INTERNATIONAL RESEARCH JOURNAL OF PHARMACY
www.irjponline.com
ISSN 2230 – 8407

Review Article

A REVIEW ON THE THERAPEUTIC AND NUTRITIONAL VALUE OF SPICES AND THEIR PROSPECTS

Saima Malik [1]*, Ruhul Amin [1], Shazia Bi Ansari [1], Roshan Jahan [1] and Samiullah Khan [2]
[1] Research Scholar Mutation Breeding Lab., Department of Botany, Aligarh Muslim University, Aligarh, India
[2] Professor, Department of Botany, Aligarh Muslim University, Aligarh, India
*Corresponding Author Email: saimamalik.amu@gmail.com

Article Received on: 29/08/19 Approved for publication: 12/10/19

DOI: 10.7897/2230-8407.1011312

ABSTRACT

Spices are not much more expensive and widely available nowadays, and they contain the massive capacity for protected human health. In India and other developing countries, a human can use spices for the cure of diseases instead of allopathic drugs because herbal drugs have no side effects for human health. In ancient times people used seeds spices as spices for making curries, pickle, bakery products and other food additives. Spices contain various phytochemical compounds or secondary metabolites, which are beneficial for many disorders of human health; thus, the scientist has the challenge to enhance or stable the medicinally active compounds which are present in spices. Seed spices belong to various families, and each spice has its pharmaceutical effects. Cumin, fennel, coriander and fenugreek are the major seed spices crop whereas ajwain, nigella belongs to minor seed spices. Essential oils and extract of seed spices contain various active compounds which are helpful in cure and prevent various diseases.

Keywords: spices, essential oils, pharmaceutical effects

INTRODUCTION

Day by day spices play a vital role in the life of humankind as an important pharmaceutical due to its oil hold the medicinal value. According to the world health organization (WHO), most of the world populations chiefly depends on plants derived drugs because there have no side effects on human health care. In Indian sub-continent has a vibrant diversity of plant species in a wide range of ecosystem, medicinal plants comprise approximately 6000-7000 species out of 17000-18000 species of flowering plants[1]. Spices contain a wide range of medicinal and pharmaceutical properties; thus, the large proportions of the world's population chiefly used spices as traditional medicine. In ancient times, all spices used in our kitchen to enhance the flavour and taste of the foods. The seed spices contain essential oils which contained various pharmacological effects. Scientist or the plant breeder has continuous effort to enhance the quality and quantity of the phytochemical, which is present in the spices because of its medicinal properties[2]. In nature, spices are present in various forms like dried seeds, fruit, barks, flowers or roots of the plant, rich in bioactive chemical compounds which possess various medicinal properties like anti-inflammatory, antibacterial, antimicrobial, antifungal, used in digestive stimulant and treatment of hypertension. In India, seed spices can grow in various states such as Uttar Pradesh, Rajasthan, Madhya Pradesh, West Bengal, Karnataka, and Tamil Nadu. Approximately 130 countries used spices to enhance the taste fragrance and flavour of the food, the main markets for spices are Israel, Saudi Arabia, Kuwait, Germany and Japan. In the world, India is the largest seed spices producer, exporter and consumer and all these spices mostly grown in rabi season[3]. (Table 1 source: www.spices.res.in).

In the world, the demands of the spices are near around 3.19 %, and the export of spices is consistently seen increases because of its medicinal properties. In India, the export of spices was 2.25 lakh tons in1996-1997 and it crossed 10.28 lakh tons in 2017-2018. (Figure 1: www.spices.res.in)

The main aim of this review article to give a brief knowledge of the spices which used as traditional medicine and highlights the beneficial effects on human health and other properties.

A General overview of some spices

Spices contain various active compounds which hold medicinal and nutritional properties. The active compounds of spices present in various parts of the seed. Here below mentions the activity of the active compounds in spices and their uses. (Table 2)

Ajwain (*Trachyspermum ammi* L.)

