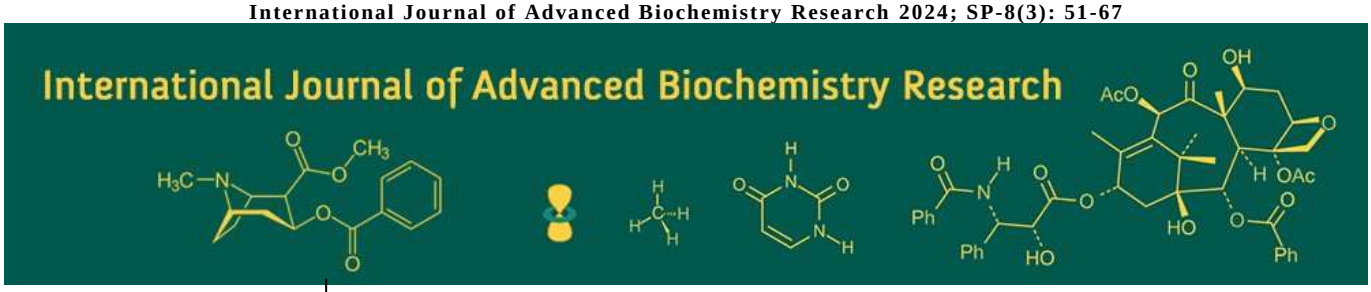

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A review on clinical application of Indian spices

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Abstract
Since ages, Indian spices are renowned and have been essential part of the nation's culinary legacy. Each spice carries a distinct personality, capable of transforming ordinary dishes into extraordinary culinary experiences. These Indian spices have become popular in medicine due to their possible therapeutic advantages and have been incorporated into ancient healing systems like Ayurveda. These spices exhibit various therapeutic benefits such as analgesic effect, anti-inflammatory, sedative effect, antidepressant, anti-dysmenorrhea and many more. By including these spices in one's diet, one can improve their general health and wellbeing. This study paper offers a brief overview of the medicinal potential of Indian spices, highlighting their importance for both increasing culinary flavor and benefiting the health and well-being. This paper aims to focus on its various biological activities. It emphasizes the necessity of more studies and clinical trials to fully utilize the therapeutic advantages of these spices in the fields of nutrition and medicine.

Keywords: Indian spices, therapeutic, clinical activity, medicinal

1. Introduction
In India during older times, naturally available herbal plants and spices were utilized in diet or as medicines to encourage good health, hygiene and sanitation as well as to extend life expectancy. Moreover, to luxury linens and ivory, spices were valued greatly in medieval Asia (De AK and De M., 2019) [41]. The word "species," was used in the middle centuries to refer to groups of unusual foods, is where the word "spice" originally came from (Mradu Gupta, 2010) [56]. The word "Masala," which means "spice" in Hindi, is widely used in Indian cooking. Spices have been closely linked to magic, preservation and medicine from the dawn of human history. Additionally, a significant portion trade in Egypt, Arabia and China with India included spices. The clove is mentioned in the Ramayana, a revered Hindu holy book, as well as in documents from the Roman Empire that date back to the first century AD (Ankit Shukla and Nagendra Yadav,2018) [119]. They are employed as antiseptics, carminatives, or to mask the unpleasant flavor of medications. In the majority of its concoctions, homoeopathic medicine utilized spices as a primary ingredient in most of its formulations. (De AK and De M., 2019) [41]. In Ayurvedic and Siddha traditional Indian medicine, a variety of spices and herbs are reported to have therapeutic properties, including being hypoglycaemic, anti-inflammatory, antithrombotic, antiatherosclerotic and anti-arthritic (Srivastava *et al.*, 1995) [123]. Finding compounds derived from natural sources which are pharmacologically efficacious and that have minimal to no adverse effects, for its utilization in medical prevention and in food sector is currently of increased interest to people globally (Vasanthi HR And Parameswari RP., 2010) [6]. However, the main obstacle to using condiments as therapeutic and preventative medicines is proving its health advantages through scientific methods equal to those used for pharmaceutical substances. Additionally, unlike pharmaceuticals, which are consumed in combinations and predefined amounts as concentrated and pure preparations, spices are utilized in mixtures and without measurement, unpredictable amounts in various cultural contexts (Tapsell *et al.*, 2006; Iyer, A. *et al.*, 2009) [129, 67].

1.1 Trade and production in India
India is a prominent participant in international spice exports being the top producer and exporter of spices in the worldand fulfils almost half of the demand for spices globally (Jaffee, 2005) [70].

Some spices, such as dried pimento/capsicum, cumin seeds, turmeric and coriander seeds offer substantial benefits in trade in terms of exports (Saxena R *et al.*, 2022) [114]. In the previous few decades, the proportion of spices in agricultural exports of India has also steadily climbed; in the years 2020–21 India surpassed the US $3.5 billion threshold for the first time. (Anonymous 3, 2020–21). Indian spice trade has had more success in gaining a reputation for upholding quality standards and providing marketing services in several countries, like the USA, UK, Germany, Sweden and Japan. In the fiscal year 2020–2021, the total value of spices exported was estimated at US$ 4.2 billion, a rise of (115%) from (84%) during the years 2014–21 (PIB, 2022). India maintained its trading edge in the global spice market due to favorable growing circumstances such as an early harvest benefit, a relatively significant benefit and an adequate trade balance. Multiple studies have demonstrated India's advantages and strengths in the export of spices around the world (Batra and Khan, 2005; Jagdambe, 2020; Shinoj and Mathur, 2008; Jambor *et al.*, 2018) [24, 71, 118, 72].

Below is the data regarding the Spices Production (Table 1.1) And its Trade – Export (Table 1.2) in India from year 2020 to 2023*.

Table 1: Spice Wise Area and Production (Area in Hec. Production in Tons)

Spice wise area and production (Area in Hec. Production in Tons)						
	2020-21		2021-22		2022-23*	
Spices	Area	Production	Area	Production	Area	Production
Pepper	309335	65000	283962	70000	278050	64000
Cardamom (Small)	69190	22520	69190	23340	70410	24463
Cardamom (Large)	44701	8803	45039	8812	45396	9074
Chilli	700563	2048622	882000	1836222	852413	1957635
Ginger (fresh)	204508	2219813	210016	2503325	205899	2431521
Turmeric (dry)	292753	1135174	333024	1221717	323838	1161025
Coriander	656075	888760	553099	735280	638652	847190
Cumin	1087010	795310	869186	555789	902010	627031
Celery	4566	6510	4568	6557	4444	6313
Fennel	82767	137388	64922	114971	82142	137408
Fenugreek	156156	241183	168716	252063	146363	226305
Garlic	392232	3190255	431218	3523436	407208	3368821
Tamarind	41626	156268	40345	152409	44056	162148
Clove	1944	1185	1924	1209	2086	1224
Nutmeg	24431	15595	23353	18429	23924	16s077
Grand total including others	4482660	11042470	4388955	11125010	4437870	11140980
Grand Total in MLN Tonne		11.04		11.12		11.14
(*) 1st Advance Estimate						

Table No. 1 (Anonymous 1, 2019) [14]

Table 2: Item-Wise Export Report of Spices from India (Quantity in Tonnes and Value in Rs. Lakhs)

Item-wise export of spices from India (Qty. in Tonnes and Value in Rs. Lakhs)						
	2020-21		2021-22		2022-23*	
Item	Qty	Value	Qty	Value	Qty	Value
Pepper	19,980	57,068.74	21,863	75,331.23	17,958	72,686.41
Cardamom (Small)	6,486	110,346.58	10,571	137,566.95	7,352	87,514.87
Cardamom (Large)	1,220	9,635.74	1,981	15,448.21	1,883	13,720.19
Chilli	649,815	924,126.56	557,138	858,180.26	516,177	1,044,412.31
Ginger	145,974	84,982.34	147,677	83,651.76	50,885	43,246.06
Turmeric	183,868	172,264.56	152,758	153,442.05	170,085	166,699.49
Coriander	57,359	49,627.93	48,656	48,247.51	54,481	66,501.19
Cumin	298,423	425,154.66	216,971	334,367.40	186,509	419,359.76
Celery	7,438	9,815.24	7,579	9,854.19	5,248	7,755.76
Fennel	33,742	29,396.40	40,139	41,197.20	21,201	31,437.42
Fenugreek	40,340	26,703.34	32,402	26,285.83	35,055	26,680.17
Other seeds	68,266	42,629.21	47,167	40,445.48	57,431	48,089.08
Garlic	17,643	14,971.04	22,135	18,575.04	57,346	24,579.64
Nutmeg & Mace	3,812	19,115.33	3,597	21,798.86	3,447	22,127.57
Other Spices	54,908	88,958.81	109,375	160,236.06	116,269	193,701.29
Curry powder/paste	51,347	117,064.38	52,479	115,836.50	57,924	141,689.27
Mint products	27,519	366,713.38	36,254	444,144.18	26,708	357,386.49
Spice oils & Oleoresins	16,997	340,568.76	21,920	447,823.73	18,398	408,551.25
TOTAL (incl others)	1,758,985	3,097,331.96	1,530,661	3,032,432.44	1,404,357	3,176,138.22
VALUE IN MILLION US $		4,178.80		4,068.45		3,952.60
(*) Provisional						

