International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Comprehensive Review on Carum Carvi Linn: Botany, Ethnopharmacology, Phytochemistry and Pharmacology Aspects

Priyanka Jayesh Hemake[1], Pratiksha Ramesh Pawar[2]

[1]Student, SMBT College of Pharmacy
[2]Assistant Professor, SMBT College of Pharmacy

Abstract:
Traditional medicine serves as the foundation of primary healthcare since it is socially and culturally acceptable, works better with the human body, and has fewer adverse effects. Due to its numerous therapeutic characteristics, carum carvi, a well-known culinary spice, is a significant medicinal herb in the Unani system of medicine (USM). Carum carvi is known for its diuretic, hepatoprotective, antioxidant, antihyperlipidemic, and anticancer properties, among other things. The pharmacological, phytochemical, and therapeutic characteristics of Carum carvi Lin are examined in this study. Caraway fruits contain phenolic acids (caffeic acids), flavonoids, protein (20%), glucose (15%), fatty acids (10-18%), petroselinic, linoleic, and oleic acids, as well as essential oil (3-7%). (quercetin, kaempferol) Caraway seeds contain essential oils, and caraway aqueous extract contained tannins, alkaloids, and terpenoids. Due of the drug's broad therapeutic potential, many of the pharmacological activities listed in unani medicine have been verified, while others still require more study.

Keywords: Carum carvi; Essential oil; Carvone

Introduction

Recently medicinal and aromatic plants have attracted the researchers worldwide as it contains major source of raw materials which have been used in pharmaceutical,cosmetic,perfumery and falvorindustires(1). Despite advances in the study of synthetic pharmaceuticals, most drugs currently in use are still manufactured from plants using old methods and modern technology(1). is one of the most significant medicinal plants grown in Poland, covering an area of 8,000 hectares(2). One of the earliest herbs to be grown in Asia, Africa, and Europe is *Carum carvi L*. Caraway oil is the essential oil produced by steam distilling the dried, ripe fruit. It is frequently referred to as caraway and is grown for its high essential oil content, which is primarily found in the seeds (Hindi: Kala Jira; Arabic: SiyahZeera)(3). Carvone and limonene, which typically make up 95% of all oil are the monoterpenes that make up oil. The quantity of carvone in a caraway fruit impacts its quality, according to Bouwmeester et al. (1995)(2). Despite having a significant medical benefit, the thorough research on the pharmacological actions of C. research on carvi phenolic extract has not been done. In the current work, we assessed C's antioxidant capacity. carvi phenolic extract employing a variety of complementary in vitro assays, including the ability to reduce and the ability to scavenge hydroxyl, superoxide anion, and DPPH radicals. Additionally, we assessed the extract's antibacterial efficacy against Gram-positive and Gram-negative microorganisms(4). Despite having a significant medical benefit, the thorough research on the pharmacological actions of C. research on carvi phenolic extract has not been done. In the current work, we assessed C's antioxidant capacity. carvi phenolic extract employing a variety of complementary in vitro assays, including the ability to reduce and the ability to scavenge hydroxyl, superoxide anion, and DPPH radicals. Additionally, we assessed the extract's antibacterial efficacy against Gram-positive and Gram-negative microorganisms(5).

1 Botanical and ecological characteristics

Leaves: Cumin leaves have several fids and lengthy filiform segments(6).Typically, Carum carvi are biennial plants that grow 30 to 100 cm tall and have a thick, fusiform tap root. The stem is upright, angular, grooved, glabrous, filled with latex, and branching from the base up. The cauline and rosette leaves are tripinnate in part and glabrous. Usually, the lower pinna is crossed.

Figure 1: Leaves

Flowers: The bracts, which are formed after flowering, cover the tiny, white, or pink flowers. both partial and general umbels. Each of the lateral branches and the main trunk end in a complex flowering umbel with eight to sixteen umbel rays. There is hardly any evidence of the epicalyx or calyx. The tiny, reddish or white florets are of varying sizes. The fruit is an elliptical, glabrous, oblong schizocarp. It comprises of two 3 to 6 mm long, brownish, sickle-shaped mericarps with five lighter, angular main ribs**.**

Figure 2: Flowers

Seeds: The cumin seed has nine protuberances, is elongated, and ranges in colour from yellow to brownish grey. It has a wide range of therapeutic benefits. The carminative, fragrant, stomachic, stimulant, astringent, cooling, and synergistic properties of cumin seeds make them useful. Cumin seed oil is employed in topical clothing ointments and multipurpose luminous paints.

Figure 3: Seeds

Table 1: Scientific Classification

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Order	Apiales
Division	Magnoliophyta
Family	Apiaceae/Umbellifers
Class	Magnoliopsida
Subclass	Rosidae
Genus	*Carum L*
Species	*Carum carvi L*(3)(6)(7)

Table 2: Vernacular Name

Hindi	Kalajira
Sanskrit	Asitajiraka, Krishna jeeraka
English	Black caraway, caraway
Telgu	Nallajeelakarra
Tamil	Karamjiragam, shimaishambu
Urdu	Kala zira and Karojeero, zirasiyah
Unani	Zeeraasiyaah, Kamoom, Kamoon-roomi
French	Carobin, carvi
German	Kaemkalm, Karbei
Gujrat	Shahijirum, Shajiru
Kashmiri	Gunyum
Ladak	Umbu
Malyalam	Karinjeerakam
Italian	Caro,Carvi
Portugeses	Alcaravia, Alcarovia

