of *Carum carvi*.

Introduction

Ayurveda is an ancient Indian therapeutic system, which is based on the curative and prophylactive properties of plants and plant derived products. A very large number of medicinal herbs of various taxonomic genera are included in many forms in this traditional therapy, which are also relied upon in other indigenous systems of medicine practiced in Southeast Asia, such as Siddha and Unani systems. *Carum carvi*, belonging to the family Apiaceae[1] according to recent articles *Carum carvi* belonging to the family Umbelliferae[2]. It is one of the earliest cultivated herbs in Asia, Africa and Europe [1]. Traditionally, the dried ripe fruits and leaves of the plant are used in folk medicine especially in the treatment of digestive disorders. The *Carum carvi* has also been mentioned vegetable in the preparation of soups, salads and sauces [3]. This oldest herbs is full of specific pleasant aroma because of its aromatic properties, it is used as a flavorant in ice cream, candy, meat, cheese, condiments, soft drinks, alcoholic beverages and further it is used in liqueurs, mouthwashes, toothpastes, perfumes, soaps and cosmetics [2].

Scientific Classification[4,5]
Kingdom: Plantae
Subkingdom: Tracheobionta
Super division: Spermatophyta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Rosidae
Order: Apiales
Family: Apiaceae
Genus: Carum
Species: *Carvi* L

Vernacular Name[5,6]
English: Black Caraway, Caraway
Hindi: Kalajira
Sanskrit: Asitajiraka, Krishna jeeraka
Tamil: Karamjiragam, Shimaishambu
Telugu: NallaJeelakarra
Unani: ZeeraaSiyaah, Kamoon, Kamoon-roomi
Urdu: Kala Zira and KaroJeero, Zira Siyah

Origin and distribution

Carum carvi, which is also known as caraway, is one of the oldest spices cultivated in Europe. Now days, it is cultivated in countries such as Jamaica, India, Canada, United States and Australia. In India, this spice is known as Kashmiri jeera[7].

Cultivation

In the first year, caraway is grown under a cover crop. If roots reach a diameter of 6 mm in the first year, plants will bolt and flower the following year. If the required root diameter is not reached, the plants will remain vegetative for one more year. Based on this knowledge farmer some time harvest caraway in two consecutive years. Caraway flowers in May and is harvested at the beginning of July. Spring caraway is an annual form of caraway. It is not grown under a cover crop. From bolting until harvest it is very similar to biennial caraway. Flowering and harvest are approximately 2.5 months later in the season than in biennial caraway [8].

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***CarumCarvi* Seeds**

***CarumCarvi* Leaves**

Plant Description

Caraway is normally a biennial and multi branched herb, 35-70 cm in height, with narrow finely grooved leafy stems. It produces a deep taproot and a rosette of dark green, finely cut, feathery leaves. It has a high vernalisation requirement to initiate the production of flowering stems in the second year, which grow to a height of up to 75cm. The flowers are produced on umbels, are white and 2-3 mm across, the outer ones larger than the inner ones. They open from late April onwards and are succeeded by fruits which are 3-6 mm long, and light brown, ripening from early June and July [5].

Chemical Composition

The major compound occurring in caraway various extracts likewise carvacrol, Carvone,α-pinene, limonene, γ-terpinene, linalool, carvenone, and *p*-cymene. Roots of *Carumcarvi* have also been found to contain flavonoids quercetin-3-glucuronides, Iso-quercitrin, Quercetin 3-o-caffeylglucoside and kaempferol-3-glucoside [9]. The seed and root of caraway showed the presence of polyacetylenic compounds [5]. *Carum carvi* seeds contain 1-9% essential oils consisting of more than 30 compounds. The essential oil compounds were included α-Pinene 0.3%, Camphene 0.2%, β-Pinene 0.1%, β-Myrcene 0.1%, Limonene 5.1%, γ- Terpinene 12.6%, β-Ocimene 0.1%, *p*-Cymene 0.1%, Terpinolene 0.1%, limonene oxide 0.1%, Camphor 0.2%, Linalool 0.7%, Linalyl acetate 0.3%, Terpinene-4-ol 0.1%, β- Caryophyllene, Dihydrocarvone 0.2%, α-Terpineol 0.1%, Germacrene-D 0.1%, Carvone 70.1%, β- Selinene 0.2%, α- Farnesene 0.4%, Citronellol 0.1%, δ-Cadinene 0.3%, γ-Cadinene 0.5%, Cuminaldhyde 0.1%, Nerol 0.2%, Trans-carveol 0.1%, Nonadecane 0.1%, Spathulenol 0.3%, Eugenol 0.2%, Thymol 0.5% and Carvacrol 0.2% [9]. The seeds contain other compounds including acetaldehyde, cumuninic aldehyde, furfural, dihydrocarveol, β-pinene, thujone, anethole, β-caryophyllene, γ-terpinene, linalool, carvenone, p-cymene, carvacrol, sabinene, perillyl alcohol, camphene, phellandrene and thymol in addition to glycosides and flavonoids [2]. An aromatic compound, glucoside and a glucide were isolated from the water-soluble portion of the methanolic extract of caraway fruit (*Carum carvi* L.) [9]. The *Carumcarvi* of GCMS analysis has also been reported in Table No.1 [10].