Table No. 2 (Anonymous 1, 2019) [14]

1.2. Significance

In order to season food and add taste, aroma and the sharpness, natural components called spices are extracted from plants or vegetables, either whole or pulverized. along with this it has been used as preservatives, appetizers, digestives and aphrodisiacs. It also has its application in non-food sectors such as odour, color. It prolongs the storage life of food by minimizing flavor of rotten meat. Many plant or tree parts, such as fruits, stigma, seeds, leaves, kernels, arils, bulbs, berries and more, can be used to make spices (Khanum F, *et al.*, 2001; Mradu Gupta, 2010) [78, 56]. A research study indicates that spices, which are abundant in antioxidants, are also powerful inflammatory and tissue-damaging inhibitors brought on by excessive blood glucose and circulatory lipid levels. As they contain phenol, these are able to prevent the synthesis of chemicals that cause damage brought on by metabolic problems. Given that spices have extremely little calories and are reasonably priced, they are trustworthy sources of anti-oxidants and other dietary bioactive substances (Muthulakshmi V *et al.*, 2009) [98].

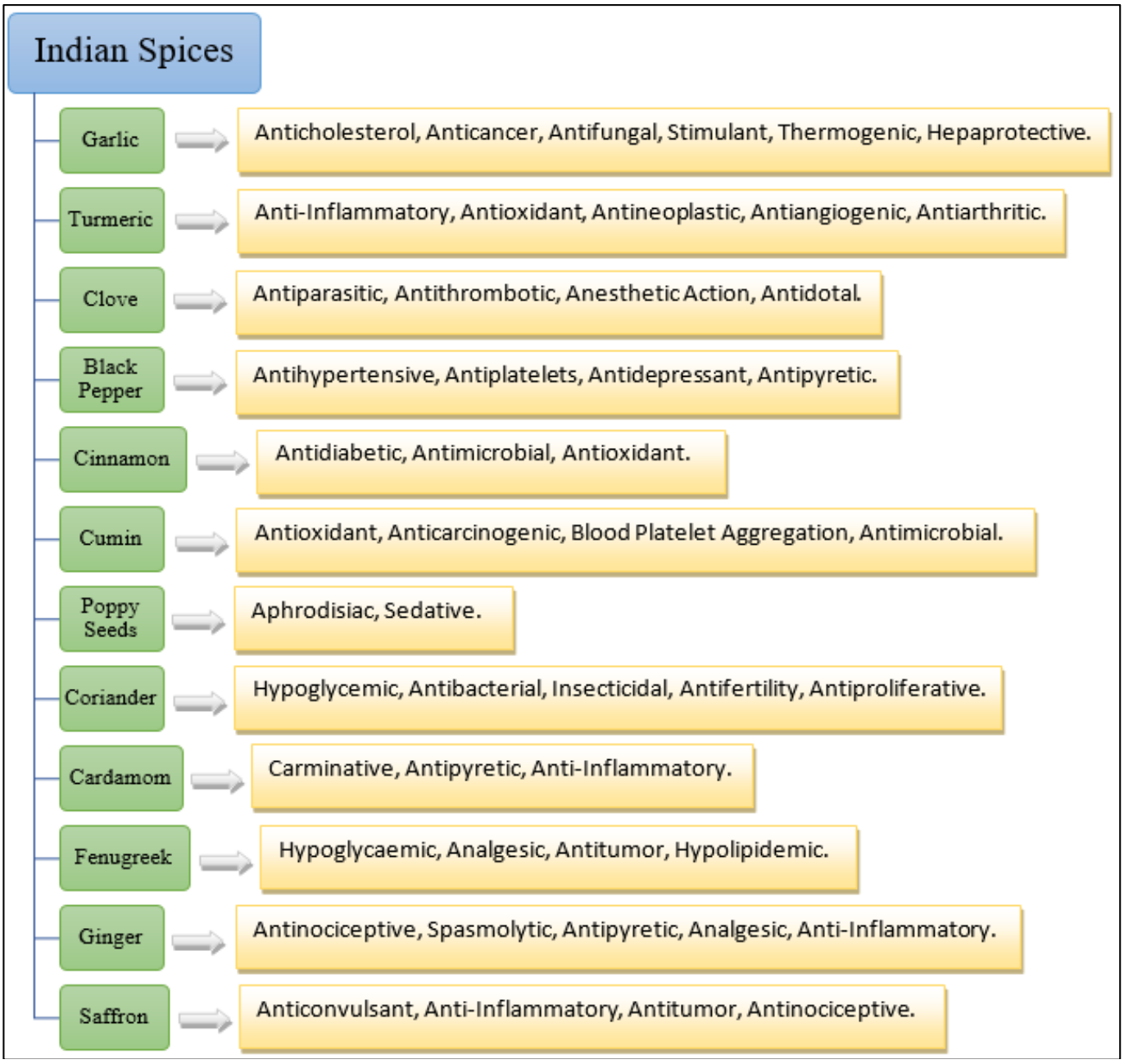

Fig 1: Indian Spices and its Benefits.

2. Indian spices

2.1. Carom seeds–Its botanical name is *Trachyspermum ammi* L. and is from Apiaceae family; commonly referred in India as ajwain (Hindi). Despite being grown and consumed mostly in the subcontinent of India, ajwain may also be seen in Egypt, Iran and Afghanistan. Carom seed is widely grown both as summer crop in the hills and as cold-season crop in lowlands. This needs protected growing season that is warm and frost-free. Any loamy or sandy-loam soil, including dark soils, are suitable for growing it. It is grown in India utilizing both irrigated and rain-fed farming techniques (Aggarwal *et al.*, 2009) [4]. Used to treat GI conditions like cholera, dyspepsia, flatulence and diarrhoea. It is used as an antiseptic, preservative and treatment for respiratory and GI issues in Ayurveda. In the Unani medical system, as a booster of the body's defences (Perry R. *et al.*, 2011;

Chauhan B. *et al.*, 2012) [104, 38]. Thymol, being main ingredient of Ajwain essential oil, can be extracted to a concentration ranging from 35 to 60 percent.
Paracymene, gammaterpinene, α-pinene, β-pinene, terpinene, styrene, betaphyllanderene and Carvacrol are all found in the Ajwain seeds with these bioactive compounds having various beneficial health effects; however, in a study, the main oil elements were introduced as carvone (46.2%), limonene (38.1%) and dillapiole (8.9%) (Asif HM, & Hashmi HAS, 2021; Choudhury S *et al.*,1998) [21, 39]. Analysed volatile oil revealed 26 components, which together accounted (96.3%) from the total, were present. Thymol (39%), paracymene (30.8%), gammaterpinene (23.3%), α-pinene (1.7%), terpinene-4-ol (0.8%) and numerous additional substances were discovered in smaller concentrations. The acetone extract revealed existence of 18 components that were identified, which made up (68.8%) of the total. Thymol (39.1%) made up the majority of the compound, which was then followed by oleic acid (10.4%), linoleic acid (9.6%), gammaterpinene (2.6%), paracymene (1.6%), palmitic acid (1.6%) and 4-hydroxy-4-methylpenta-2-one (1.1%) along with exhibiting its potential as antiviral, hepaprotective, anticancer, antiseptic (Singh *et al.*, 2004) [121].