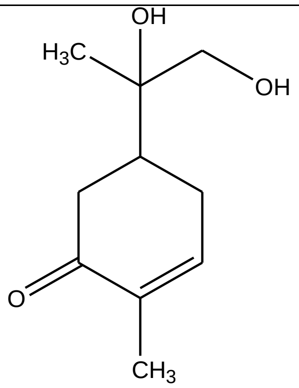
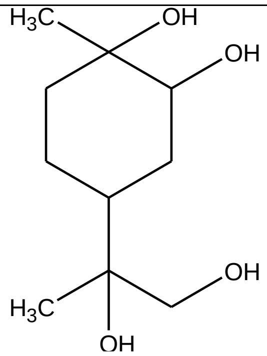
Norway	Karve
Persian	Kumoon,Karoya,zeera

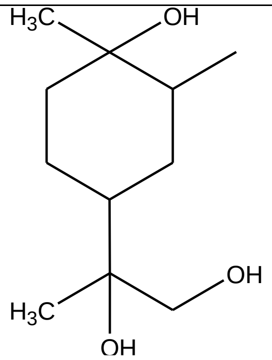
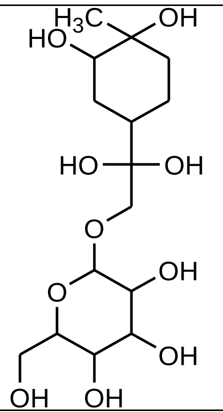
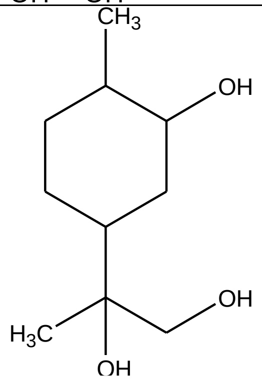
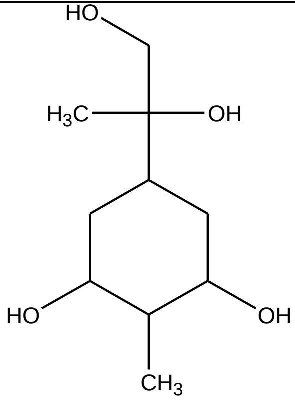
(8)(9)(10)

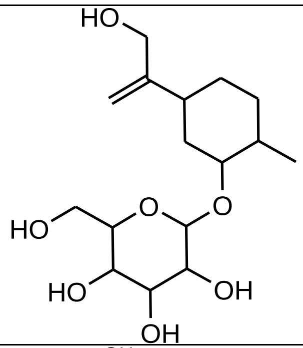
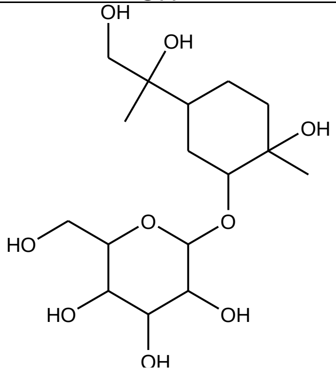
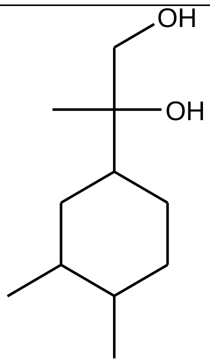
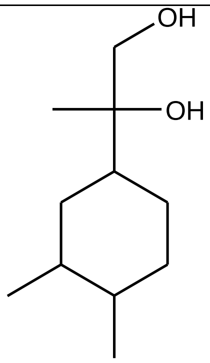
2 Phytochemistry