Table No. 1: Chemicalconstituents of volatile oil of *Carum carvi* fruit [10]

Name of Compound	%age
α-Pinene	5.17
β-Pinene	3.54
(-)-β-pinene 6,6-dimethyl-2- methylenebicyclo [3.1.1] heptane	1.74
Myrcene	2.27
α –Terpinene	0.73
Limonene	15.82
Crithmene; Moslene	31.12
p-Cymene	7.16
Trans-Sabinene hydrate	0.34
4,8-epoxy-p-menth-1-ene	0.10
Limonene oxide	0.12
1-(3-isopropenyl-2,2-dimethylcyclopropyl)-2-methyl-propan-1- One	0.14
1,4-dimethyl-.delta.-3 Tetrahydroacetophenone	0.08
4-thujanol	0.47
Cis-Para-Menth-2-en-1-ol	0.08
Para-Menth-3-en-7-al	5.19
(1)-1-(isopropyl)-4- Methylcyclohex	1.80
4-Isopropyl-1-methyl-2- cyclohexen-1-ol	0.06
p-mentha-e-2,8(9)-dien-1-ol	0.04
1,8-menthadien-4-ol	0.17
α-Terpineol	0.53
Cuminaldehyde	16.75
4-ethyl-3-nonen-5-yne	2.00
γ-Terpinen-7-al	2.23
(4-Isopropyl-2-cyclohexen-1-yl) Methanol	0.36
1,4-p-Menthadien-7-ol	0.47
Cumin alcohol (4- isopropylbenzyl alcohol, Cuminol)	0.97
Thymol	0.20
Carvacrol	0.33

Biological and Pharmacological Activities

Anti-diabetic Activity

The ethanolic extract of *Carum carvi* seeds (0.2, 0.4 & 0.6 g/kg i.p.) given to streptozotocin (70 mg/kg i.p.) induced diabetic rats. The seeds of plant significantly decrease serum glucose level and increase plasma insulin level in diabetic rats, but not in healthy rats [11].

The aqueous extract of *Carum carvi* seeds on body weight and blood glucose. STZ (60 mg/kg) induced diabetic rats were treated with aqueous extract of *Carum carvi* seeds (1 g/kg; p.o.) for 21 days. It shows the significant decrease in blood glucose level and elevated body weight as comparison to diabetic rats[12].

Caraway seed oil (5, 10 & 20 mg/kg p.o.) given to streptozotocin induced diabetic rats for 30 days. At the end of treatment, rats showed significantly decrease in blood glucose level as compare to diabetic rats and significantly increase in mean body weight of caraway seeds oil treated rats was observed when compared with diabetic rats. Furthermore, the elevated level of MDA was significantly decreased ($p<0.05$) in

caraway seed oil treated rats as compared to diabetic rats and significantly induction in GSH-Px level[13].

Antioxidant activity

Caraway products (aqueous and solvent derived extracts) have shown significant antioxidant activity in several test methods. Phenolic extract of caraway seeds has shown 50% DPPH scavenging activity at 2.7 mg/ml, the extract was also found to scavenge superoxide anion radicals with an IC_{50} value of 35 mg/ml. Further, *Carum carvi* phenolic extract effectively inhibited the growth of Gram +ve bacteria as compared to Gram –ve bacteria estimated by *Foline Ciocalteau* method[7, 14, 15].

A caraway fruit aqueous extract has also shown 50% scavenging of superoxide radicals at 105 µg, 50% inhibition of lipid peroxide at 2100 µg. The quantity needed for 50% inhibition of hydroxyl radicals was 1150 µg investigated in comparison with the known antioxidant ascorbic acid in *in vitro* studies [16].

The antiradical profile of caraway has been proposed as the underlying mechanism for their multifaceted pharmacological properties such as antimicrobial, antidiabetic, anticarcinogenic/antimutagenic, antistress, antiulcerogenic, etc. as outlined in the succeeding sections.