2.1.1. Nutrient Composition:

Table 3: (Javed S. et al. 2012) [74]

Composition	gm per 100 gm
Water	11.6
Protein	20.23
Fat	4.83
Carbohydrates	47.54
Ash	11.5

2.1.2. Clinical potential

2.1.2.1. Antibacterial activity: Testing was done on acetone and ajwain aqueous extracts using an agar diffusion assay for their antibacterial effects against *Salmonella typhi*, *Shigella flexneri*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Escherichia coli*, *Salmonella typhi-murium* and *Staphylococcus aureus* (Zaidi SF. *et al.*, 2009) [139]. According to the study, acetone extract is greater in activity than aqueous extract. A further investigation found that an ethanolic extract of ajwain has antibacterial efficacy against eight *Helicobacter pylori* strains (Nahak, G. *et al.*, 2011) [99].

2.1.2.2. Insecticidal activity: According to reports, the essential oil from ajwain seeds can block *Callosobruchus chinensis* of *Helicobacter pylori* from hatching its eggs and developing as well as exhibit insecticidal activity during the oviposition stage (Chaubey MK., 2008; Kostyukovsky M. *et al.*, 2002) [37, 82]

2.1.2.3. Diuretic and anti-lithiasis activity – In ethnopharmacological accounts, carom seed was said to exhibit diuretic and anti-lithiasis action. As a result, a human trial was conducted in which individuals with urinary stones were given Ajwain seeds decocted in milk over a nine-day period. The outcomes against pure calcium oxalate stone were reported as satisfactory (Boskabady MH. *et al.*, 2003) [28].

2.1.2.4. Antiulcer activity: When in relation with the control group observed, the ethanolic extract of ajwain reduced ulcerative lesions and the efficacy was investigated using several ulcer models (Ramaswamy S. *et al.*, 2010) [7].

2.1.2.5. Anti–platelet activity: By increasing adrenaline, arachidonic acid and collagen, the extract of ajwain has antiplatelet effects and prevents platelet aggregation (Lim TK, 2012) [87].

2.2. Asafoetida: Its botanical name *is Ferula asafoetida* L. and it belongs to Apiaceae family. It is often referred in India as Hing (Hindi). The dried latex, also known as gum oleoresin, that is secreted by the tap root or living underground rhizome of various species of *Ferula*, a perennial herb that grows one to 1.5 meters long, with three species identified in India. The species are found all throughout, from Central Asia to the areas of Mediterranean. This is been produced in Kashmir and other parts of Punjab in India (Anonymous 1, 2019) [14].
Asafoetida is composed of three principal parts: gum (25%), resin (40-64%) and essential oil (10-17%) (Takeoka G, 2001) [128]. Coumarins, sesquiterpene coumarins, ferulic acid and its esters, as well as various terpenoids, having various health advantages can be found in the resin part. One-arabinose, rhamnose, glucose, galactose, glucuronic acid, polysaccharides and glycoproteins make up the gum component. The volatile fraction has compounds which contains sulphur, other volatile terpenoids, monoterpenes (Iranshahy M and Iranshahi M, 2011) [66]. Resin from *F. asafoetida* contains sulphur compounds that have a variety of biological effects and have potential medical applications (Iranshahi M *et al.*,2006) [65].

2.2.1. Nutrient Composition

Table 4: (George, C. K. 2012) [51].

Composition	gm per 100 gm
Moisture	10
Food Energy	297 kcal
Protein	4
Fat	1.1
Carbohydrates	67.8
Ash	7
Ca	690
Fe	39.4 mg

2.2.2. Clinical potential

2.2.2.1. Antioxidant activity: When given oral dosages to Sprague-Dawley rats of 1.25 and 2.5 percent w/w, asafoetida markedly enhanced the activity of the antioxidant system, that had been diminished by the N-methyl-N-nitrosourea treatment. In rat liver, lipid peroxidation was significantly reduced as determined by thiobarbituric acid-reactive compounds (Mallikarjuna GU, *et al.*, 2003) [89].

2.2.2.2. Antibacterial and antifungal activity: When studied on model organisms like *E. coli*, *B. subtilis*, *Klebsiella pneumonia and S. aureus* for antibacterial activity, *Aspergillus niger* and *Candida albicans* for antifungal activity; significant antibacterial and antifungal activity were been observed for ethanol, methanol and ethyl acetate extracts, with methanolic extract having the highest activity (Patil SD. *et al.*, 2015) [103].

2.2.2.3. Antiviral activity: Asafoetida's *in vitro* antiviral effectiveness has recently been tested against a few HRV serotypes. It was found that asafoetida's gum and resin decreased the cytopathic effects of HRV-2 in hela cells dose-dependently. The aforementioned investigation clarified the traditional medical usage of this gum resin in treating upper respiratory infections (Lee CL. *et al.*, 2009; Fatehi M. *et al.*, 2004) [86, 46].

2.2.2.4. Neuro-pharmacological studies: anxiolytic, analgesic and sedative activity: Using elevated plus maze, hole-board test and hot plate as models for anxiety, as well as locomotor motor activity meters for analgesic and sedative activity, Alqasoumi evaluated the analgesic, anxiolytic and sedative characteristics of asafoetida in rodents. He utilized the anxiolytic drug diazepam as a standard. The asafoetida aqueous extract was found to have a dose-dependently anxiolytic and analgesic influence along the slight sedative effect at dosages of 250 mg kg^{-1} and 500 mg kg^{-1} in mice. After one hour of administration of medication, he discovered the greatest analgesic effect. The author came to the conclusion that asafoetida is been more effective alternative to diazepam for curing anxiety. To precisely determine its safety and effectiveness for treating chronic anxiety, additional experimental and clinical investigations are required (Alqasoumi S., 2012) [9].

2.2.2.5. Antihyperglycemic activity: In a study, an STZ-induced diabetic rat model was being used for evaluating the effects of asafoetida on diabetes. It is widely known that administering rats with a high doses of streptozotocin (>45 mg/kg) severely impairs the pancreatic β-cells' capacity to produce and release insulin. Therefore, these animals experience reduced insulin sensitivity in response to feed and glucose loading, as well as compromised intake of glucose and utilization capacities, simulating type 1 diabetes mellitus in humans. As a result, in Streptozotocin-diabetic rats, the water-soluble extract of asafoetida at amounts of 50 mg kg^{-1} demonstrated the hypoglycemic effect. Tannins and phenolic acids (ferulic acid) present can help to explain this action (Szkudelski, T., 2001; Zhang, M. *et al.*, 2008; Ar Rajab, A. and B. Ahren, 1993) [125, 141, 16].

2.3. Black pepper: Black pepper's botanical name is *Piper nigrum* L. whcich is from Piperaceae family. It is often referred in India as Kali Mirch (Hindi). Amongst the most popular and extensively utilized spices globally, black pepper, also often titled as the "King of Spices" is a native of southern India (Nair KP, 2011) [100]. The highlands of India's South Western Ghats are thought to be where pepper first originated. Aside from the country of origin, now also produced in Indonesia, Sri Lanka, Malaysia, Thailand, Vietnam, Cambodia, China, Guatemala, Mexico and Brazil (Anonymous 1, 2019) [14].

The primary element in the essential oil of black pepper seeds grown in South India is β-caryophyllene, which is followed by limonene, sabinene, α-pinene, β-bisabolene, α-copaene α-cadinol, α-thujene and α-humulene; pepper leaves are rich in nerolidol, which also includes α-pinene and β-caryophyllene simultaneously possessing antioxidant, anti-inflammatory, antimicrobial, anticancer as its health benefits (Sruthi D *et al.*, 2013; Utpala P *et al.*, 2008) [124, 130].

2.3.1. Nutrient Composition

Table 5: (Anonymous 1, 2019) [14]

Composition	mg per 100 gm
Moisture	10.51 g
Food Energy	255 kcal
Protein	10.95 g
Fat	3.26 g
Carbohydrates	64.81 g
Ash	4.33 g
Ca	0.437 g
P	173
Na	44
K	1259
Fe	28.86
Vitamin B1	0.109
Vitamin B2	0.240
Vitamin B3	1.142
Vitamin A Activity (RE)	19

2.3.2. Clinical potential

2.3.2.1. Cytotoxicity activity: The efficiency of tumor necrosis factor (TNF)-related apoptosis in breast cancer cells may be improved by BPEO and piperine (Abdelhamed S. *et al.*, 2014) [1]. According to Greenshields *et al.*, in immune-deficient animals, piperine and radiation together exhibited higher cytotoxicity and were more efficient at halting the proliferation of triple-negative cancer cells than only radiation. Without affecting the proliferation of healthy mammary epithelial cells, piperine prevents development of human breast cancer cells. It blocks the cell cycle and uses the mitochondrial route to cause caspase-dependent apoptosis. It suppresses the development of matrix metalloproteinases-2 and -9, also prevents the migration of breast cancer cells. In immune-deficient mice, it prevents formation of breast cancer xenografts. While piperine and BPEO have been shown to be safe, the clinical applicability of this result is limited by the use of cell lines exclusively in in-vitro experiments (Greenshields AL. *et al.*, 2015) [55].