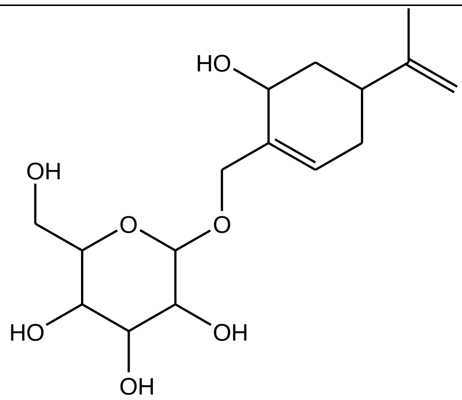
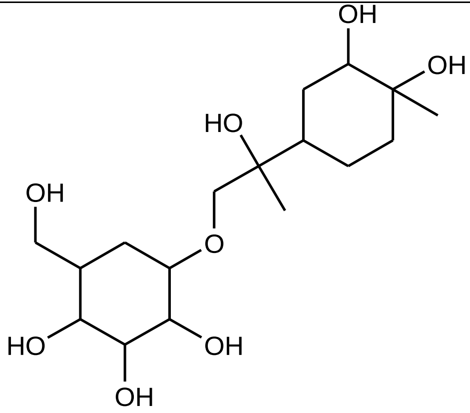
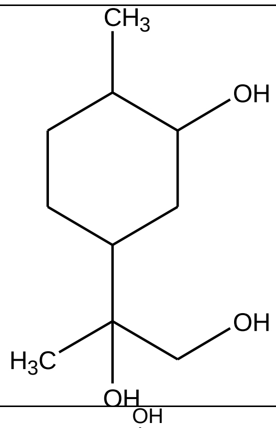
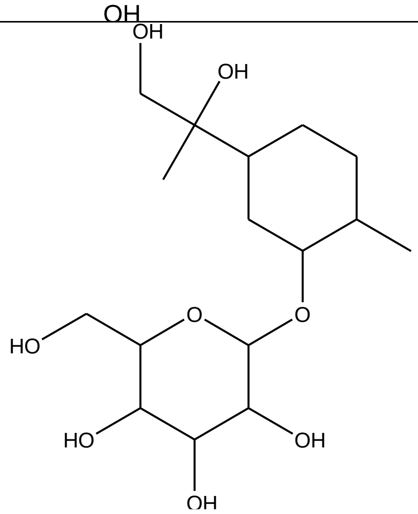
Essential oils (3–7%), fatty acids (10–18%), including petroselinic, linoleic, and oleic acids, protein (20%), and carbohydrates (15%) are all present in caraway fruits(11). Caffeic acids and flavonoids (quercetin and kaempferol) are phenolic acids(3).In the caraway aqueous extract, tannins, alkaloids, and terpenoids were all found(12)(13). Essential oils can be found in carum carvi seeds. which are primarily abundant in oxygenated monoterpene hydrocarbons, oxygenated sesquiterpenes, saturated and unsaturated fatty acids, aldehydes, ketones, and esters. Polysaccharides, lignine, and triacylglycerol are other components. The primary chemicals included in *Carum carvi* seed oil include Cavacarol, Carvenone, Carvone, Limonene, etc(14). 1-9% of the essential oils of *Carum carvi* seeds are made up of more than 30 different substances. Pinene 0.3%, Camphene 0.2%, Pinene 0.1%, Myrcene 0.1%, Limonene 5.1%, Terpinene 12.6%, Ocimene 0.1%, p-Cymene 0.1%, Terpinolene 0.1%, Limonene Oxide 0.1%, Camphor 0.2%, Linalool 0.7%, Linalyl acetate 0.3%, were among the chemicals found in essential oils.Terpinen-4-ol (0.01%), Caryophyllene (0.02%), Dihydrocarvone (0.0%), Terpineol (0.01%), Germacrene-D (0.01%), Carvone (70.1%), Selinene (0.02%), Farnesene (0.04%), Citronellol (0.01%), Cadinene (0.03%), Cadinene (0.5%), Cuminaldhyde (0.01%), Nerol (0.02%)(15). In addition to glycosides and flavonoids, the seeds also include additional substances such acetaldehyde, cumuninic aldehyde, furfural, dihydrocarveol, β-pinene, thujone, anethole, β-caryophyllene, γ-terpinene, linalool, carvenone, p-cymene, carvacrol, sabinene, perillyl.

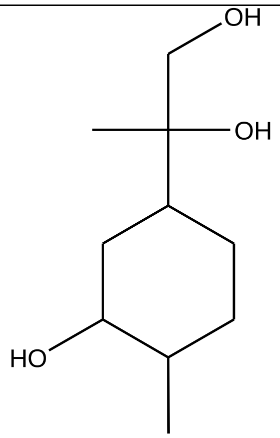
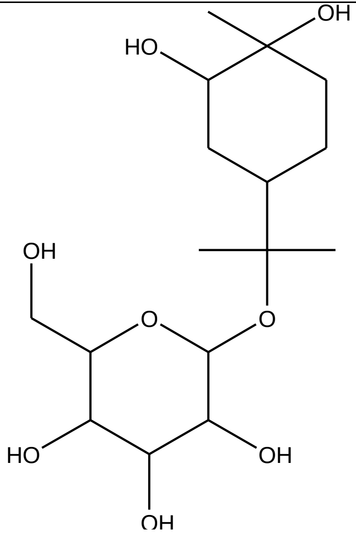
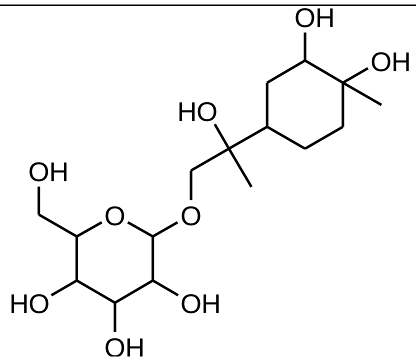
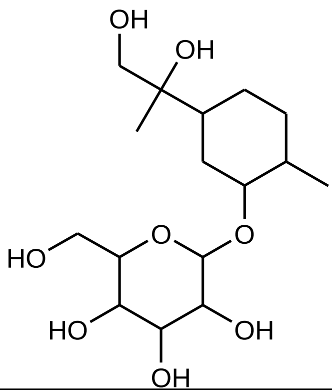
Table 3: Major chemical components and structures present in the seeds and root of *carum carvi*

Plant part	Chemical present	Structure
Seed	(4S,8S)-8,9-Dihydroxy-p-menth-1(6)-en-2-one	
Seed	(1S, 2S, 4R, 8R)-p-Menthane-1,2,8,9-tetrol	

Seed	(1S,2S,4R,8S)-p-Menthane-1,2,8,9-tetrol	
Seed	(1S*, 2R*, 4R*, 8S*)-p-Menthane-1,2,8,9-tetrol	
Seed	(1R*,2S*,4R*,8R*)-p-Menthane-2,8,9-triol	
Seed	(1alpha,2alpha,4alpha,6alpha,8R)-p-Menthane-2,6,8,9-tetrol	

Seed	(1S,2S,4R,)-p-Menth-8-ene-2,10-glucoside	
Seed	(1S,2R,4R,8S)-p-menthane-1,2,8,9-tetrol-2-glucoside	
Seed	(1S,2R,4R,8R)-p-Menthane-2,8,9-triol	
Seed	(1R*,2S*,4R*,8S*)-p-Menthane-2,8,9-triol	
Seed	(4S,6R)-p-Mentha-1,8-diene-6,7-diol-7-glucoside	

		
Seed	(1R*,2R*,4R*,8S*)-p-Menthane-1,2,8,9-tetrol	
Seed	(1S, 2S, 4R, 8S)-p-Menthane-2,8,9-triol	
Seed	(1S,2R,4R,8S)-p-Menthane-2,8,9-triol-9-glucoside	