Hepatoprotective Activity

To evaluate oral administration of 50% ethanolic extract of *Carum carvi* on paracetamol induced hepatic injury. 50% ethanolic extract (hydro-alcoholic) of *Carum carvi* (100, 200 and 400 mg/kg p.o) once daily for 9 days in succession followed by single administration of paracetamol 3 g/kg p.o., only 8th day. Silymarin was taken 50 mg/kg, p.o. in gum acacia (0.2%, w/v) as reference standard. 50% ethanolic extracts of *Carum carvi* significantly reversed the elevated levels of SGOT, SGPT, ALP, bilirubin, Triglycerides and lipid peroxidation and significantly increase the reduced level of GSH and Albumin.

To evaluate oral administration of 50% ethanolic extract of *Carum carvi* on thioacetamide induced hepatic injury. Rats were treated with 50% ethanolic extract of *Carum carvi* for 8 days followed by administration of single subcutaneous injection of thioacetamide (100 mg/kg in olive oil, 1:1) on 6th day.Silymarin was taken 50 mg/kg, p.o. in gum acacia (0.2%, w/v) as reference standard. The pretreatment of 50% ethanolic extract of *Carumcarvi* exhibited inhibition of thioacetamide induced hepatotoxicity, resulting in significant restoration of levels of SGOT, SGPT, ALP, bilirubin, Triglycerides, lipid peroxidation, GSH and Albumin [10].

Antiulcerenogic Activity

Based on the gastric emptying in fasted rats, animals were pretreated (30 min before the necrotizing agents) with aqueous extract of *Carum carvi*(250 and 500 mg/kg p.o.). Ulcer was induced by 1ml of different necrotizing agent (80% ethanol, 0.2MNaOH and 25% of NaCl). Gastric mucosal (NP-SH: Non-protein sulfhydryl) was measured according to the method of Sedlak and Lindsay (1968) to analyze the oxidant/antioxidant balance and Histopathology of gastric tissue was done. The depletion of gastric mucosa was significantly ($p<0.05$) replenished with the pretreatment of aqueous extract of *Carum carvi* at the high dose (500 mg/kg, body weight) as compared to the Ethanol (80%) induced decrease in gastric mucosal in the gastric tissue. Pretreatment with *Carumcarvi* (500 mg/kg, body weight) was also found to completely protect the different histopathological changes (hemorrhage, inflammatory, erosions and ulceration) caused in the gastric mucosa of ethanol treated rats [17].

To evaluate the effect of oral administration of alcoholic extract of *Carum carvi* on gastric content, pepsin content, mucin content, prostaglandin and leukotrienes content. Alcoholic extract of *Carum carvi* (2.5 ml/kg p.o.) given before 1 hour of pylorus ligation. After, pylorus ligation indomethacin (10 mg/kg i.p.) given to induce gastric ulcer. Indomethacin significantly decrease the mucin, pepsin, prostaglandins levels and increase acid output and leukotrienes levels. While on treatment with *Carumcarvi*(2.5 ml/kg p.o.) significantly reversed these above contents. These finding indicated that extract at dose 2.5 ml/kg, p.o. showed the cytoprotective actions, which might be mediated by inhibition of leukotrienes content as well as elevation of prostaglandins level [18].

To evaluate oral administration of water and 70% ethanolic extract of *Carum carvi* seeds for determination of total acidity and ulcer index. Total acidity was measured with the titration of 0.1 ml of gastric juice specimen with 0.01 N NaOH, 1-2 drops of Topfer's reagent and 1-2 drops of phenolphthalein were added. A colour change was observed; a bright red colour appears if free hydrochloric acid is present. Mixing was done after each addition of 0.01 N NaOH until the last trace of red colour disappeared and was replaced by a canary yellow colour. Reading was taken (milliliters of NaOH used) for total acidity. Ulcer index was calculated using following formula:

Ulcer index= Arithmetic mean of (number of ulcers the intensity in a group) positive animals/ Total number animals

Aspirin (500 mg/kg) induced gastric ulcer rats were treated with aqueous and 70% ethanolic extract of *Carum carvi* seeds (100mg & 200 mg/kg, p.o.) that rats were sacrificed after 6 hour of drug administration. Furthermore, 70% ethanolic extract of *Carum carvi* seeds at high dose (200mg/kg) significantly reduced the total acidity and ulcer index and the percentage (66.7%) of ulcer protection in test group is almost similar with ulcer protection with a standard drug (75%) [19].