2.3.2.2. Hypoglycemic activity: In comparison to diabetic rats (270 mg/100 ml), diabetic rats treated for 4 weeks with its aqueous seed extract had blood glucose levels that were 129 mg/100 ml (Kaleem *et al.*, 2005) [75]. Due to increased activity along the polyol pathway, aldose reductase is principally responsible for the emergence of long-term diabetic issues, including retinopathy, neuropathy and nephropathy. Pharmacological inhibition of aldose reductase is therefore regarded as a key approach in the prevention and attenuation of these issues. With an IC_{50} value of 35.64 lg ml^{-1}, goat lens aldose reductase was inhibited by hydromethanolic extract of the seed (Gupta, S. *et al.*, 2014) [57].

2.3.2.3. Antidepressant activity: Piperine's potential antidepressant impact was investigated in a corticosterone-induced depression mice model. Through a decline in consumption of sucrose and rise in immobility time during forced swim and tail suspension test, depression in rats was assessed. Levels of brain-derived neurotrophic factor protein therefore decreased dramatically in the hippocampus of corticosterone-treated animals. The biochemical ssand behavioral abnormalities in mice caused by corticosterone finally returned to normalcy after treatment with piperine (Q.Q. Mao *et al.*, 2014) [91].

2.3.2.4. Antidiarrheal activity: The black pepper's aqueous extract was tested for its antidiarrheal capabilities by boosting the antimotility and antisecretory effects in the gut at doses of 75, 150 and 300 mg kg^{-1}. This was possible due to alkaloids (like piperine) and carbohydrates. (P.B. Shamkuwar *et al.*, 2012) [117].

2.3.2.5. Antioxidant activity – Free radicals are generated as a consequence of radiation exposure, tissue damage, infections, environmental pollution and autoimmune diseases (Bagchi and Puri 1998) [22]. Increasing the amount of antioxidants in tissues can reduce the damage that free radicals can do to tissues. With its antioxidant properties, piperine can reduce thiobarbituric acid-reactive compounds, keep glutathione peroxidase, superoxide dismutase, catalase, glutathione S-transferase and glutathione levels stable and minimize oxidative stress in cells caused by a diet high in fats. Due to piperine's antioxidant properties, piperine possesses liver-protective properties (Vijayakumar *et al.*, 2004) [133].

2.4. Cloves: Its botanical name is *Syzygium aromaticum* (L) Merr. & Perry and falls in Myrtaceae family. It is referred in India as Laung (Hindi). The plant is native to Indonesia's North Molucca Islands. Additionally, it is well produced in India, Malaysia, Sri Lanka, Madagascar and Zanzibar. The tree prefers rich, well-drained soil that is consistently moist throughout the year (Anonymous 1, 2019) [14]. Due to its antibacterial, antiseptic and antibiotic characteristics, clove oil is utilized in medicine. By administering it orally, it has also been used successfully for treating allergy diseases including asthma (Kim HM *et al.*, 1998) [79]. Cloves have mutagenic, inflammatory, antioxidant, antiviral, thrombotic and parasite-repelling properties (Mittal M *et al.*, 2014) [92]. (15-20%) of the essential oil found in buds of clove is made up of eugenol (70-85%), eugenyl acetate (15%) and caryophyllene (5-12%). Vanillin, gallotannic acid, crategolic acid, eugenitin, tannins, methyl salicylate, rhamnetin, eugenin, kaempferol and triterpenoids like oleanolic acid are some of the other essential oil components in clove oil which also performs a variety of biological activities and could be used for its aroma and medicinal properties. Methyl amyl ketone, alpha and betahumulene, methyl salicylate, benzaldehyde, chavicol and β-ylangene are other components of the oil. Minor components like methyl salicylate and methyl amyl ketone are what give cloves their particular, pleasant aroma. Six sesquiterpenes, namely: α-cubebene (1.3%), β- caryophyllene (64.5%), α-copaene (0.4%), γ-cadinene (2.6%), β-humulene (9.1%) and δ-cadinene (2.6%), were identified in the freshly distilled Indian clove bud oil's hydrocarbon fraction. (Gopalakrishnan *et al.*, 1984) [54].

2.4.1. Nutrient Composition

Table 6: (Anonymous 1, 2019) [14]

Composition	mg per 100 gm
Water	6.86 g
Food Energy	323 kcal
Protein	5.98 g
Fat	20.06 g
Carbohydrates	61.22 g
Ash	5.88 g
Ca	0.646 g
P	105
Na	243
K	1102
F	8.68
Vitamin B1	0.115
Vitamin B2	0.267
Vitamin B3	1.458
Vitamin C	80.81
Vitamin A Activity (RE)	53

2.4.2. Clinical potential

2.4.2.1. Antithrombotic activity: Acute thrombosis, a major contributor to morbidity and mortality in humans, is largely caused by platelet aggregation. It is well known that cloves and clove oil have a wide range of medicinal benefits. In this study carried by Saeed and Gilani (1994) [111], clove oil was reported to reduce human platelet aggregation caused by AA and PAF *in vitro* at low dosages. Studies on clove oil in living animals showed positive results in a rabbit model of AA and/or PAF-induced sudden death. Clove oil (50–100 mg kg^{-1}) pretreatment of rabbits inhibited the fatal effects of PAF and/or AA, indicating clove oil serves as an antagonist of PAF and AA. Because of its dual AA and PAF antagonistic characteristics, clove oil may thus represent a novel class of antithrombotic agents (Saeed, S. A. and Gilani, A. H. 1994) [111].

2.4.2.2. Antibacterial activity: Numerous investigations have demonstrated the potent antibacterial properties of clove. Clove contains a number of components that contribute to its inhibitory action, mainly eugenol, 2-heptanone, eugenyl acetate, βcaryophyllene, methyl salicylate, acetyl-eugenol, α-humulene, iso-eugenol, phenyl propanoides, methyl-eugenol, dehydrodieugenol, biflorin, trans-confireryl aldehyde, kaempferol, oleanolic acid, rhamnetin, gallic acid, myricetin and ellagic acid (Chaieb K. *et al.*, 2007; Cai L and Wu CD, 1996; Yang YC *et al.*, 2003) [32, 31, 137]. These substances can interact with phospholipids in cell membranes to change their permeability and denature proteins. Clove oil reported to be efficacious against *Escherichia coli* O157:H7 non-toxigenic strains. (Burst SA and Reinders RD, 2003).

2.4.2.3. Antifungal activity: To evaluate *in vivo* antifungal efficacy, multiple studies have been carried out. In mice with orally infected with *Candida albicans*, a hot water extract of clove added to the drinking water reduced oral candidiasis symptoms. This extract's chemical composition was not disclosed (Abe S, 2004) [2]. In a different experiment, mice which were affected by *C. albicans* orally, after receiving an unknown clove preparation (10.4 mg) in mouth cavity, the amount of macroscopic lesions on the lingual surface and the rate at which *Candida mycelia* invaded the lingual tissue were both reduced (Taguchi Y, *et al.*, 2005) [126].

2.4.2.4. Cytotoxicity activity: The ability of the clove oil derivatives borneol and eugenol to regulate resistance to the DNA-damaging effects of H_2O_2 was looked at. Human fibroblast cells (VH10) were significantly damaged by eugol, however hepatocyte cells (hepg2) did not experience any genotoxic effects (Jannuzzi A, 2022) [73].

2.4.2.5. Anti-stress activity: Clove extracts inhibit sound stress-related biochemical changes like increased plasma levels of alanine aminotransferase, glucose, aspartate aminotransferase, corticosterone, cholesterol and also the cold-induced stomach ulcers formation (Singh AK *et al.*, 2009) [120].

2.5. Coriander: Its botanical name is *Coriandrum sativum* L. and it belongs to Apiaceae family. It is oftenly referred in India as Dhaniya (Hindi). Since coriander is a tropical plant, it can be grown effectively during the rabi season in areas that are not frequently severely frost-affected in February, when the plant blossoms and sets its seeds (Anonymous 1, 2019) [14].