Trachyspermum ammi is an annual plant belongs to family Apiaceae and commonly known as Ajwain or Bishop's weed. Seeds of ajwain contain highly medicinal values, as compared to root and leaves. The seeds of ajwain are aromatic contains 2-5% essential oils, thymol is the main constituent (35 % to 60%) along with carvacrol, para-cymene, γ-terpenine, dipentene, α-terpinene are a non-thymol fraction[4]. The seeds of ajwain possess pungent and bitter test, aromatic due to the presence of the thymol content. Ajwain seeds contain protein, carbohydrate, fat, saponins and minerals such as calcium, phosphorus and iron[5]. Seeds of the ajwain are used in curries, making pickles, making many foods, preservative, making biscuits and in perfumery industries. Seeds of ajwain contain antiseptic, antifungal, antibacterial,

antimicrobial, nematicidal, anti-inflammatory, anthelmintic, digestive, germicidal and abortifacient[6].

Black cumin (*Nigella sitava*)

Black cumin belonging to the family Ranunculaceae and it is a native of Southern Europe, North Africa, and Southwest Asia. The seeds of *N. sativa* have a pungent, bitter taste and aroma is used in food as a flavoring additive in pickles, flavor curries. In traditional Indian system Unani and Ayurveda, the seeds of black cumin are used as a medicine[7]. The active compounds like thymoquinone (TQ) (30%–48%), thymohydroquinone, traditional Indian, *p*-cymene (7%–15%), carvacrol (6%–12%), 4-terpineol (2%–7%), sesquiterpene longifolene (1%–8%), α-pinene, and thymol are present in the oil constituents of black cumin[8,9]. Seeds of black cumin possess protein (26.7%), fat (28.5%), carbohydrates (24.9%), crude fiber (8.4%), and total ash (4.8%), various vitamins and minerals are present in different amounts[10]. Thymoquinone is an active compound in essential oil, which acquires an aromatic flavour. After the advent of Islam since; Prophet Muhammad (PBUH) mentioned its therapeutic potential and said that it is a remedy for all disease, but cannot prevent ageing or death. Seeds of black cumin possess numerous therapeutic activities like antimicrobial, antibacterial, anthelmintic, analgesic, antihypertensive, antidiabetic, anticancer, gastroprotective and anti-inflammatory. The used of seeds of black cumin for the treatment of various diseases such as asthma, bronchitis, rheumatism, diabetes, hypertension, fever, skin disorders, and gastrointestinal disturbances, control parasitic infections, enhance the immune system and other inflammatory diseases[11].

Cumin (*Cuminum cyminum*)

Cumin is aromatic, minor seed spices, annual crop belongs to family Umbelliferae, a member of the parsley family commonly called as jeera. Seeds of cumin are used as a popular condiment in the world from Latin America to Northern Africa and all over Asia. The seeds of Cumin are oblong and yellow–grey and used as flavoring agents in several products[10]. Besides, to use as traditional spices, cumin seeds contain several medicinal importance. In India, Ayurvedic system seeds of cumin have been used as a medication because the cumin seeds have immense medicinal value, particularly for digestive disorders, i.e. treatment of flatulence, diarrhea, dyspepsia and as a remedy against indigestion and colic. The main constituent of essential oil is cumin aldehyde, cymene and terpenoids and all are the major volatile components of cumin oil. High amounts of fat, protein, Vitamin, dietary fibers and several dietary minerals are present in the cumin seeds[12]. Range of the essential oil of cumin varies from 2.4% to 4.5% depending on the regions[13]. The essential oil of cumin has various pharmacological effects and responsible for the characteristic of the intense aroma of cumin due to presence of aldehydes. The various therapeutic potential has been reported in the oil as well as seeds of the cumin like anti-diabetic, anti-inflammatory, antiseptic, immunologic, cancer, acute gastric, anti-tumor, hypertension and antimicrobial activities. Recent research shows that cumin seeds contain potent antioxidant, which is capable of scavenging hydroxyl radicals, peroxy and 1, 1- diphenyl-2-picrylhdrazyl (DPPH) free radicals and thus inhibits radical-mediated lipid peroxidation[14].

Coriander (*Coriandrum sativum*)

Coriander is an annual plant belongs to family Umbelliferae has various medicinal properties and can commonly grow in India, Pakistan, Bangladesh, Russia, Central Europe, Morocco, and China. India is the world's largest coriander producer; thus, seeds of coriander contain essential oils which can differ in different regions depending on the climate of the environment. Seeds and leaves of coriander have been used in food products as a flavoring agent, making pickles, chutneys, sauces, flavoring curries, perfumes and cosmetics[15]. Many phytochemical investigations reveal that the chemical composition of the essential oil will also be different. Seeds of the coriander retain various pharmaceutical activities such as carminative, spasmolytic, antimicrobial, indigestion, vomiting and used in rheumatoid.