Seed	(1S*,2S*,4R*,8R*)-p-Menthane-2,8,9-triol	
Seed	(1R,2R,4S)-p-Menthane-1,2,8-triol	
Seed	(1R*,2R*,4R*8S*)-p-Menthane-1,2,8,9-tetrol-9-glucoside	
Seed	(1S,2R,4R,8s)-p-Menthane-2,8,9-triol-2-glucoside	

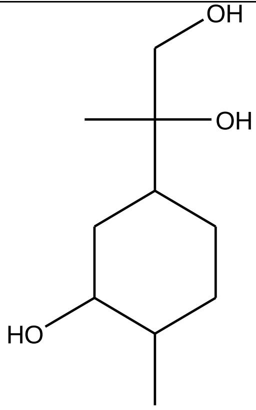
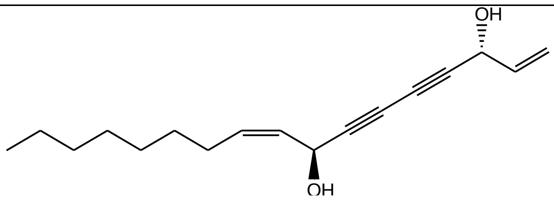
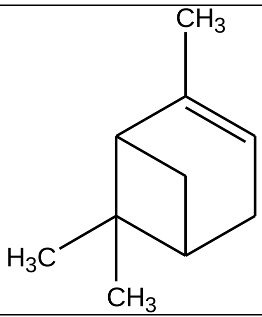
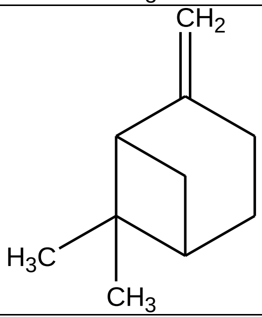
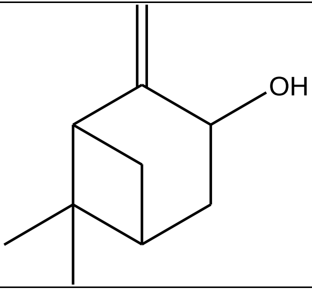
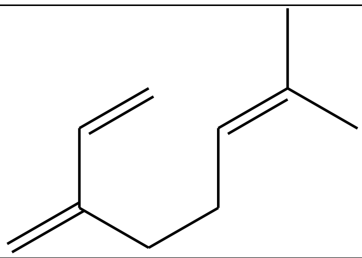
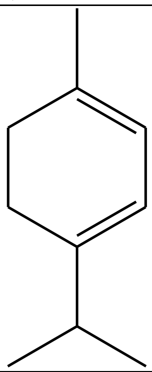
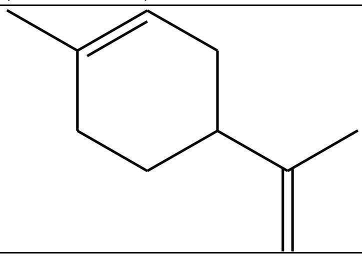
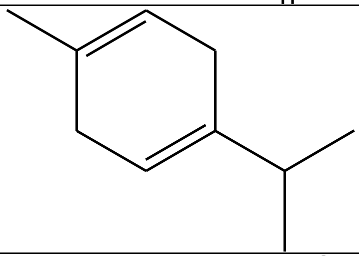
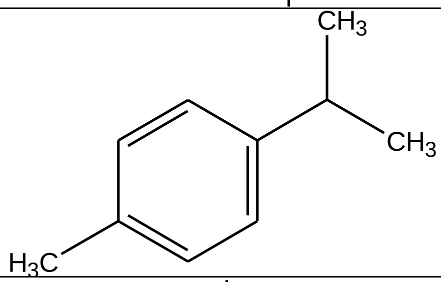
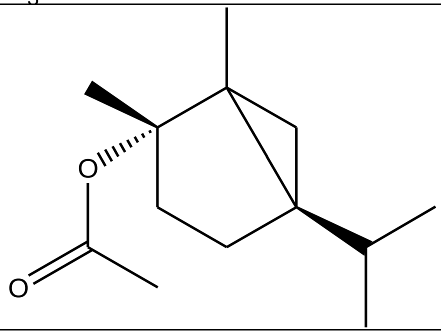
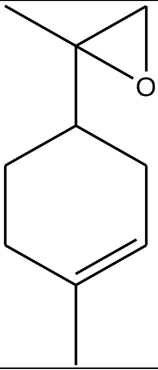
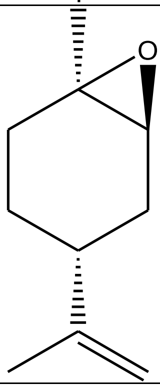
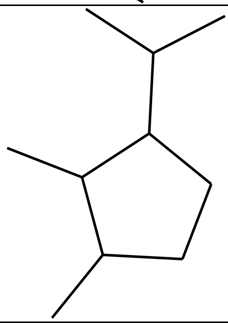
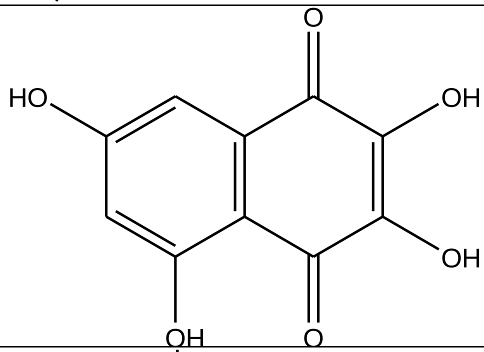
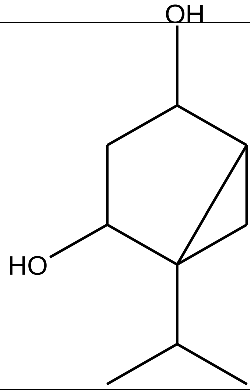
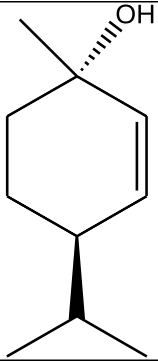
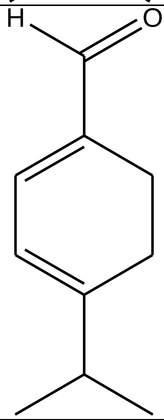
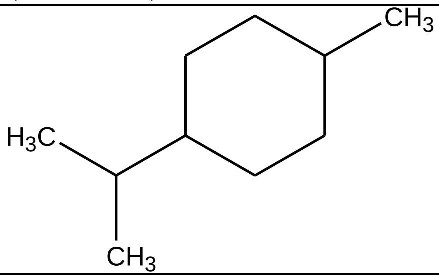
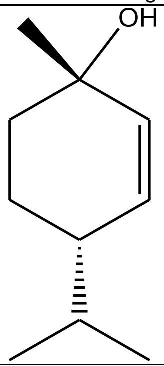
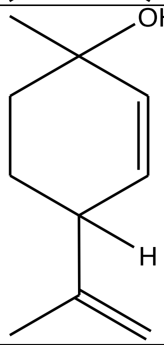
Seed	(1S,2S,4S,8R)-p-Menthane-2-,8,9-triol	
Seed	Falcarindione	