By using GC-FID and GC-MS, the essential oil composition of coriander fruits hydrodistilled at three different stages of maturity was investigated. During the maturation phase, essential oil outputs increased noticeably and 41 compounds were discovered. In the first maturity stage (immature fruits), the primary chemicals were geranyl linalool (10.96%), acetate (46.27%), nerol (1.53%) and neral (1.42%). Linalool (76.33%), cisdihydrocarvone (3.21%) and geranyl acetate (2.85%) were noted as the primary ingredients at the middle stage. Linalool (87.54%) and cisdihydrocarvone (2.36%) make up majority of the essential oils in mature fruits at the peak of their development and to add to its application it can be used as preservative, for aroma and in pharmaceutics (Msaada, K. *et al.*, 2007) [96].

2.5.1. Nutrient Composition

Table 7: (Anonymous 1, 2019) [14]

Composition	mg per 100 gm
Water	8.86 g
Food Energy (kcal)	298 kcal
Protein	12.37 g
Fat	17.77 g
Carbohydrates	54.99 g
Ash	6.02 g
Ca	0.709 g
P	409
Na	35
K	1267
Fe	16.32
Vitamin B1	0.239
Vitamin B2	0.290
Vitamin B3	2.130
Vitamin A Activity (RE)	Trace

2.5.2. Clinical potential

2.5.2.1. Analgesic activity: The analgesic effect of coriander seed aqueous extracts is likely caused by suppression of central pain receptors. Linalool, a monoterpene alcohol that is frequently present as a essential component of coriander essential oil, is said to play a significant part in the analgesic effect. In this context, some researchers have noted linalool's antinociceptive activity, while others have investigated how the glutamatergic system contributes to the antinociception that linalool causes in mice or shown that linalool complexed with β-cyclodextrin has antinociceptive effects that are more effective than those of linalool in experimental pain protocols (Laribi B. *et al.*, 2015) [85]. In order to assess coriander seeds' ability to reduce pain, water extracts of the seeds were given (125–1000 mg/kg, IP). In comparison to controls, dose-dependent antinociceptive effects were seen across all tests (Taherian AA *et al.*, 2012) [127].

2.5.2.2. Diuretic activity: Wistar rats of either sex (weighing 200 to 250 g) were used in Jabeen *et al.*'s (2009) [69] investigation into the diuretic efficacy of plant extracts. While the other groups with similar numbers of animals got varied amounts of plant extracts diluted in saline (50 ml kg^{-1}), the five-animal negative and positive control groups received saline and the common diuretic drug furosemide (10 mg kg^{-1}).

The findings indicated that rats' considerable rise in urine production (diuresis), which was comparable to that of the common diuretic furosemide, verified coriander's diuretic action. For this reason, diuretics are thought to be among the best choices when it comes to managing and treating uncomplicated hypertension. (Q. Jabeen *et al.*, 2009; S. Bhat *et al.*, 2014) [69, 27].

2.5.2.3. Sedative hypnotic activity: Traditional Iranian medicine has suggested *Coriandrum sativum* L. To treat

insomnia. To assess hypnotic and sedative action, rats are given extracts that are aqueous and hydroalcoholic, as well as essential oils. The experiment's findings indicate that aqueous extract, at amounts of 200, 400 and 600 mg kg^{-1}, increased the duration of pentobarbital-induced sleep. Pentobarbital-induced sleep duration was prolonged by hydro-alcoholic extract at doses of 400 and 600 mg kg^{-1} compared to the saline-treated group. Only at 600 mg kg^{-1} did the essential oil prolong the period of sleep induction caused by pentobarbital. Coriander seed extracts and essential oil have sedative-hypnotic properties (Emamghoreishi M and G Heidari-Hamedani, 2006) [44].

2.5.2.4. Antioxidant activity: Because they shield the body against risks brought on by free radicals produced in conditions like ischemic heart disease, atherosclerosis, Alzheimer's disease and also the aging process, antioxidants are of interest to biologists and physicians (Aruoma OI, 2003) [17]. The existence of the extract's total phenolic contents was held accountable for this activity (Wangensteen H. *et al.*, 2004) [135].

2.5.2.5. Anthelmintic activity: On the egg and adult nematode parasite known as *Haemonchus contortus*, crude aqueous and hydroalcoholic extracts of the fruits of *C. sativum* were tested for their anthelmintic properties *in vitro*. The aqueous extract of coriander was tested for its *in vivo* anthelmintic activity in sheep that were infected with *H. contortus.* At a concentration lower than 0.5 mg ml^{-1}, both extract types entirely prevented eggs from departing. The hydroalcoholic extract's ED was 0.18 mg ml^{-1}, compared to the aqueous extract's 0.12 mg ml^{-1} (Eguale T *et al.*, 2007) [43].

2.6. Nutmeg: Its botanical name is *Myristica fragrans Houtt*. from Myristicaceae family. It is oftenly referred in India as Jaiphal (Hindi). According to Al-Rawi *et al*. (2011) [10], nutmeg is widely available in Malaysia, Indonesia, India and Southeast Asia. The flavor of nutmeg differs according to its growing region. It has a variety of flavors, includes smooth, peppery and robust (Charles, 2013) [34]. At heights up to 21 meters, myristicaceae could be seen in tropical lowland forests, submontane forests, swamp woods and cloud forests. This family's anatomical traits suggest they might have previously lived in xeric (dry) circumstances (Malik *et al.*, 2021) [88].

Recent research revealed that nutmeg leaf oil from the Western Ghats of South India contained (3.2%) v/w of sabinene (17.2%), myristicin (9.1%), eugenol (16.6%), caryophyllene (8.8%), limonene (5.0%), α-pinene (5.4%), copaene (3.2%), betapinene (6.4%), betamyrcene (4.7%), germacrene D (3.0%) and 3-Carene (2.7%), while mace oil (8.1% v/w) had sabinene (38.4%), limonene (7.1%), α-pinene (8.2%), 3-carene (5.1%), betapinene (7.6%), myristicin (5.9%), 3-carene (5.1%), 4-carene (4.2%), β-phellandrene (3.6%), safrole (3.9%) and terpinen-4-ol (3.0%) as the principal components along with several studies have concluded it having antimicrobial, anti-inflammatory, anticancer, insecticidal and many other biological benefits . Further sabinene, limonene, α-pinene, β-pinene and β-myrcene make up the majority of the nutmeg kernels grown in the Western Ghats in South India (Ashokkumar *et al.*, 2022) [19].

2.6.1. Nutrient Composition

Table 8: (Anonymous 2, 2019) [15]

Composition	mg per 100 gm
Moisture	6.23 g
Food Energy	525 kcal
Protein	5.84 g
Fat	36.3 g
Carbohydrates	49.3 g
Ash	2.34 g
Ca	0.184 g
P	213
Na	16
K	350
Fe	3.04
Thiamine	0.346
Riboflavin	0.057
Niacin	1.3
Ascorbic acid	3
Vitamin A Activity (RE)	5 µg

2.6.2. Clinical potential

2.6.2.1. Anti-inflammatory and analgesic activity: The anti-inflammatory and pain-relieving effects of nutmeg oil make it beneficial. The oil helps alleviate joint and muscle problems if it is applied directly to the troublesome areas. It is also effective in treating rheumatic fever and helps lessen joint swelling (Duke and Edward, 1985; Ernest, 2002) [42, 45]. Myristicin is an effective anti-inflammatory, according to tests. According to numerous studies, it has the ability to prevent the synthesis of prostaglandins (PGE2), one of the primary chemicals contributes in the inflammatory process (Seneme, E.F.; *et al.*, 2021) [116].

2.6.2.2. Antioxidant activity: Chemical assays such as DPPH (2,2-diphenyl-1-picrylhydrazyl), FRAP (ferric reducing/antioxidant power assay), suppression of lipid peroxidation and bleaching of β-carotene can be used to demonstrate the antioxidant activity of MFEO (*Myristica fragrans* essential oil). With an EC50 dosage of 181.4 g ml^{-1}, the nutmeg essential oil demonstrated (88.7%) suppression of linoleic acid oxidation. Another study found that for EO concentrations of (0.2-20%), pure MFEO and MFEO with (1%) magnesium aluminometasilicate showed comparable antioxidant efficacy. This study also reported a dose-dependent increase in antioxidant activity (Ashokkumar, K *et al.*, 2022) [19].

