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The curative role of some dietary spices in inflammation

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ABSTRACT

Spices are mainly plants or their parts which lends an aroma or flavour to food. They form an integral part of Indian cuisine and are used to flavour and preserve our daily food besides other uses. Their immense traditional uses as diuretic, purgative etc. have been known to man since time immemorial. The traditional use to treat ailments has only currently been scientifically validated. The study of the pharmacological principles responsible for the activity of crude spices has also gained importance in recent times. Some of the spices used daily in Indian cuisine have been known to possess major anti-inflammatory effects. When the body is injured, it mounts a protective inflammatory response to prevent further injury or infection. In spite of its apparently docile nature, inflammation may sometimes cause extensive tissue damage. This condition is extremely dangerous if left untreated. The review underlines the importance of some of the frequently used spices in the treatment of inflammation. It also highlights the molecular mechanisms responsible for the reduction in inflammation by these spices and further investigates the active principle responsible for the same from the various studies done in this field in an attempt to highlight the importance of spices in our lives.

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INTRODUCTION

Inflammation can be defined as the protective response of the body against an injury. Inflammation is responsible for healing wounds and shielding the body against injuries and pathogens, but in some cases (for e.g. in autoimmune diseases or if the condition has progressed beyond repair) it may prove to be dangerous if left untreated. The current anti-inflammatory drugs, consisting mainly of the non-steroidal anti-inflammatory drugs (NSAIDs), are associated with various side effects, including hepatic and renal toxicity. An appropriate alternative can be the medicinal plants which are found in abundance in India, by virtue of its being a mega diversity country.

Spices and herbs are usually whole plants or parts of plants that are used for flavouring and preservation of food all over the world. The people of the Indian subcontinent exploit their rich biodiversity and use various plants or their parts as spices for daily cooking and preservation of food from time immemorial. These spices also have medicinal properties that have been underlined in the traditional systems of medicine like Ayurveda, Unani etc. The side effects of the available chemical drugs have given rise to the current trend of herbal treatment and have led scientists all over the world to scientifically validate the traditional claims of their pharmacological properties. Therefore, apart from serving as a preservative and increasing flavour of food, spices and herbs also

have certain health benefits, thus validating their use in our everyday life.

Various plants/ plant parts are used as spices in India. Cumin, turmeric, black cumin, coriander, fennel, asafoetida, cardamom, bay leaf, pepper, red chilli etc. are a few of the wide spectrum of spices used in India. Most of the spices have been studied for their various pharmacological properties. Black cumin seed is known for its anti-microbial, anti-diabetic, anti-oxidant, anti-tumorigenic properties alongside its gastroprotective, hepatoprotective and cardioprotective properties (Ahmad *et al.*, 2013). Thymoquinone, a potent compound isolated from black cumin is responsible for most of the activities of the seed (Ahmad *et al.*, 2013). The present review focuses on the anti-inflammatory potential of a few of the spices used in the Indian Subcontinent.

MATERIALS AND METHODS

The various spices used in the Indian household (mainly Eastern India) were randomly selected after consultation with the persons of the household and were then searched in an online database to see whether they were listed under spices. The spices having anti-inflammatory properties were then identified using Google Scholar, Pubmed, Science Direct etc. The active principles and mechanisms responsible for their anti-inflammatory properties were then looked into using the same database mentioned above.

RESULTS AND DISCUSSION

A great number of spices possess anti-inflammatory activity though some like mustard is known for their pro-inflammatory activity too. A few of the common spices mainly used in eastern India (typical Bengal household to be precise) were selected randomly, the constituents responsible for their anti-inflammatory properties identified and their mechanisms studied in detail from various studies (Table 1).

Turmeric

Turmeric is actually the rhizome of the perennial herb *Curcuma longa* belonging to family Zingiberaceae. Turmeric is derived from the Latin word "terra merita" meaning meritorious earth and the Latin word *Curcuma* is derived from Arabic "kourkoum" meaning saffron. It has been rightly named as the "golden spice" not only because of its yellow colour but also because of its immense beneficial effects on human health. It is known by different names like haldi, holud, manjal, haridra etc. in various parts of India. The use of turmeric as spice dates back to the Vedic period and also finds mention in the Ayurveda and Unani systems of traditional medicine. It was used for improving digestion, killing worms, regulating menstruation, reducing respiratory troubles and arthritis, liver disorders etc.