Antimicrobial activity

The *Carum carvi* seeds crushed dried and then grinned. The grinned material was soaked in distilled water. This water mixture was placed with Clevenger-type apparatus. The material was hydro-distilled using Clevenger-type apparatus. The essential oil obtained from *C. carvi* was tested for its antibacterial activity against 10 potential pathogenic bacteria *viz*., *Bacillus subtilis*(BTCC 17), *B. cereus* (BTCC 19), *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* CRL (ICDDR, B), *Shigelladysenteriae* (AE 14396), *S. sonnei*CRL. (ICDDR, B), *Salmonella typhi*(AE 14612), *S.*

paratyphi(AE 14613), *Staphylococcus aureus* (ATCC 6538) and *Vibrio cholera* (AE 14748) and six phytopathogenic fungi *viz*., *Alternaria alternate* (Fr.) Kedissler., *Botryodiplodia theobromae* pat., *Colletotrichumcorchori*I kata (Yoshida), *Curvularialunata*(Wakker) Boedijin, *Fusariumequiseti* (Corda) Saccc. And *Macrophominaphaseolina* (Maubl) Ashby. The *in vitro* sensitivity of the bacteria to the test materials was done by disc diffusion method. Mueller-Hinton medium was used for culture of bacteria. Each experiment was repeated thrice. All the results were compared with the standard antibacterial antibiotic ampicillin (20µg/disc) and *in vitro* antifungal activities of the essential oil of *C. carvi* seeds were determined by poisoned food technique. Sabouraud agar medium was used for culture of fungi. Linear mycelial growth of fungus was measured after 3-5 days of incubation. The percentage inhibition of radial mycelial growth of the test fungus was calculated as follows:

$I = C\text{-}T/C \times 100$

Where, I= %age of inhibition; C= diameter of the fungal colony in the control and T= diameter of the fungal colony in treatment.

All the results were compared with the standard antifungal antibiotic Nystatin (100 ppm). A control set was also maintained in each experiment. Each experiment was repeated thrice. The essential oil and standard antifungal and antibacterial agents were dissolved separately in specific volume of 30% dimethyl sulfoxide (DMSO) before used.

The minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC) and minimum fungicidal concentration (MFC) values of essential oil against 10 test bacteria and fungi were determined by micro and macrodillution broth technique using Mueller-Hinton medium and Sabouraud agar medium respectively. During MIC, MBC and MFC experiments, essential oil of 50 to 500 ppm concentrations were used. The essential oil showed promising inhibitory activity against all the test bacteria, even at 2µl/disc. The MIC (100-300 ppm) and MBC (200-400 ppm) values of essential oil were determined. The antifungal screening of the essential oil showed 100% inhibition of radial mycelial growth of all the test fungi at 100 ppm. The MIC and MFC values were found to vary from 50-300 ppm and200-400ppm respectively [20].

Insecticidal activity

Essential oil of *C. carvi* fruits and its major components were possessing strong insecticidal activity against different insects. The essential oil of *Carum carvi* fruits have strong contact toxicity against *Sitophilus zeamais* and *Tribolium castaneum* adults, with LD_{50} values of 3.07 and 3.29 µg/adult, respectively. Compared with the famous botanical insecticide, pyrethrum extract (25% pyrethrine I and pyrethrine II), the essential oil was nine times less active against *T. castaneum* adults because pyrethrum extract displayed a LD_{50} value of 0.36 µg/adult. However, it exhibited the same contact toxicity against *S. zeamais* (pyrethrum extract, LD_{50}= 4.29 µg/adult). The essential oil of *C. carvi* fruits also possessed strong fumigant activity against *S. zeamais* and *T. castaneum* adults with LC_{50} values of 3.37 and 2.53 mg/L, respectively. The currently used grain fumigant, methyl bromide was reported to have fumigant activity against *S. zeamais*and *T. castaneum*a dults with LC_{50} values of 0.67 and 1.75 mg/L, respectively, thus the essential oil was five times less toxic to *S. zeamais* adults compared with the commercial fumigant methyl bromide. However, the essential oil exhibited the same fumigant toxicity to *T. castaneum* adults as methyl bromide. The ground powder of *C. carvi* fruits were subjected to hydro distillation using a modified Clevenger type apparatus for 6h. Anhydrous sodium sulphate was used to remove water after extraction. The crude essential oil was chromatographed on a silica gel column by gradient elution with *n*-hexane first, then with *n*-hexane-ethyl acetate, and last with acetone to obtain 25 fractions. These, fraction 6 and 9 were further separated by PTLC with petroleum ether-acetone (50:1, v/v) to afford D-limonene and (*R*)-Carvone pure compounds, respectively. The isolated compound, (*R*)-carvone showed stronger contact toxicity against *S. zeamais* and *T. castaneum* adults (LD_{50} = 2.79 and 2.64 µg /adult, respectively) than the other isolated compound, D-limonene (LD_{50} = 29.86 and 20.14 µg /adult, respectively). Moreover, (*R*)-carvone also possessed stronger fumigant toxicity against *S. zeamais* and *T. castaneum* adults (LC_{50} = 2.76 and 1.96 mg/L air, respectively) than D-limonene (LD_{50} = 48.18 and 19.10 mg/L air, respectively). Compared with the commercial fumigant methyl bromide, (*R*)-carvone exhibited the same fumigant toxicity against *T. castaneum*adults although four times less toxic to *S. zeamais*adults. [21].