2.6.2.3. Skin protectant activity: It has been demonstrated that the neolignane Licarin E shields human skin fibroblasts from UVB radiation harm. It offset the upregulation of matrix metalloproteinase-1 (MMP-1) and downregulation of procollagen expression brought on by UVB. The molecular mechanism behind these effects has been identified as stimulation of the TGF/Smad signaling pathway. Like macelignan, licarin E might be a promising novel photoaging therapy (Kwon *et al.*, 2011) [84].

2.6.2.4. Hepatoprotective activity: Thioacetamide (TAA) has a long history of usage as a traditional experimental hepatotoxicant that can cause both acute and long-term liver damage. In this investigation, the control group's plasma ALT and AST activity were 80 and 57 U L^{-1}, respectively. The activity of both transaminases was considerably elevated by a single dose of TAA exposure to 3560 and

2210 U L^{-1}, respectively, demonstrating severe hepatotoxicity brought on by TAA. ALT and AST activity were significantly reduced by NME to 1050 and 377 U L^{-1}, respectively (p 0.01). Furthermore, mice's weights decreased after 24 hours of TAA administration and their hepatic indices increased. These alterations were markedly reduced by NME in the TAA + NME group (Fitzhugh, O. G. and Nelson, A. A, 1948; Fontana, L *et al.,* 1996; Fernandez-Martinez, A *et al.*, 2006) [48, 49, 47].

2.6.2.5. Antibacterial and antifungal activity: According to studies, nutmeg essential oil (*Myristica fragrans*), which only contains (10%) myristicin, has the power to significantly reduce the development of the fungi *Aspergillus flavus* and *Aspergillus ochraceus*. The essential oil and extract of nutmeg (*M. fragrans*) were tested against the bacteria *Staphylococcus aureus* and *Cutibacterium acnes* as part of a study to determine the efficacy of myristicin in treating acne and the results showed good antibacterial action against both (Seneme, E.F.; *et al.,* 2021) [116].

2.7. Thyme: Its botanical name is *Thymus vulgaris* belonging to Lamiaceae family. It is often referred in India as Banajwain (Hindi). From Spain to Italy, thyme is a native of Southern Europe. It is grown outside of Europe in Australia, North Africa, North Asia, Canada and the United States. It is produced in India's Nilgiris and Western Temperate Himalayas. Thyme thrives on the hills, preferring a temperate climate and mallow upland soil (Anonymous 1, 2019) [15]. Thyme has high amounts of monoterpene phenols, along with thymol (2-isopropyl-5-methylphenol or iso-propyl-meta-cresol; $C_{10}H_{14}O$; (10–64%), carvacrol (iso-propyl-ortho-cresol;0.4–20.6%) and paracymene (9.1–22.2%) and other monoterpenes such as 1,8-cineole (0.2–14.2%), linalool (2.2–4.8%), borneol (0.6–7.5%),α-pinene (0.9–6.6%) and camphor (0–7.3%); with these compounds having biological and therapeutical properties (Amiri, 2012; Burt, 2004; Nickavar B. *et al.,* 2005) [12, 30, 102]. Carvacrol is the isomer of thymol, a naturally found monoterpene derivative of cymene. Thymol and carvacrol both exhibit antibacterial, antioxidative, antimicrobial, expectorant and antispasmodic properties among other bioactivities (Salehi *et al.,* 2018) [112].

2.7.1. Nutrient Composition

Table 9: (Anonymous 1, 2019) [14]

Composition	mg per 100 gm
Moisture	7.79 g
Food Energy	276 kcal
Protein	9.10 g
Fat	7.43 g
Carbohydrates	63.94 g
Ash	11.74 g
Ca	1.890 g
P	201
Na	55
K	814
Fe	123.6
Vitamin B1	0513
Vitamin B2	0.399
Vitamin B3	4.940
Vitamin A Activity (RE)	380

2.7.2. Clinical potential

2.7.2.1. Spasmolytic activity: The reflexes of the isolated trachea of a guinea pig are widely thought to match those of the smooth muscle in the airways of humans. The relaxing effects of thyme extracts on guinea-pig trachea are of relevance since tracheal smooth muscle spasmolysis may help to alleviate cough, particularly in spastic cough and pertussis and bronchodilator medications may be beneficial for the treatment of asthma (C. O. V. D. Broucke and J. A. Lemli, 1981) [131].

2.7.2.2. Antitumoral activity: Researchers found that essential oils with high carvacrol content have more cytotoxic activity with thyme carvacrol being highly effective cytotoxic product against the p815mastocytoma cell line. The cytotoxic action of thyme on tumor cells is responsible for its antitumoral effects, particularly for the two pure components carvacrol and thymol. (Jaafari *et al.,* 2007) [68].

2.7.2.3. Anti-dysmenorrhea activity: *Thymus vulgaris* and ibuprofen were examined in terms of how well they treated primary dysmenorrhea. Although the two drugs did not differ significantly in statistical terms, the ability to reduce pain, they both had a substantial effect when compared to placebo (p 0.001). According to the findings, *Thymus vulgaris* and ibuprofen can both be useful in easing primary dysmenorrhea sufferers' pain and spasms (Salmalian H *et al.,* 2014) [113].

2.7.2.4. Analgesic activity: In the study mice treated with different drugs and thyme syrup and thyme tincture with different doses and combination were observed for their analgesic activity using Hot Plate Method. In the hot plate pain model, the active compounds thymol and carvacrol demonstrated good analgesic efficacy. Thyme formulations, perhaps by interfering with their metabolic pathways, considerably increased the duration of pentobarbital-induced sleep behavior and amplified the impairment of motor coordination caused by diazepam in mice. They also potentiated paracetamol's analgesic activity and decreased codeine's analgesic activity (Rašković AL *et al.,* 2021) [109].

2.7.2.5. Anxiolytic activity: According to a study's findings, orally given doses of *T. vulgaris* extract to rats might show anxiolytic effects. The phenolic compounds and chemicals found in essential oils in the *T. vulgaris* extract supports the plant's anxiolytic properties as seen in this study (Komaki *et al.,* 2016) [80]. Additionally, a different study found that thymol may act as a neuroprotectant by reducing the negative effects of amyloid β on memory (Asadbegi *et al.* 2017) [18].

2.8. Fenugreek- The botanical name for fenugreek is *Trigonella foenum-graecum* and is from Fabaceae family. It is often referred in India as Methe (Hindi). It is native to Europe and Asia Minor. It is a common crop in Northern India since it does well in cold climates. It thrives in an environment that is typically moderate. The dry and cold weather are favorable for high seed output (Anonymous 1, 2019) [14]. When ingested, biologically active components in fenugreek have pharmacological effects on the human system. Due to their hypoglycemic, anti-carcinogenic, anti-lipedemic and cholagogic qualities, their consumption need

to be motivated in daily diets to treat diabetes mellitus, hypercholesterolemia and cancer (Meghwal and Goswami, 2012) [97].

Fenugreek is made up of a variety of chemical elements. They consist of alkaloids (trimethylamine, trigonelline, neurin, choline, carpaine, gentianine and betain), amino acids (isoleucine, 4-hydroxyisoleucine, lysine, histidine, leucine, L-tryptophan, arginine), saponins (graecunins, fenugreekine, fenugrin B), steroidal (yamogenin, diosgenin, smilagenin), flavonoids (rutin, vitexin, isovitexin, quercetin), fibers (neutral detergent fiber, gum), coumarin, vitamins, minerals, lipids, mucilage and proteins (Sowmya and Rajyalakshmi, 1999; Yadav and Kaushik, 2011) [122, 108]. Neryl acetate, β-caryophyllene, camphor, β-pinene, 2,5-dimethylpyrazine, geranial, α-selinene, 3-octen-2-one, 6-methyl-5-hepten-2-one, α-pinene, α-campholenal, α-terpineol and gamaterpinene and simultaneously possessing various health beneficial activity like antioxidant, antidiabetic, antimicrobial (Hamden *et al.*, 2011) [60].