Fennel (*Foeniculum vulgare*)

Throughout the world, temperate to tropical regions the fennel crop has widely cultivated, it is an annual medicinal and aromatic plant belonging to family Apiaceae. In Asian countries, fennel is a popular herb plant for its economic value and medicinal properties[16]. It has reported that seeds of fennel contained various components such as protein, minerals, vitamins, fat, carbohydrates, fiber and various minerals. The main components of fennel oils have transanethole, estragol, fenchone, and α-phellandrene, which varies according to the environment and the origin[17]. Seeds of fennel contain an essential oil which used as flavouring agents in food products, pickles, salad, pasta, vegetable dishes, ice cream and pastries and ordinarily used as a mouth freshener[18]. The essential oil of fennel seeds has been consented for their useful pharmaceutical properties such as antibacterial, antifungal, antibacterial, antiprotozoal and antiviral properties. Several studies have revealed that the fennel is effective for relaxing smooth muscles, improving memory, and increasing antioxidant effects, reducing dysfunction in the gastrointestinal tract.

Fenugreek (*Trigonellafoenum-graecum*)

Fenugreek (*Trigonellafoenum-graecum*) is an annual major seed group belongs to family Fabaceae, commonly known as methi and used as spices in Indian kitchen. Seeds of fenugreek have a long history as both as comestible and most promising therapeutic herb[19]. The seeds of fenugreek retain strong aroma and bitter taste due to the presence of two major constituents such as alkaloid and volatiles[20]. Constituents of fenugreek seeds include flavonoids, alkaloids, coumarins, vitamins and saponins out of this most extensive is trigonelline and coumarins[21]. Many studies have been carried out to identify seed composition of fenugreek which contains 45-60% carbohydrates, mainly mucilaginous fiber (galactomannan), 20-30% proteins (high in lysine and tryptophan), 5-10% fixed oils, pyridine type alkaloids mainly trigonelline (0.2-0.36%), choline (0.5%), gentianine and carpaine, flavonoids, calcium and iron; cholesterol vitamins and volatile oils[19]. The seeds of fenugreek are known for their carminative, antidiabetic effects[22] and extract of fenugreek contains various therapeutic properties such as antiulcer, hypoglycaemic activity[23], anti-inflammatory and antipyretic, hypercholesterolemia and gastroprotective effects[24]. The alkaloids, flavonoids and saponins, the main constituent of fenugreek have a pharmacological effect and used to manage diabetes mellitus, hypercholesterolemia[25].

Black pepper (*Piper nigrum*)

In seed spices black pepper is commonly known as the "king of spices" because it is a good exchange for red chilies and commonly known as kali mirch[26]. Black pepper belongs to family Piperaceae one of the most deliberate spices which exhibit various therapeutic properties[27]. Seeds of black pepper contain an average amount of vitamin K, iron and manganese and the trace amount of protein, dietary fiber and essential nutrients. The main bioactive compound of black pepper is piperine or piper-amide,

which gives a pungent smell of the seeds. In addition to piperine other alkaloids such as piperidine and piperettine are responsible for most of the advantageous effects of this spice. In Ayurveda, seeds of black pepper used as traditional medications for cough, cold, digestive problems, cholera, anti-rheumatoid, asthma and sinusitis problems[28]. It also gives a beneficial role in the treatment of various other diseases such as constipation, insomnia, earache and pneumonia, tooth decay, anti-influenza, anti-rheumatoid, anti-arthritis and antispasmodic. Seeds of pepper possess antiseptic, antimicrobial, antifungal and antibacterial properties and piperine, the extract of black pepper shows maximum antibacterial and antifungal activity[29].

Cloves (*Syzigium aromaticum*)

Cloves belong to family Myrtaceae, can grow as a tropical tree in a humid and warm environment and commercially grown in Sri Lanka, Pakistan, India, Tanzania and Indonesia. The clove oil has many therapeutic properties, and the primary active component of clove oil is eugenol, with β-caryophyllene and the other components such as benzyl alcohol, 2-heptanone, a-humulene, methyl-salicylate, phenylpropanoids, bioflorin, aldehydes, and oleanolic acid, but the percentage of this component varies widely[30]. Cloves are highly aromatic and used in food flavoring, preparing of spice masala, pickles, and cakes as well as used in making perfume in perfuming industry[31]. The clove oil has various therapeutic uses such as to control nausea, vomiting, diarrhea, dyspepsia, flatulence, stomach distension, gastrointestinal spasm, cough and it also possesses anti carcinogenic, antioxidant, and anti-parasitic properties[31]. In dental practices, the extracts of clove can be uses as analgesic, antispasmodic, and antiseptic[32]. Eugenol and caryophyllene, which is the active compound of the essential oil of clove, exhibit an antimicrobial, antibacterial and antifungal properties[33].