Carvone has been demonstrated to possess insecticidal activity against several species of insects and mites, e.g. Japanese termite (*R. speratus*) [22] and sciarid fly (*L. ingenua*) [23].

D-limonene has been demonstrated to possess insecticidal activity against several stored-product insects such as the Cowpea weevil (*C. maculates*), lesser grain borer (*R. dominica*), flat grain beetle (*C. pusillus*), rice weevil (*S. oryzae*), maize weevil (S. *zeamais*) and red flour beetle (*T. castaneum*) [21, 24].

Analgesic Activity

The analgesic effect of aqueous and 80% Ethanolic extract of *Carum carvi.* (100 and 200 mg/kg p.o.) were tested in rats by hot water tail immersion (55°C) method. The extract of *Carum carvi* given orally and withdrawal time of tail from hot water (in seconds) was noted as tail flick latency. The initial reading was taken immediately before administration of the test and standard drugs and then 15,30,45,60 and 75 minutes after the administration. Aqueous and hydro-alcoholic extract of *Carum carvi* (200 mg/kg p.o.) significantly ($p<0.01$) increase the tail flick latency at 45 min as compare to the control and standard group [19].

Diuretic Activity

The diuretic (Acute and Chronic) activity of *Carum carvi* was explored in rats. Before treatment, all animals received normal saline (0.9% NaCl) dose of 5 mL, p.o. /100 g body weight. In Acute diuretic activity, the first group received orally distilled water 10 mL/kg body weight and served as the control group. The second group was administered orally 100 mg/kg body weight of caraway fruit extract. The third group was treated with an oral dose of 10 mg/kg body weight of furosemide as a standard. Urine was collected and measured at 1, 2, 4, 6, and 24 h after the dose. Sodium and potassium concentrations were determined in the 24 h urine samples as well as in the plasma of rats.

In Chronic diuretic activity, Daily oral doses of caraway fruit extract (100 mg/kg body weight) and furosemide (10 mg/kg body weight) were administered to three groups of rats for 8 days; the control animals received water (10 mL/kg) every day. For each rat, after 24h urine was collected daily and its volume measured. Urinary sodium and potassium concentrations were measured in each urine specimen. Sodium, potassium and creatinine levels were measured in plasma of rats on 8^{th} day. Urinary creatinine excretion was also determined and its clearance was calculated for Day 8. The rats were observed daily for apparent toxicity. The single doses of *Carum carvi* extract (100 mg/kg body weight) showed the significant increase in diuresis (12.8 ± 0.1 ml) as compare to control group (7.7 ± 0.47 ml) and significantly enhance the urinary electrolyte excretion of Na^+ (138.7 ± 1.5 mmol/L) and K^+ (75.0 ± 2.0 mmol/L) as compare to control (89.7 ± 1.8 mmol/L & 62.9 ± 1.1 mmol/L) respectively. In chronic diuretic activity, administration of *Carum carvi* fruit extract (100 mg/kg body weight) produced significant ($P<0.001$) diuresis 20.2 ± 0.4 ml as compare to control 5.8 ± 1.0 ml. All other parameters don't show significant difference after treatment [25].

Renoprotective Activity

The renoprotective effect of aqueous extract of *Carum carvi* seeds was investigated in experimentally induced diabetic nephropathy in rats. Diabetic nephropathy was induced by the single injection of STZ (60 mg/kg i.p.) as a standard, after 1 week aqueous extract of *Carum carvi* seeds (30 and 60 mg/kg p.o.) were administered for 60 days. The augmented level of Serum glucose, urea, creatinine, microalbuminuria and urine output were significantly ($p<0.05$) decrease with aqueous extract of *Carum carvi* seeds (30 and 60 mg/kg p.o.). High dose of aqueous extract of *Carum carvi* seeds (60 mg/kg p.o.) showed renoprotection against STZ induced diabetic nephropathy in rats. Urine albumin excretion is considered to be the most sensitive marker of renal injury and it was reduced back to normal level on treatment with 60 mg/kg of aqueous extract of *Carum carvi* seeds [26].