2.8.1. Nutrient Composition

Table 10: (Anonymous 1, 2019) [14]

Composition	mg per 100 gm
Moisture	8.84 g
Food Energy	323 kcal
Protein	23.00 g
Fat	6.41 g
Carbohydrates	58.35 g
Ash	3.40 g
Ca	0.176 g
P	296
Na	67
K	770
Fe	33.53
Vitamin B1	0.322
Vitamin B2	0366
Vitamin B3	1.640
Vitamin C	3.00
Vitamin A Activity (RE)	8.84

2.8.2. Clinical potential

2.8.2.1. Antibacterial and antifungal activity: Antibacterial and antifungal plant-derived substances are found and reviewed. However, Trigonella's antibacterial and antifungal properties have just lately come to light. In a study, fenugreek leaves, stems, roots, ground and unground seeds were prepared as aqueous extracts and their antifungal potential was assessed against a variety of fungal strains, including *Fusarium graminearum*, *Botrytis cinerea*, *Alternaria sp.*, *Pythium aphanidermatum* and *Rhizoctonia solani*. They discovered that fenugreek plant exhibits antifungal activity in all of its sections, with the strength of the action contigent on the type of fungus and the components of plant (Haouala *et al*. 2008; [61].

2.8.2.2. Anti-diabetic activity: It has been studied that natural ingredients work well as anti-diabetic medications. Large amounts of soluble dietary fiber (galactomannan), diosgenin, 4-hydroxyisoleucine, trigonelline, flavone C-glycosides and other compounds which exhibited hypoglycemic activity in animal studies were present in fenugreek seeds. Galactomannan, a type of soluble dietary fiber, helped diabetic patients lower their blood sugar levels by boosting bowel movements, blocking digestive enzymes, delaying gastric emptying of carbs and controlling gut microbiota (Hamden *et al*. 2010; Zentek *et al*. 2013) [59, 140]. Trigonelline demonstrated anti-diabetic action by enhancing the insulin signaling pathway and reducing oxidative and endoplasmic reticulum stress in type 2 diabetic rats. These effects affected the insulin release, pancreatic islet β-cell regeneration and the activity of enzymes that break down glucose (Zhou *et al*. 2012) [142].

2.8.2.3. Antioxidant activity: It features a positive impact on the liver and pancreas; antioxidant capabilities are linked to natural goods' health advantages. These qualities are investigated using fenugreek seeds that have undergone germination, which is thought to be more advantageous than ungerminated seeds since germination enhances the bioavailability of many fenugreek constituents (Balch, 2003) [23]. The deoxyribose system and pulse radiolysis were used to ascertain the seed extract's capacity to scavenge OH. Antioxidants included in the fenugreek seed extract guard against oxidative damage to cellular components. An aqueous methanolic fenugreek extract was examined for its in-vitro antioxidant and antiradical activity in various model systems. The findings from various methodologies highlight certain crucial elements connected to the anti-oxidant action of fenugreek seeds (Kaviarasan *et al.*, 2007) [77].

2.8.2.4. Galactogogue function: In a 6-year study involving 1,200 women, most experimental subjects produced increased breast milk in 24-72 hours after taking 2-3 fenugreek capsules (580 mg or 610 mg) three times each day (Huggins 1998) [64].

2.8.2.5. Antihyperlipidemic effect: By lowering the adipogenetic factors expression levels such as PPAR-, SREBP1C and CAAT element binding protein, fenugreek reduced production of fat in 3T3-L1 cells (Vijayakumar *et al.*, 2010) [132]. Additionally, fenugreek extract boosted the absorption of LDL by upregulating LDL receptor and lowered the cellular tgs and cholesterol levels in hepg2 cells (Mandegary, A *et al.*, 2012) [90]. A study reported that alcoholic FSE had an antidyslipidemic impact on rats fed a high-fat diet and those given triton-induced hyperlipidemia. They reported that at dosages of 200 mg kg^{-1} body weight, there was a reduction in tgs and plasma cholesterol of (26.2 and 36.6%), respectively. The extract's continuous feeding decreased the liver lipid levels. The activation of many enzymes, including TG lipase, lipoprotein lipase and lecithin-cholesterol acyltransferase, may represent the mechanism of action, according to the authors (Chaturvedi, U. *et al.*, 2013) [36].

2.9. Saffron: Its botanical name is *Crocus sativus* L. belonging to Iridaceae family. It is referred in India asKesar (Hindi). Southern European native saffron is cultivated in Mediterranean nations, majorly in Spain, Greece, Austria, France, England, Turkey and Iran. In India, it is cultivated in Himachal Pradesh and Jammu & Kashmir. Saffron is best grown in warm subtropical areas. (Anonymous 1, 2019) [14]. Volatile, nonvolatile and aromatic chemicals abound in saffron. Hydrophilic and non-hydrophilic proteins, carbohydrates, minerals, vitamins, mucilage, gums, pigments, saponins, safranal, alkaloids, crocins, picrocrocin, crocetin and other chemicals in traces are among these substances. The major constituents of saffron found in the

reddish stigmatic lobes are crocetin and its related glucosidic derivatives. Carotenoids (crocetin) in the form crocetin, which also comprises diglucoside, betacarotene, gammacrocetin and zeaxanthin as glycosidic forms, are primary components of saffron. The primary element in saffron that gives it a bitter flavor is called picrocrocin. It crystallizes after being hydrolyzed and yields safranal and glucose (J. Ghanbari *et al.*, 2019; M. Kosar *et al.*, 2017; E. Anastasaki *et al.*, 2009) [53, 13, 81]. Along with few clinical trials, animal research has demonstrated the pharmacological benefits of saffron or its active ingredients, including: anticonvulsant, depressive, anti-inflammatory, anticancer, radical scavenger effects and increasing learning and memory (Moshiri M *et al.*, 2014) [95].

2.9.1. Nutrient Composition

Table 11: (Anonymous 2, 2019) [15]

Composition	mg per 100 gm
Moisture	11.9 g
Food Energy	310 kcal
Protein	11.4 g
Fat	5.85 g
Carbohydrates	65.4 g
Ash	5.45 g
Ca	0.111 g
P	252
Na	148
K	1720
Fe	11.1
Vitamin B1	0.115
Vitamin B2	0.267
Vitamin B3	1.46
Vitamin C	80.8
Vitamin A Activity (RE)	27 µg

2.9.2. Clinical potential

2.9.2.1. Antitumor activity: Numerous cellular models have shown anti-tumor properties, which have been thoroughly reviewed. The survival of healthy cells frequently remained unaltered by saffron's selective lethal effects on cancerous cells, including human cancer cell lines, at effective dosages in the low micromolar levels. Healthy cell division and proliferation were unaffected, while tumor cells' ability to form colonies was shown to be dose-dependently hindered. Saffron extracts were administered topically or taken orally decreased the frequency of artificially produced cancer *in vivo*, inhibited the formation of tumors and increased the lifespan of the test animals. In addition, cytostatic medicines like cisplatin have less toxicity when used in animal models of cancer therapy (Schmidt M *et al.*, 2007; Nair SC *et al.*, 1991) [115, 101].

2.9.2.2. Cardiovascular activity: antioxidant and anti-inflammatory activity: The primary cause of cvds, atherosclerosis, is heavily influenced by inflammation. Pro-inflammatory cytokines, chemokines and adhesion molecules are released during the early stages of atherogenesis as a result of inflammation in the innermost layer of the arteries. Additionally, oxidative stress influences numerous CVD symptoms. Overproduction of reactive oxygen species (ROS) causes inflammation and kickstarts atherogenesis-related processes via a number of important enzymes. When relating with other tissues, cardiac tissue has a high rate of oxidative metabolism and limited antioxidant defense, making this organ more vulnerable to oxidative damage. Saffron is well renowned for its powerful natural antioxidant and anti-inflammatory capabilities, much like certain other medicinal plants. Carotenoids, flavonoids and anthocyanins are the parts of saffron extract that are primarily in charge of its anti-inflammatory and antioxidant properties. According to numerous studies, crocin and crocetin, two carotenoids that make up saffron, have the highest radical-scavenging capacities. Safranal comes in second. These components' high ability to scavenge free radicals may account to their capacity to contribute a single hydrogen atom to them. Studies on animals and in-vitro trials have demonstrated that saffron extracts—particularly crocetin and crocin—reduce plasma levels of malondialdehyde (MDA), a marker of lipid peroxidation brought on by ROS (S. Ghaffari and N. Roshanravan 2019) [52].