Increase tendency for the expenditure of spices in international as well as the domestic market, the needs of spices is increasing day by day thus the scientists have been developing a high yielding spices varieties with better quality by improved technologies[34]. In the National Research System for seed spices crops, National Research Centre On Seed Spices (NRCSS), All India Coordinated Research Project On Spices (AICRPS) and State Agricultural Universities, have imparted significantly by enhancing germplasm, developing high yielding varieties, raise the production and productivity of the spices[35].

Table 1: Production of spices area and state-wise (Area in hectare, production in tons)

Spices	State	2015-2016		2016-2017		2017-2018 (est)	
		Area	Production	Area	Production	Area	Production
Ajwain	Rajasthan	11660	4670	15480	10540	15480	10540
	Madhya Pradesh	-	-	3890	3890	4050	4030
	Telangana	1380	5720	1380	5720	1380	5720
	Andhra Pradesh	9120	4150	8320	2600	8320	2600
	Gujarat	1550	1470	5320	5050	5320	5050
Fennel	Rajasthan	27590	30720	45200	56240	45200	56240
	West Bengal	1020	1030	1020	1020	1020	1020
	Gujarat	45400	96770	40910	87820	40910	87820
	Madhya Pradesh	-	-	1430	2520	1470	2600
	Uttar Pradesh	710	670	690	760	690	760
Coriander Seed	Rajasthan	212730	227200	181710	206960	181710	206960
	Madhya Pradesh	203950	108490	275760	387430	277410	391460
	West Bengal	11450	14520	11460	14560	11460	14560
	Andhra Pradesh	25340	10400	4300	2370	4300	2370
	Gujarat	88600	138800	121200	189520	121200	189520
	Uttar Pradesh	7470	2580	7000	3650	7000	3650
Cumin Seed	Rajasthan	511080	200850	500140	206940	500140	206940
	Gujarat	295400	300940	278750	291490	278750	291490
Pepper	Tamil Nadu	4349	1500	4910	2000	4360	2000
	Karnataka	34990	23000	37750	31000	37750	35000
	Kerala	85948	21000	85210	20000	86740	22000
Fenugreek Seed	Rajasthan	157000	190360	129710	157930	129710	157930
	West Bengal	2420	2640	2410	2600	2410	2600
	Madhya Pradesh	42840	25000	54390	103000	53440	104220
	Uttaranchal	400	2610	400	2610	400	2610
	Gujarat	7040	14170	14960	28920	14960	28920
Cloves	Tamil Nadu	980	950	970	940	990	970
	Kerala	1080	80	1070	80	1070	80
	Andaman and Nicobar	160	10	40	40	50	10
	Karnataka	120	170	120	170	120	170

Source: Other spices - State Agri/Horti Departments/DASD Kozhikkode. Est: Advance Estimate

Table 2: List of seed spices their name, active compound and parts used as a medicine

Plant Scientific name	Common name	The active compound(s)	Part used	References
Trachyspermum ammi	Ajwain	Thymol	Seeds	(Chopra, 1982)[4]
Nigella sativa	Black cumin	Thymoquinone	Seeds	(Souza *et al*.,2017)[36]
Cuminum cyminum,	Zeera	Cuminaldehyde	Seeds	(Derakhshan *et al*.,2010)[37]
Foeniculum vulgare	Fennel	Anethole	Seeds	(Bilia, 2002)[17]
Trigonellafoenum-graecum	Fenugreek	Trigonelline	Seeds	(Ouzir, 2016)[21]
Coriandrum sativum	Coriander	Linalool	Seeds / leaves	(Souza *et al*., 2017)[36]
Piper nigrum	Black pepper	Piperine / piper amide	Seeds	(Kunnumakkara *et al*.,2009)[38]
Syzigiumaromaticum	Cloves	Eugenol	Seeds	(Souza *et al*., 2017)[36]