The Renoprotective effect of *Carum carvi* essential oil (10 mg/kg p.o.) was investigated in experimentally induced diabetic nephropathy in rats. Diabetic nephropathy was induced by the subcutaneous injection of STZ (60 mg/kg). *Carum carvi* essential oil (10 mg/kg) administered orally for 21 days. Thereafter, animals were subjected to serum glucose and glutathione peroxidase levels. The augmented level of blood glucose significantly ($p<0.05$) decrease on treatment with *Carum carvi* essential oil (10 mg/kg) and significant induction in the reduced level of GSH. The morphological examination of untreated diabetic rats kidney showed glomerular and tubular degeneration with massive cellular infiltration, hemorrhage in interstitial tissue and deformed renal tissue architecture. The kidney of the STZ induced diabetic rats induce to caraway oil showed marked improvement with slightly pathological changes [27].

Molluscicidal activity

Seed powder of *Carum carvi* were extracted with 95% of ethanol, 98% ether, 99.7% chloroform and 98% acetone at room temperature for 24 h (Maceration process). The solvents were removed under vacuum and the remaining dried parts were used for the determination of the Molluscicidal activity: *Carum carvi* 95% ethanol-385mg, 99.7% chloroform-370mg, 98% ether-405 mg and 98% acetone-370 mg. Toxicity experiments were performed by method [28]. Six aquaria were set for each concentration of plant derived molluscicides. Ten experimental animals: adult *Lymnaea acuminata* (2.25 ± 0.20 cm in length) were kept in each glass aquarium containing 3l of dechlorinated tap water. Snails were exposed to different concentrations and preparations of *C. carvi* and mortality was observed on 24,48,72 and 96 hour. Control animals were kept in an equal volume of dechlorinated water under similar conditions but without treatment. Snail mortality was established by the contraction of the body within the shell; no response to a needle probe was taken as evidence of snail death. The toxicity of seed powder of *C. carvi* and their organic solvent extracted fractions against *L. acuminata* were time and concentration dependent. The LC_{50} of seed powder of *C. carvi* at 24 h was 269.96 and at 96 h 140.58 mg/l. Ethanol extract was more toxic than other organic extracts. The LC_{50} of ethanol extract of C. carvi at 24 h: 130.61 mg/l and at 96 h 50 was 58.98 mg/l in killing the test animals. In control group of animals there was no mortality upto 96 h of exposure period [29].

Endocrine Activity

The effects of aqueous and ethanolic extract of the seeds of *Carum carvi*. (150, 200, 250 & 300mg/kg, p.o.) were investigated on hormone and reproductive parameter of female rat. Ethanolic and aqueous extracts of the seeds (150, 200, 250 & 300 mg/kg p.o.) were administered orally to female rat for 30 consecutive days exhibited its effect on ovarian endocrinology i.e. FSH, LH quantities. The gonadotropins follicle stimulating hormone (FSH) and luteinizing hormone (LH) were measured after 24 hours of the last dose of the drug. On treatment with drug, the FSH and LH level were significantly ($p<0.05$) decreased and elevated level of estrogen only on treatment with ethanolic extract on drug. The estrus phase was blocked by treatment with both extract. Drugs also increase the ovaries weight, uterus and body weight, while the

weight of uterine in immature rats increased. Potential effects of caraway on hormone and reproductive parameters were demonstrated possibly due to the presence of estrogenic isoflavonoids, luteolin and apigenin[30].

Anti-cholinesterases Activity

Cholinesterases (ChE) are responsible for the termination of the nerve impulse transmission at the cholinergic synapses by fast hydrolysis of acetylcholine (ACh). The fruit extract of *Carumcarvi*effectively inhibited AChE (4.47±1.23eserine µmol dm^{-3}, approx.73%) and BChE (butyrylcholinesterase) (6.65 ± 0.87 eserineµmol dm^{-3}, 77%). This result confirms that the fruit extract of *Carumcarvi*potential inhibitor of Cholinesterases (ChE) and have potential of restoring of cognitive function and improving the memory [31].

Antihyperlipidemic Activity

The antihyperlipidemic effect of aqueous extract of *Carumcarvi*seeds (60 mg/kg p.o) was investigated on diet induced hyperlipidemia in rats. Hyperlipidemia was induced by feeding 2% cholesterol diet for 6 weeks. After six weeks, lipid profile was determined and hyperlipidemic rats were included for further study. Rats were treated with aqueous extract of *Carumcarvi*seeds (60 mg/kg p.o) for 8 weeks and simvastatin (1 mg/kg p.o) taken as standard drug for 8 weeks. Aqueous extract of *Carumcarvi*seeds (60 mg/kg p.o) significantly ($p< 0.01$) reduced the cholesterol, triglyceride, LDL levels and significantly ($p<0.01$) increase the HDL level as compared to control group. *Carumcarvi*decrease lipid profile more effectively than simvastatin [32].