2.9.2.3. Antioxidant activity: The discovery of radical scavenging action in the methanolic extract of *Crocus sativus* and its constituents, such as safranal, crocin, etc. were pointing to its potential application as a food supplement, cosmetic to cure disorders associated with aging, etc (Hosseinzadeh H and Sadeghnia H.R. 2007) [62]. In neuronally differentiated pheochrosmocytoma cells depleted of glucose, whose absence led to the peroxidation of their cell membrane lipids and a reduction in intercellular superoxide dismutase activity, crocin was discovered to possess stronger antioxidant ability than alpha tocopherol. Crocin reversed these effects, demonstrating its potential as a special and powerful antioxidant that protects against oxidative stress in neurons (Chatterjee S *et al*., 2005) [35]. Additionally, it was claimed to preserve the functional levels of other antioxidants while also raising the levels of several enzymes, including glutathione reductase and glutathione S transferase, indicating its potential as an antioxidant (Vijaya Bhargava K, 2011) [26].

2.9.2.4. Antidepressant activity: The antidepressant effects of aqueous and ethanolic extracts of saffron stigmas were seen in mice and were mostly attributed to safranal and crocin, which work by inhibiting the uptake of norepinephrine, dopamine and serotonin (Karimi G *et al*.,2001; Hosseinzadeh H *et al.*, 2003) [76, 63]. Using behavioral models, these findings further demonstrated that crocin is incharge of the antidepressant qualities of aqueous saffron extract (Wang H *et al.*, 2010) [134].

2.9.2.5. Premenstrual syndrome (PMS): Several studies on the effects of saffron have their primary focus largely on premenstrual syndrome (PMS), one gynecologic disorder. The term "PMS" refers to a collection of cyclical and recurrent emotional, physical, psychological and mental pain that often follows ovulation and occurs before the start of a period (Dante G and Facchinetti F., 2011) [40]. A RDBPCCT study looked examined the effectiveness of stigma against saffron in easing the symptoms of this condition in 20- to 45-year-old women who had regular menstrual cycles and had been dealing with PMS symptoms for at least 6 months. The effectiveness of saffron varied significantly between the Total PDS (Premenstrual Daily Symptoms) and HAM-D (Hamilton Depression Rating Scale). The outcomes showed that *C. sativus L*. had a

beneficial effect on reducing PMS symptoms (Agha-Hosseini M *et al.,* 2008) [5].

2.10. Fennel: Its botanical name is *Foeniculum vulgare Mill*. and it belongs to Apiaceae family. It is often referred in India as Saunf (Hindi). It is indigenous to Asia Minor and Europe. As a cold-weather crop, it is widely grown in Northern India. It grows nicely in a generally mild climate. High seed production is favored by the dry and cold conditions (Anonymous 1, 2019) [15]. Due to the plant's diuretic qualities, it is used to treat kidney and bladder diseases. Additionally, is utilized to reduce nausea and stop vomiting. The herbs can be used to alleviate blockages in the hepatic, urinary tracts, gastrointestinal and respiratory and also in chronic fever. Also, they are used to treat issues with the endocrine, reproductive, respiratory, stomach such as recurrent diarrhea, eyes such as cataracts (Bettaieb Rebey, I. *et al.,* 2019) [25].
Saponins, flavonoids, cardiac glycosides, sterols, triterpenes, coumarin and volatile oils were found in the preliminary phytochemical investigation. (Al-Snafi, 2018) [11] From the seeds of *Foeniculum vulgare*, triterpenes, flavanoid glycosides, smaller terpenes (monoterpenoids, sesquiterpenoids and diterpenoids) and reducing sugars were identified. Neochlorogenic acid (1.40%), gallic acid (0.169%), chlorogenic acid (2.98%), p-coumaric acid (4.325%), caffeic acid (2.960%), ferulic acid (3.555%), ferulic acid-7-o-glucoside (5.223%), quercetin-7-oglucoside (3.219%), cinnamic acid (0.131%), 1,5-dicaffeoylquinic acid (4.095%), hesperidin (0.203%), rosmarinic acid (14.998%), quercetin (17.097%) and apigenin (12.558%) were the phenolic compounds identified in the fruit of this plant and these phenolic compounds also exhibit various biological activities like antispasmodic, gastroprotective, analgesic, antimetastatic (Roby MHH *et al.,* 2013) [110].

2.10.1. Nutrient Composition

Table 12: (Anonymous 1, 2019) [14]

Composition	mg per 100 gm
Moisture	8.81 g
Food Energy	345 kcal
Protein	15.80 g
Fat	14.87 g
Carbohydrates	52.29 g
Ash	8.22 g
Ca	1.196 g
P	487
Na	88
K	1694
Fe	18.54
Vitamin B1	0.408
Vitamin B2	0.353
Vitamin B3	6.050
Vitamin A Activity (RE)	14

2.10.2. Clinical potential

2.10.2.1. Antibacterial activity: Fennel has antibacterial effects because of compounds such as linoleic acid, 1, 3-benzenediol, oleic acid and 2,4-undecaprenyl and is used for treatment of an array of infectious bacterial, viral, fungal and mycobacterial illnesses. 5-hydroxyfuranocoumarin, a vital component of the plant's antibacterial effect, is present in fennel. (Kwiatkowski P., *et al.,* 2015) [83]. "*Escherichia coli, Shigella flexneri, Staphylococcus aureus, Pseudomonas aeruginosa, Salmonella typhi* and *Enterococcus faecali*" are among the bacteria that the aqueous extract of fennel is bactericidal toward (Ahmed, A. *et al.,* 2019) [6]. According to a research, this plant extract substantially reduces the development of majority bacteria, but *K. pneumoniae* and one strain of *Pseudomonas aeruginosa* (Moradi H. *et al.,* 2020) [94].

2.10.2.2. Gastro-protective activity: It's demonstrated that the fennel has a notable preventive impact on gastrointestinal illnesses. Fennel oil emulsions were reported to completely abolish colic in (65%) of treated infants, which was a significant improvement over the control group (Chakŭrski I *et al.,* 1981; Alexandrovich I *et al.,* 2003) [33, 7] A study examined the impact of fennel plant on gastric ulcer in a study. Based on the result, the herb prevented the stomach ulcers. Futhermore, the herb decreased the stomach's mucosal lining. These actions were related to the antioxidant power of the substance (Al-Mofleh I *esst al.,* 2013) [8].

2.10.2.3. Antimetastatic activity: Anethole's antimetastatic action was clarified in the DU145 cell line. According to the study, matrix metallopeptidases-9 and epithelial to mesenchymal transition molecules interacted to control the antimetastatic activity (Ha B *et al*. 2014) [58].

2.10.2.4. Anti-diabetes activity: *Foeniculum vulgare* decreased fasting blood sugar, superoxide dismutase (SOD) and malondialdehyde (MDA) levels in alloxan-induced diabetic rats. The concentrations of insulin, hepatic reduced glutathione (GSH), glutathione-S-transferase (GST) and catalase all significantly rise (Zaahkouk *et al*. 2016) [138]. The blood glucose level was significantly reduced in a mouse model where animals were given a glucose overload (Monalisa and Rahmatullah 2015) [93]. For the purpose of researching its antidiabetic effects, the phenolic component of fennel was evaluated *in vitro*. Since α-amylase and α-glucosidase were inhibited, it was determined that the methanolic extract's phenolic component was particularly efficient for treating diabetes (Abu-zaiton *et al*. 2015) [3].

2.10.2.5. Hypolipidemic activity: Rats were used to study the impact of fruit extracts from *the Foeniculum vulgare* plant on high-fat diets as well as their potential contribution to obesity and related cardiovascular problems. Three fractions were created from a methanol extract of *Foeniculum vulgare* using a sequential solvent method. For a six-week span, the female albino rats were fed a high-fat diet, 300 mg/bw of fruits orally administered by gavage and 0.2 ml/bw of hydrodistillation-produced volatile oil intraperitoneally once daily. As a result of extract feeding, animals' body weight and fat pad weights decreased in a variety of ways, according to the results. The levels of triglycerides and cholesterol, which were raised in animals fed a diet of high-fat, were decreased (Garg G *et al.,* 2011) [50].

3. Conclusion

Indian spices have drawn a lot of attention because of their extraordinary medicinal qualities. These spices provide a rich source of bioactive substances, from the anti-inflammatory capabilities of nutmeg to the digestive advantages of ajwain and the antioxidant properties of

cinnamon. The medicinal potential of these spices is clear, but it's important to remember that each person will react differently to them. New developments in food processing and preservation technology present chances to improve the nutritional content, expand product offers and increase the shelf life of spices. Based on extensive study, not only they possess the capacity to improve health and treat an array of ailments but also are widely used as an ingredient in preservation thus an approach of making it chemical free, owing to its clinical potential in pharmaceuticals. Additionally, more thorough clinical trials are required to prove their effectiveness in diverse medical situations.

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