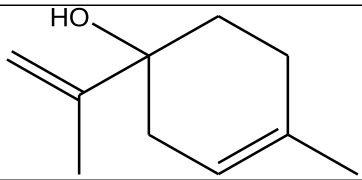
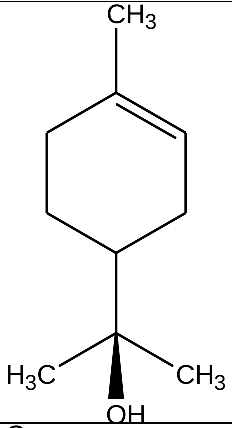
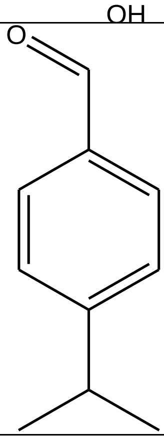
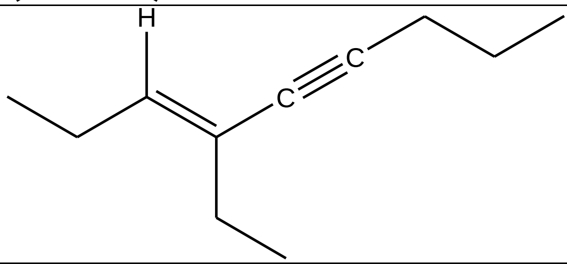
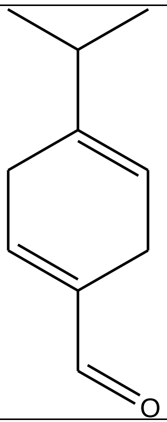
Table 4: Chemical constituents of volatile oil of *Carum carvi* fruit

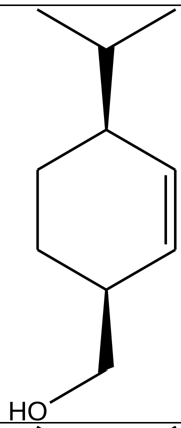
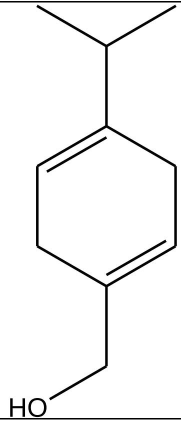
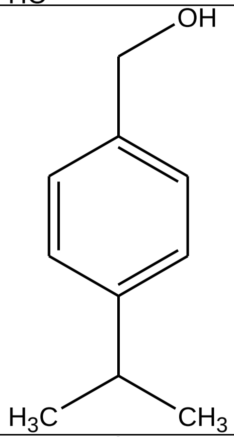
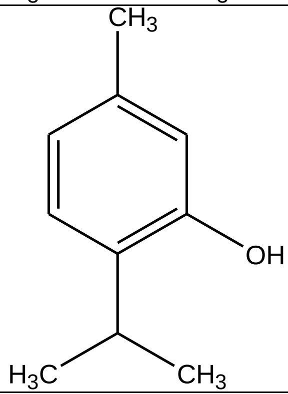
Name of Compound	% Age	Structure
α-Pinene	5.17	
β-Pinene	3.54	
(-)-β-pinene 6,6-dimethyl-2-methylenebicyclo[3,1,1] heptane	1.74	

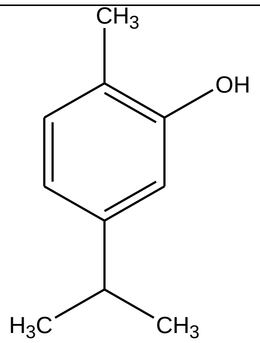
Myrcene	2.27	
α-Terpinene	0.73	
Limonene	15.82	
Crithmene, Moslene	31.12	
p-Cymene	7.16	
Trans-Sabinene hydrate	0.34	

4,8-epoxy-p-menth-1-ene	0.10	
Limonene oxide	0.12	
1-(3-isopropenyl-2,2-dimethycyclopropyl)-2methyl-propan-1-one	0.14	
1,4-dimethyl-delta-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-Methylcylohex	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	
γ-Terpinen-7-al		

(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	

3 Pharmacological activity

3.1 Anti Bacterial Activity

The genera Clavibacter, Ralstonia, Rhodococcus, Erwinia, Curtobacterium, and Agrobacterium, which cause widespread plant or cultivated mushroom disease, had high activity. Pseudomonas bacteria, in general, were discovered to have decreased activity. Findings point to the potential application of essential oils in the management of bacterial diseases. (16).