Latest marketed Ayurvedic Preparations of *Carum Carvi*

S-.No.	Preparation	Composition	Pharmacological activity	Manufactured by	Reference
1	SUPACHAK Tablet (Digests All Types of Food) 	Dadim (*Punicagranatum*)- 80mg Sindhav (*Saindhavalavana*)-20 mg Sanchal (*Black salt*)- 60 mg Dhanyak (Coriandrumsativum)- 28mg Jirak (Cuminumcyminum)- 20 mg KrushnaJirak (*Carumcarvi*)- 20 mg Sunth (*Zinziberofficinale*)-20 mg. Ganthoda (*Piper longum*)-20 mg. Pipar (*Piper longum*) -20 mg. Kali Mirch (*Piper nigrum*)- 8mg Tavak (*Cinnamomumzeyianicum*) -04mg Elaichi (*Elattariacardamomum*)- 04mg Amchur (*Mangiferaindica*) -20mg Imlisar (*Tamarindusindica*)- 03mg AjwanPhool (*Trachyspermumammi*)-	1. Improve digestion & Increase appetite 2. Promotes Health and Energy 3. Detoxicates the digestive tract 4. Quick relief from abdominal discomfort and colic pain.	Ayursun Pharma (Ichchhapor, Gujarat)	http://www.ayursun.in/supachak-tablet-digests-all-types-of-food--1489217.html

		0.3mg Variyali (*Foeniculumvuigarae*)-10mg Hing (*Ferula alliacea*) -10mg			
2	Bioease Capsule 	Fennel (*Foeniculumvulgarae*)-50mg Peppermint (*Menthapiperta*)-50 mg Kala Jira (*Carumcarvi*)-40 mg Cumin (*Cuminumcyminum*)-40 mg Black Pepper (*Piper nigrum*)-30 mg Tulsi (*Ocimumbasilium*)-30 mg Ginger (*Zingiberofficianale*)-30 mg	1. Prevents gaseousness and relieves excessive belching 2. Regularizes gastric secretions and motility and procure digestive function 4. Promotes digestion and improves appetite	Himalaya P'ceuticals (Makali Bengaluru, Karnataka)	https://www.apexpharmacy.com.my/Shop/bioease-capsules-60s
3	Bonnispaz Drops 	Caraway (*Carumcarvi*)-0.69 mg Ajwain (*TrachyspermumAmmi*)-0.69 mg Sunthi (*Zingiberofficinale*)-0.46 mg	1. Antispasmodic 2. Carminative	Himalaya P'ceuticals (Makali Bengaluru, Karnataka)	http://www.himalayastore.com/pharmaceuticals/bonnispaz.htm
4	MedhyaChurna 	Vacha (*Acoruscalamus*)-50gm Ashwagandha(*Withaniasomnifera*)- 5gm Ajmoda (*Craumroxburghianum*)-5gm Shwetjeerak (*Cuminumcyminum*)-5gm Caraway (*Carumcarvi*)-5gm Sonth (*Zingiberofficinale*)-5gm Marich (*Piper nignum*)-5gm Pipali (*Piper longum*)-5gm Shankhpushpi (*Convolvulus pluricaulis*)- 5gm Bramhi (*Bacopamonneiri*)- 5gm	1. Improvement of memory concentration 2. Anxiety and stress relief.	Planet Ayurveda (JLPL Industrial Area, Mohali, Punjab)	http://www.planetayurveda.com/medhya-churna.htm

5	JawarishKamoniSada 	ZeeraSiyha (*Carumcarvi*)- 100gm Common rue (*Rutagraveolens*)-10gm Bolus armonus (*Armeniam bole*)-10gm Black pepper (*Piper nigrum*) -10 gm Ginger (*Zingiberofficinale*)-20gm	1. Antispasmodic 2. Laxative 3. Improve digestion 4. Useful in hiccups	Hamdard Laboratories (2A/3 Asaf Ali Road, New Delhi)	https://www.justrelief.com/HealthCare/Detail/HAMDARD-JAWARISH-KAMUNI-1KG
6	Hepa complex 	Artichoke (*Cynarascolymus*)-900 mg Dandelion (*Taraxacum*)-600 mg Peppermint (*Menthapiperita*)-600 mg Juniper (*Juniperuscommunis*)-318 mg Caraway (*Carumcarvi*)-180 mg	1. Improve liver & bile duct function 2. Diuretic 3. Improve Digestion	SanbiosP'ceuticals (Ul. Ligocka 17 b 44-100 Gliwice)	https://elivera.co.uk/products/hepa-complex-tablets-x-60
7	Finocarbo Plus 	Fennel (*Foeniculumvulgare*) Chamomile (*Chamomillarecutita*) Caraway (*Carumcarvi*) Cumin (*Cuminumcyminum*) Peppermint (*Menthapiperta*)	1. Improve the digestion 2. Carminative	Aboca Laboratories (Via dellevetrerie, 1 - c.c.be, Novi Ligure)	https://www.aboca.com/en/our-products/finocarbo-plus-caps
8	HingwastakChurna 	Pippali (*Piper longum*)-3gm Ginger (*Zingiberofficinale*)-3gm Black Pepper (*Piper nigrum*)-3gm Cumin (*Cuminumcyminum*)-3gm Caraway (*Carumcarvi*)-3gm Asafoetida (*Ferula asofoetida*)-3gm	1. Carminative 2. Antispasmodic 3. Relieves constipation 4. Diet supplement in RA	Swadeshi Ayurveda (Aryanagar, jwalapur, haridwar)	https://www.medicjar.com/product/swadeshi-hingwastak-churna-50-gms/
9	Zynex Syrup 	Ajwain (*Trachyspermunammi*)-350mg Caraway (*Carumcarvi*)-175mg Ginger (*Zingiberofficinalis*)-175mg	1. Potent Digestant	MansonsP'ceuticals (147/E, Green Road, Dhaka)	http://www.mansonspharma.com/
10	Verdin Fix GRATIS	Verdin Complex: Rosemary	1. Manifests symptoms such as feeling of fullness, gravity	U.S Pharmacia International	https://elivera.co.uk/products/verdin-