Table 3: Improved varieties developed by NRCSS

Crop	Varieties	Characteristic features
Ajwain	AA-1	3.4 % essential oil; Seed yield 11-14 q/ha
	AA-2	3.0 % essential oil; Seed yield 10-12 q/ha
	AA-93	Seed yield 14.15 q/ha
Nigella	AN-1	0.7% essential oil; Seed yield 8-12 q/ha
	AN-20^{+}	Essential oil is higher than other varieties; Seed yield 10.25 q/ha (Average yield)
Fenugreek	AFg-1	Bold seeds; Seed yield 20-22 q/ha
	AFg-2	Small seeds (High medicinal value); Seed yield 15-18 q/ha
	AFg-3*	Seed yield 15-18 q/ha
	AFg-4^{+}	Seed yield 19.25 q/ha (Average yield)
Coriander	AGCr-1	1.6% essential oil
Fennel	AF-1	1.6% volatile oil content; Seed yield 20-22 q/ha
	AF-2	1.9% essential oil content; Seed yield 17.9 q/ha

Source: www.nrcss.res.in *--National release. +--Rajasthan state

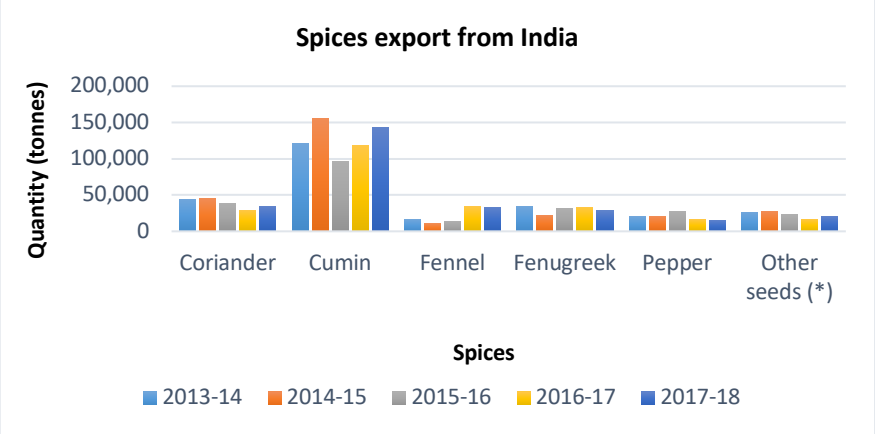

Figure 1: Spices export from India in the year 2013-2018
Source: www.dasd.gov.in/adminimage/Itemwise_export_of_Spices.pdf. (*): include Ajwain, Dill etc.

Future prospective

Most of the seed spices are less noticed by the scientist but in recent years for the high scope, opportunities and higher demands of seeds spices in the national and international level we need to improve the yield, productivity and develop disease and pest resistant varieties of spices. For the focus on present conditions and future need for the vital prominence on the following areas:

- Crop Improvement
- Production and Protection Technology
- Quality and Value addition

For knowing the genetic architecture of some crop and seed spices are still undetermined because these crops have a narrow genetic base. Since years, seed spices genetic improvements have been made mainly by selections, after that, unconventional approaches like mutations, advanced biotechnology tools and application of tissue culture techniques are all applied for genetic improvement of the spices. Molecular and biochemical profiling of germplasm and marker-assisted strategies are also used in seed spices improvement. These strategies are used to develop a high yielding genotype with desired quality traits and also the development of biotic and abiotic resistance spices. By production technology, research will target to establish a technique to harvest a maximum output from input. The researcher have been focusing on value addition of spices because they hold the medicinal properties. Good agricultural practices will help to enhance seed spices production. Various technologies, tools have been developed for the higher production of the seed spices (Table 3).

CONCLUSION

Spices contain an essential oil which is rich in therapeutic properties and widely used in herbal medicine to combat and cure for various health hazards. Many bioactive chemical constituents, including alkaloids, glycosides, steroids, terpenoids, saponins and polyphenol, showed remarkable health benefits. Phytochemicals are inexpensive, effective and safe antimicrobial agents, and they can be used in forms of drugs due to its non-side effect nature. Spices are used for the manufactured of new drugs because the phytoconstituents of the seeds contain various therapeutic properties. Several improved technologies have been used for the development of high yielding production; enhance phytochemical contents and disease resistance varieties of spices because the consumption of spices in India and other countries is increasing due to its medicinal properties.