3.2 Antiulcerogenic Activity

The caraway extracts demonstrated a dose-dependent antiulcerogenic activity against indomethacin-induced stomach ulcers, along with decreased acid and leukotriene production and increased mucin and prostaglandin E2 release. Gastric mucosa damage caused by HCl/ethanol and antiulcerogenic action of *C. carvi* essential oil(17)(18).

3.3 Antioxidant Activity

The antioxidant of a molecule is valuable because free radicals are the cause of numerous illnesses in the body or the degradation of compounds in various industries(19). In numerous test methods, caraway products (derived from solvent and aqueous extracts) have demonstrated considerable antioxidant activity. Caraway seed phenolic extract has been reported to have 50% DPPH scavenging activity at 2.7 mg/ml and an IC50 value of 35 mg/ml for superoxide anion radical scavenging. Additionally, *Carum carvi* phenolic extract significantly reduced the development of Gram +ve bacteria as measured by the FolineCiocalteau method as compared to Gram -ve bacteria (20).A caraway fruit aqueous extract has also demonstrated 50% superoxide radical scavenging at 105 g and 50% lipid peroxide inhibition at 2100 g. When compared to the well-known antioxidant ascorbic acid, the amount required for 50% suppression of hydroxyl radicals was 1150 g in in vitro experiments(21).

3.4 Hepatoprotective Activity

to assess the effects of oral administration of a 50% ethanolic extract of *Carum carvi* on hepatic damage caused by paracetamol. Following a single injection of paracetamol 3 g/kg p.o. on the eighth day, a 50% ethanolic extract (hydro-alcoholic) of *Carum carv*i (100, 200, and 400 mg/kg p.o.) once daily for nine consecutive days was administered. As a reference standard, silymarin was administered 50 mg/kg orally in gum acacia (0.2%, w/v). SGOT, SGPT, ALP, bilirubin, triglycerides, and lipid peroxidation were all dramatically reduced by 50% ethanolic extracts of *Carum carvi*, while GSH and albumin were both significantly increased(22).

3.5 Antidibetic Activity

In streptozotocin-induced diabetic rats, the effects of oral administration of *Carum carvi* on weight, blood glucose, and lipid profile were shown by Haidari F et al (23). The results demonstrated that oral caraway administration significantly decreased the treated rats' blood glucose levels and prevented them from losing weight. In diabetic rats, caraway exerts both hypolipidemic and antihyperglycemic effects(24)(25).

3.6 Antimicrobial Activity

Begum J. et al. investigated the composition and antibacterial properties of essential oil from seed against ten pathogenic bacteria and six phytopathogenic fungi. At 2 l/disk, the essential oil showed encouraging inhibitory effectiveness against all test microorganisms. Essential oil's minimum bactericidal concentration (MBC) and minimum inhibitory concentration (MIC, 100- 300 ppm) values were established(26). The MIC value for caraway oil, which has the main constituents limonene (468.8%) and carvone (52.3%), was 18.8 10.3 lL/mL against clinical isolates of S. aureus (n = 14) from patient's skin sores. Caraway essential oil's MIC value against S. aureus ATCC 29213 was 2.1- 0.9 lL/mL(27).

3.7 Analgesic Activity

In-vivo screening of analgesic and antiulcer activity on seeds was carried out by Swathi V et al. In accordance with CPCSEA's correct standards, analgesic activity in rat models was assessed. Aspirin-induced ulcer models were used to assess antiulcer activity.Effect of simultaneous administration of seeds extracts in ethanolic and aqueous form *Carum carvi* was administered orally at doses of 100 and 200 mg/kg body weight, respectively. When compared to a conventional medicine, the hydro-alcoholic extract's performance at a dose of 100 mg demonstrated analgesic and antiulcer activity at 200 mg (28).

3.8 Diuretic activity

For eight days, three groups of rats received daily oral dosages of caraway fruit extract (100 mg/kg body weight) and furosemide (10 mg/kg body weight); the control rats received water (10 mL/kg) daily. Urine was collected everyday and its volume was assessed for each rat after 24 hours. We assessed the salt and potassium levels in each urine sample. On the eighth day, the plasma sodium, potassium, and creatinine levels of rats were assessed. Additionally, the excretion of urinary creatinine was measured, and Day 8 clearance was estimated. Every day, the rats were checked for any signs of poisoning. The single doses of *Carum carvi* extract (100 mg/kg body weight) significantly increased diuresis (12.8 0.1 ml) in comparison to the control group's (7.7 0.47 ml) and significantly increased the excretion of the electrolytes Na+ (138.7 1.5 mmol/L) and K+ (75.0 2.0 mmol/L) in the urine as compared to the control group's (89.7 1.8 Administration of *Carum carvi* fruit extract (100 mg/kg body weight) resulted in substantial (P 0.001) diuresis of 20.2 0.4 ml as compared to control of 5.8 1.0 ml in chronic diuretic activity. None of the other indicators significantly change following treatment(29).