		(*Rosmarinusofficinalis*)-500 mg Artichoke (*Cynarascolymus*)-400mg Turmeric (*Curcuma longa*)- 36mg Peppermint(*Menthapiperita*)- 6.56 mg Verdin Fix: Herb peppermint (*Menthapiperita*)- 2.16 gm Coriander (*Coriandrumsativum*)-2.16 g Caraway fruit (*Carumcarvi*)- 1.08 gm Rosehip (*Rosa canina*)-0.56gm Lemongrass (*Cambopogan citrates*)-0.44gm Green tea (*Camellia sinensis*)- 0.40gm Licorice (*Glycyrrhizaglabra*)-0.20 gm Dandelion (*Taraxacumofficinale*)-0.20 gm	and pressure in the stomach bloating, belching and epigastric discomfort.	(966, Hungerford Dr. Rockville, USA)	complexx-x-30-tablets-verdin-fix-20-sachets-x-free
11	Raja malt Granules 	Kacholam (*Kaempferiagalanga*)-20gm Mundiringa (*Vitisvinifera*)-19gm Jadamnaji (*Nardostachysjatamansi*)-19gm Mutanhga (*Cyperusrotundus*)-20gm Carway (*Carumcarvi*)-21gm Gokshura (*Tribulusterrestris*)-20gm Twak (*Cinnamomumzeylanicum*)-20gm Pippali (*Piper longum*)-21gm Cumin(*CuminumCyminum*)20gm Shilajith (*Asphaltumpunjabinum*)-20gm	1. Increase the sperm motility 2.vigour and vitality	Shankar Pharmacy (Udyogamandal P.O., Manjummel, ErnakulamDistrict,Kerala)	https://ayurmedinfo.com/2012/08/02/raja-malt-benefits-how-to-use-ingredients-side-effects/

Discussion and Conclusion

Caraway (*C. Carvi*) seeds are rich sources of essential or aromatic oils containing diverse group of phytoconstituents. It has a wide spectrum pharmacological effect in treatment of traditional healing systems in the worldwide. A natural product used in conventional treatment provides intimation for the existence of phytochemical. New researches on caraway proved it as a source of new entities to perform different pharmacodynamic properties, responsible for their pharmacological effects. The present review is co-operate the step an ahead in that direction or motivation to open a new insight for therapeutic efficacy of this marvelous plant.

Abbrevations:

i.p.-Interaparetonial
p.o. - Orally
STZ- Streptozotocin
MDA- Malondialdehyde
GSH- Glutathione
GSH-Px- Glutathione peroxidase
DPPH- 1,1-diphenyl-2-picrylhydrazyl radical
IC_{50}- Concentration of an inhibitor where the response (or binding) is reduced by half
SGPT- Serum glutamate pyruvate transminase
SGOT- Serum glutamate oxaloacetate transminase
ALP- Alkaline phosphatase
LD_{50}-Median lethal dose
LC_{50}- Median lethal concentration
MeBr- Methyl bromide
NaOH- Sodium hydroxide
NaCl- Sodium chloride
FSH- Follicle-stimulating hormone
LH- Luteinizing hormone
HDL- High density lipoprotein
LDL- Low density lipoprotein
Topfer's Reagent- It is an indicator used for measurement of free acidity (Color change or when Ph reaches 3.5 means free HCl present).

Conflict of Interest: None

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