REFERENCES

1. Sachan AK, Kumar S, Kumari K, Singh D. Medicinal uses of spices used in our traditional culture: Worldwide. Journal of Medicinal Plants Studies 2018; 6(3): 116-122.
2. Sharma A, Kumar N, Mishra IG. Role of Molecular Marker in the Genetic Improvement of the Medicinal and Aromatic Plants. In Biotechnological Approaches for Medicinal and Aromatic Plants Springer, Singapore; 2018. p. 557-567.
3. Lal G. Scenario, Importance and Prospects of Seed Spices: A Review. Current Investigations in Agriculture and Current Research 2018; 4(2): 491-498.
4. Chopra RN. Chopra's Indigenous Drugs of India. 2ndEd, Academic Publishers Calcutta; 1982. p. 93-94.
5. Pruthi JS. Spices and Condiments, 4thEd, National Book Trust, New Delhi; 1992.
6. Pathak AK, Nainwal N, Goyal BM, Singh R, Mishra V, Nayak S, Bansal P, Gupta V. Pharmacological activity of *Trachyspermum ammi*: a review. Journal of Pharmacy Research 2010; 3(4): 895-899.
7. Sharma PC, Yelne MB, Dennis TJ. Database on medicinal plants used in Ayurveda. New Delhi: CCRAS; 2005.
8. Boskabady M, Shirmohammadi B. Effect of *Nigella sativa* on isolated guinea pig trachea. Archives of Iranian Medicine 2002; 5(2): 103-107.
9. Ali BH, Blunden G. Pharmacological and toxicological properties of *Nigella sativa*. Phyto therapy Research: An international journal devoted to pharmacological and toxicological evaluation of natural product derivatives 2003; 17(4): 299-305.
10. Srinivasan K. Cumin (*Cuminum cyminum*) and black cumin (*Nigella sativa*) seeds: traditional uses, chemical constituents, and nutraceutical effects. Food Quality and Safety 2018; 2(1): 1-16.
11. Goreja WG. Black seed. Nature's Miracle, Remedy Amazing Herbs Press, New York; 2003. p. 1-64.
12. Bettaieb I, Bourgou S, Sriti J, Msaada K, Limam F, Marzouk B. Essential oils and fatty acids composition of Tunisian and Indian cumin (C*uminum cyminum* L.) seeds: a comparative study. Journal of the Science of Food and Agriculture 2011; 91(11): 2100-2107.
13. Thippeswamy NB, Naidu KA. Antioxidant potency of cumin varieties—cumin, black cumin and bitter cumin—on antioxidant systems. European Food Research and Technology 2005; 220(5-6): 472-476.
14. Johri RK. *Cuminum cyminum* and *Carum carvi*: An update. Pharmacognosy Review 2011; 5(9): 63-72.
15. Emamghoreishi M, Khasaki M, Aazam MF. *Coriandrum sativum*: evaluation of its anxiolytic effect in the elevated plus-maze. Journal of Ethno pharmacology 2005; 96(3): 365-370.
16. Orhan İE, Özçelik B, Kartal M, Kan Y. Antimicrobial and antiviral effects of essential oils from selected Umbelliferae and Labiatae plants and individual essential oil components. Turkish Journal of Biology 2012; 36(3): 239-246.
17. Bilia AR, Flamini G, Taglioli V, Morelli I, Vincieri FF. GC–MS analysis of essential oil of some commercial Fennel teas. Food Chemistry 2002; 76(3): 307-310.
18. Zoubiri S, Baaliouamer A, Seba N, Chamouni N. Chemical composition and larvicidal activity of Algerian *Foeniculum vulgare* seed essential oil. Arabian Journal of Chemistry 2014; 7(4): 480-485.
19. Krishnaswamy K. Traditional Indian spices and their health significance. Asia Pacific Journal of Clinical Nutrition. 2008; 17(S1): 265-268.
20. Fæste CK, Namork E, Lindvik H. Allergenicity and antigenicity of fenugreek (*Trigonella foenum-graecum*) proteins in foods. Journal of Allergy and Clinical Immunology 2009; 123(1): 187-194.
21. Ouzir M, El Bairi K, Amzazi S. Toxicological properties of fenugreek (*Trigonella foenum graecum*). Food and Chemical Toxicology 2016; 96: 145-154.
22. Eidi A, Eidi M, Sokhteh M. Effect of fenugreek (*Trigonella foenum-graecum* L.) seeds on serum parameters in normal and streptozotocin-induced diabetic rats. Nutrition Research 2007; 27(11): 728-733.
23. Zia T, Hasnain SN, Hasan SK. Evaluation of the oral hypoglycaemic effect of *Trigonella foenum-graecum* L.(methi) in normal mice. Journal of Ethno pharmacology 2001; 75(2-3): 191-195.
24. Ahmadiani A, Javan M, Semnanian S, Barat E, Kamalinejad M. Anti-inflammatory and antipyretic effects of *Trigonella foenum-graecum* leaves extract in the rat. Journal of Ethno pharmacology 2001; 75(2-3): 283-286.
25. Izzo AA, Di Carlo G, Borrelli F, Ernst E. Cardiovascular pharmacotherapy and herbal medicines: the risk of drug interaction. International Journal of Cardiology 2005; 98(1): 1-14.
26. Friedman M, Levin CE, Lee SU, Lee JS, Ohnisi-Kameyama M, Kozukue N. Analysis by HPLC and LC/MS of pungent piperamides in commercial black, white, green, and red whole and ground peppercorns. Journal of Agricultural and Food Chemistry 2008; 56(9): 3028-3036.
27. Chaudhry NM, Tariq P. Bactericidal activity of black pepper, bay leaf, aniseed and coriander against oral isolates. Pakistan Journal of Pharmaceutical Sciences 2006; 19(3): 214-218.
28. Rani SS, Saxena N, Udaysree N. Antimicrobial activity of black pepper (*Piper nigrum* L.). Global Journal of Pharmacology. 2013; 7: 87-90.
29. Palaksha MN, Banji D, Rao AS. *In vitro* evaluation of antibacterial activity of alcoholic extracts of ten South Indian spices against multi resistant gram positive and gram negative bacteria by agar well diffusion method. World Journal of Pharmacy and Pharmaceutical Sciences 2013; 2: 3840-3847.
30. Prashar A, Locke IC, Evans CS. Cytotoxicity of clove (*Syzygium aromaticum*) oil and its major components to human skin cells. Cell Proliferation 2006; 39(4): 241-248.
31. Shrivastava K, Sahu S, Mishra SK, De K. *In vitro* antimicrobial activity and phytochemical screening of *Syzygium aromaticum*. Asian Journal of Research in Pharmaceutical Science 2014; 4(1): 12-15.
32. Hartnoll G, Moore D, Douek D. Near fatal ingestion of oil of cloves. Archives of Disease in Childhood 1993; 69(3): 392-393.
33. Ayoola GA, Lawore FM, Adelowotan T, Aibinu IE, Adenipekun E, Coker HA, Odugbemi TO. Chemical analysis and antimicrobial activity of the essential oil of *Syzigium aromaticum* (clove). African Journal of Microbiology Research 2008; 2(7): 162-166.