3.9 Hepatoprotective Activity

The in vitro antioxidant activity was assessed using two different induction systems to examine the effects of the essential oils on lipid peroxidation (LP) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) and OH radical scavenging activities. Animals pre-treated with essential oils and then intoxicated with CCl4 had some liver biochemical markers measured to determine the in vivo hepatoprotective efficacy. The tested essential oils were able to neutralise H2O2 and diminish stable DPPH in a dose-dependent manner, with IC50 values for Carvi aetheroleum and Coriandriaetheroleum being 2.5 L/mL and 4.05 L/mL, respectively. Both systems of induction were significantly blocked by caraway essential oil, but coriander essential oil displayed prooxidant activity (29).to assess the effects of oral administration of a 50% ethanolic extract of Carum carvi on hepatic damage caused by thioacetamide. Rats were given an 8-day course of treatment with a 50% ethanolic extract of *Carum carvi* before receiving a single subcutaneous injection of thioacetamide (100 mg/kg in a 1:1 ratio of olive oil) on the sixth day. As a reference standard, silymarin was administered 50 mg/kg orally in gum acacia (0.2%, w/v). The thioacetamide-induced hepatotoxicity was inhibited by pretreating a 50% ethanolic extract of *Carum carvi*, which significantly restored levels of SGOT, SGPT, ALP, bilirubin, triglycerides, lipid peroxidation, GSH, and albumin(30).

3.10 Antihyperlipidemic activity

The goal of the study was to determine how an aqueous extract of *Carum carvi* seeds affected rats with hyperlipidemia brought on by diet. Rats were fed a diet containing 2% cholesterol for six weeks, and those that had high lipid levels were included in the study.All of the rats were then split into three groups: a normal control group (A), a hyperlipidemia positive control group (B), and two experimental groups (C and D). Aqueous dried extract of *Carum carvi* seeds at a dose of 60 mg/kg of body weight was given daily for eight weeks to group C of experimentally hyperlipidemic rats. Simvastatin was administered to group D rats for eight weeks at a dose of 1.0 mg/kg body weight. After eight weeks, blood samples were taken. The levels of blood triglycerides, LDL, and total cholesterol variedly increased in the hyperlipidemic positive control group rats. In hyperlipidemic positive control groups, serum HDL values fell.Simvastatin and carum carvi both dramatically lowered these values in rats. Simvastatin did not reduce cholesterol levels as well as *Carum Carvi* did. Constituents of *carum carvi*, particularly flavonoids and carvone, have potent anti-oxidant properties that may contribute to hypolipidemia(31).

3.11 Anticancer Activity

research on any possible anti-cancer properties of carvone (CVN) in cultured primary rat neurons and N2a NB cells. Results showed that compared to control cells, treatment with CVN (only at 25 mg/L) increased the levels of total antioxidant capacity in cultured primary rat neuron cells. Additionally, CVN treatment (at doses greater than 100 mg/L) increased the overall oxidative stress levels in both cell types. In both cells, it was not discovered that the mean values of the total scores of cells with DNA damage (for the comet assay) were significantly different from the control values ($p > 0.05$).However, a 24-hour CVN treatment revealed that at concentrations greater than 100 mg/L, CVN administration dramatically decreased the cell survival rates in both cell types. This was demonstrated by a 3-(4,5-dimethylthiazol-2-yl)-2,5 diphenyltetrazolium bromide assay. In conclusion, our findings indicate that CVN has limited promise as a promising anticancer drug to advance the treatment of brain malignancies(32)

4 Conclusion

We can infer from the current review that many people suffer from a variety of chronic diseases as a result of the high environmental and climatic variation. Herbs' multifaceted approach can aid in the treatment of a number of chronic illnesses, and they can also be utilised as adjuvant therapy. These medications are more widely accepted, compatible with the human body, and have less side effects.. Based on these details, this review can highlight ZeeraSiyah (*Carum carvi* Linnuse)'s in a variety of diseases treatments and suggest that more clinical and phytochemical research be done on this potentially useful traditional Unani medicine in order to find safer medications

5 References

1. Ahmad BS, Talou T, Saad Z, Hijazi A, Ahmad BS, Talou T, et al. The Apiaceae : Ethnomedicinal family as source for industrial uses To cite this version : HAL Id : hal-01607960. 2019;
2. Seidler-Łozykowska K, Kedzia B, Karpińska E, Bocianowski J. A atividade microbiológica do óleo essencial de alcaravia (Carum carvi L.) de várias origens. Acta Sci - Agron. 2013;35(4):495–500.
3. Sachan AK, Das DR, Kumar M. Carum carvi-an important medicinal plant. J Chem Pharm Res [Internet]. 2016;8(March):529–33. Available from: www.jocpr.com

4. Thippeswamy NB, Naidu KA, Achur RN. Antioxidant and antibacterial properties of phenolic extract from Carum carvi L. J Pharm Res [Internet]. 2013;7(4):352–7. Available from: http://dx.doi.org/10.1016/j.jopr.2013.03.028
5. Thakur S, Bawara B, Dubey A, Nandini D, Chauhan NS, Saraf DK. Effect of Carum carvi and Curcuma longa on hormonal and reproductive parameter of female rats. Int J Phytomedicine. 2009;1(1):31–8.
6. Johri RK. Cuminum cyminum and Carum carvi: An update. Pharmacogn Rev. 2011;5(9):63–72.
7. Naquibuddin M, Hamiduddin R, Mehfooz S, Tabassiya K. Zeera siyah (Carum carvi Linn.): A culinary spice and an important drug of unani medicine. Int J Herb Med. 2021;9(4):101–5.
8. Goyal M, Gupta VK, Singh N, . M. Carum Carvi- An Updated Review. Indian J Pharm Biol Res. 2018;6(04):14–24.
9. AKHTAR MWW, Naseer M. An appraisal of Unani fundamentals in the management of Humma (fever). J Drug Deliv Ther. 2019;9(1-s):516–9.
10. Edition F. THE PHARMACOPOEIA OF THE PHARMACOPOEIA OF. 2016;
11. Кахраманова СД, Боков ДО, Самылина ИА. Количественное определение полисахаридов в лекарственном растительном сырье. 2020;7(968):0–3.
12. Mahboubi M. Caraway as Important Medicinal Plants in Management of Diseases. Nat Products Bioprospect [Internet]. 2019;9(1):1–11. Available from: https://doi.org/10.1007/s13659-018-0190-x
13. Showraki A, Emamghoreishi M, Oftadegan S. Anticonvulsant effect of the aqueous extract and essential oil of Carum carvi L. seeds in a pentylenetetrazol model of seizure in mice. Iran J Med Sci. 2016;41(3):200–8.
14. Prajapati RM, Agarwal A, Thakur LK, Singh U. World Journal of Pharmaceutical and. 2017;3(8):157–65.
15. Overview OS. THE CHEMICAL CONSTITUENTS AND PHARMACOLOGICAL EFFECTS Indian Journal of Pharmaceutical Science & Research. 2017;(January 2015).
16. Iacobellis NS, Lo Cantore P, Capasso F, Senatore F. Antibacterial activity of Cuminum cyminum L. and Carum carvi L. essential oils. J Agric Food Chem. 2005;53(1):57–61.
17. Alhaider AA, Al-Mofleh IA, Mossa JS, Al-Sohaibani MO, Rafatullah S, Qureshi S. Effect of Carum carvi on experimentally induced gastric mucosal damage in wistar albino rats. Int J Pharmacol. 2006;2(3):309–15.
18. Khajuria V, Tandon V, Arora E, Choudhary N, Gillani Z. Effect of Carum carvi, a herbal bioenhancer on pharmacokinetics of antitubercular drugs: A study in healthy human volunteers. Perspect Clin Res. 2014;5(2):80.
19. Suhaj M. Spice antioxidants isolation and their antiradical activity: a review. J Food Compos Anal. 2006;19(6–7):531–7.
20. Asensio-Vegas C, Ben Khedim M, Rico D, Brunton N, Rai D, Hossain M, et al. *In-vitro* Approach for the Determination of Antioxidant and Anti-inflammatory Activity of Wild Marjoram (*Thymus mastichina L.*). J Food Nutr Res. 2018;6(12):731–9.
21. Rajkiran K, Eswar Kumar K, Satyanarayana S. Evaluation of in vitro antioxidant activity of aqueous extract of root of Coleus edulis and its correlation with in vivo hepatoprotective activity in paracetamol induced hepatotoxicity in rats. Asian J Pharm Clin Res. 2015;8(4):56–61.
22. Himaja N, Neelufar Shama S. Herbal wealth for hepatotoxicity: A review. Asian J Pharm Clin Res. 2015;8(1):3–9.
23. Abou El-Soud NH, El-Lithy NA, El-Saeed G, Wahby MS, Khalil MY, Morsy F, et al. Renoprotective effects of Caraway (Carum carvi L.) essential oil in streptozotocin induced diabetic rats. J Appl Pharm Sci. 2014;4(2):27–33.
24. Haidari F, Seyed-Sadjadi N, Taha-Jalali M, Mohammed-Shahi M. The effect of oral administration of Carum carvi on weight, serum glucose, and lipid profile in streptozotocin-

induced diabetic rats. Saudi Med J. 2011 Jul;32(7):695–700.
25. Xu Q, Nakajima M, Liu Z, Shiina T. Their Applications. 2010;1–20.
26. Begum J, Bhuiyan MNI, Chowdhury JU, Hoque MN, Anwar MN. Antimicrobial Activity of Essential Oil from Seeds of *Carum carvi* and Its Composition. Bangladesh J Microbiol. 1970;25(2):85–9.
27. Mahboubi M. Caraway as Important Medicinal Plants in Management of Diseases. Nat Products Bioprospect [Internet]. 2019;9(1). Available from: https://doi.org/10.1007/s13659-018-0190-x
28. Swathi V, Sathish Kumar V, Rahaman SA, Male A. in Vivo Screening of Analgesic and Antiulcer Activity on Carum Carvi Seeds. 2017;9(3):18–24. Available from: www.ejbps.com
29. Lahlou S, Tahraoui A, Israili Z, Lyoussi B. Diuretic activity of the aqueous extracts of Carum carvi and Tanacetum vulgare in normal rats. J Ethnopharmacol. 2007;110(3):458–63.
30. Kumar G, Banu GS, Pappa PV, Sundararajan M, Pandian MR. Hepatoprotective activity of Trianthema portulacastrum L. against paracetamol and thioacetamide intoxication in albino rats. J Ethnopharmacol. 2004;92(1):37–40.
31. Saghir MR, Sadiq S, Nayak S, Tahir MU. Hypolipidemic effect of aqueous extract of Carum carvi (black Zeera) seeds in diet induced hyperlipidemic rats. Pak J Pharm Sci. 2012 Apr;25(2):333–7.
32. Aydın E, Türkez H, Keleş MS. Potential anticancer activity of carvone in N2a neuroblastoma cell line. Toxicol Ind Health. 2015;31(8):764–72.