34. State Agri/Horti Departments/DASD Kozhikkode.
35. Malhotra SK. Recent advances in seed spices research–a review. Annals of Plant and Soil Research 2016; 18(4): 300-308.
36. D'Souza SP, Chavannavar SV, Kanchanashri B, Niveditha SB. Pharmaceutical perspectives of spices and condiments as alternative antimicrobial remedy. Journal of Evidence-Based Integrative Medicine 2017; 22(4): 1002-1010.
37. Derakhshan S, Sattari M, Bigdeli M. Effect of cumin (*Cuminum cyminum*) seed essential oil on bio film formation and plasmid Integrity of *Klebsiella pneumoniae*. Pharmacognosy Magazine 2010; 6(21): 57-61.
38. Kunnumakkara AB, Koca C, Dey S, Gehlot P, Yodkeeree S, Danda D, Sung B, Aggarwal BB. Traditional uses of spices: an overview. Molecular Targets and Therapeutic Uses of Spices; 2009. p. 1-24.
39. www.dasd.gov.in/adminimage/Itemwise_export_of_Spices.pdf

Cite this article as:

Saima Malik *et al*. A review on the therapeutic and nutritional value of spices and their prospects. Int. Res. J. Pharm. 2019;10(11):10-15 http://dx.doi.org/10.7897/2230-8407.1011312

Source of support: Nil, Conflict of interest: None Declared