Curcumin, isolated from turmeric, has been widely studied for its anti-inflammatory activity. In persons with metabolic syndrome, treatment with curcumin inhibited inflammatory mediators and cytokines like tumour necrosis factor-alpha (TNF-α), tumour growth factor-beta (TGF β), interleukin 6 (IL-6) and monocyte chemoattractant protein 1(MCP-1) (Panahi *et al.*, 2016). Edwards *et al.* (2017) referred curcumin as a pro-drug which on oxidative activation inhibited p65 subunit of nuclear factor kappa beta (NF-$\kappa\beta$) and inhibitor kappa beta kinase (IKKβ), the enzymes responsible for activation of NF-$\kappa\beta$ and its subsequent translocation to the nucleus to activate the pro-inflammatory mediators. In spite of having such an attractive activity, the poor bioavailability of curcumin has lead scientists to develop more stable analogs of curcumin like demethoxycurcumin, bisdemethoxycurcumin etc. (Arshad *et al.*, 2017).

Though curcumin has been extensively studied for their anti-inflammatory activity, other components isolated from *Curcuma longa* are yet to receive due recognition. Curcuminoids and oil free extract of *Curcuma longa* at 90- 360 mg/kg b.w. inhibited cotton pellet induced granuloma and xylene induced ear edema in Wistar rats and Swiss Albino mice respectively (Bagad *et al.*, 2013). Similarly, curcumin free turmeric consisting of components like tumerone, furanodiene, cyclocurcumin, tumerin etc. also exhibited anti-inflammatory and anti-cancer activity by downregulating the mediators of inflammation (Aggarwal *et al.*, 2013). In amyloid β treated BV2 microglial cell line, aromatic tumerone reduced inducible nitric oxide synthase (iNOS), cycloxygenase-2 (COX-2), monocyte chemoattractant protein-1 (MCP-1), matrix metalloproteinase-9 (MMP-9), IL-6, TNF-α, IL-1β etc. along with the inhibition of NF-$\kappa\beta$, p38 mitogen activated protein kinase (p38 MAPK) and c-Jun-N terminal kinase (JNK) pathways (Park *et al.*, 2012). The studies indicate that more than one component of turmeric is potent enough to be developed into an anti-inflammatory drug.

Cumin seeds

Cumin seeds, having an aromatic and bitter taste, are actually the dried fruits obtained from *Cuminum cyminum* plants belonging to family Apiaceae. Cumin is named from Kerman, an Iranian city,

Table 1: The major constituents of spices responsible for anti-inflammatory activity

Name of spice	Scientific name	Part used	Active principles responsible for inflammation
Turmeric	*Curcuma longa*	rhizome	Curcumin Curcuminoid Tumerone Furanodiene Cyclocurcumin Tumerin
Cumin	*Cuminum cyminum*	seed/dried fruit	Essential oil Cuminaldehyde
Black cumin	*Nigella sativa*	seed	Thymoquinone
Black pepper	*Piper nigrum*	dried unripe fruit	Piperine Piperic acid Guineensine Chabamide Pellitorine 6,7 dehydrobrachyamide B
Fenugreek	*Trigonella foenum graecum*	seed	4-hydroxyleucine Trigonelline Doisgenin/Dioscin
Fennel	*Foeniculum vulgare*	seed	Essential oil 8-methoxypsoralen Bergapten Imperatorin Scopoletin Anethole
Garlic	*Allium sativum*	bulb	Caffeic acid S-allyl cysteine Uracil 2-linoleoylglycerol Allicin 14 kDa protein
Clove	*Syzighium aromaticum*	dried flower bud	Oleanolic acid Eugenol Biflorin
Ginger	*Zingiber officinale*	rhizome	6,8 and 10-gingerol 6-shaogol Zingerone Zingerone derivative D2

around which it was grown. They are known to be used as spices since time immemorial and finds mention in the Biblical texts. They were used by Greeks and Romans as spices and by ancient Egyptians for the mummification process. Cumin is known as jeera, jeeru, jeerakam, ziragum etc. in India. The seeds find mention in folk, Unani and Ayurvedic systems where they were used for the treatment of toothache, diarrhoea, corneal opacities, jaundice etc.

The aqueous and ethanolic extract of cumin seeds effectively reduced inflammation in animal models. Both the extracts caused a significant reduction in paw edema induced by carrageenan and cotton pellet granuloma in Wistar rats. The ethanolic extract was more effective as an analgesic as it reduced the number of writhes (in acetic acid induced writhing) and increased response time (in Eddy's hot plate method) while the aqueous extract did not show changes in the latter method (Bhat *et al.*, 2014).

The essential oil obtained from cumin seeds inhibited iNOS, COX-2, IL-1, IL-6 mRNA expression and this inhibition was due to the inhibition of NF-$\kappa\beta$, p38 MAPK and JNK pathways (Wei *et al.*, 2015). Cuminaldehyde, one main component obtained from cumin, and its bioconverted molecules also inhibited COX-2 and lipoxygenase activity, another well known mediator of inflammation as studied by in-silico molecular docking method (Joseph and Mahapatra, 2017).

Black cumin seeds

Black cumin seeds are obtained from *Nigella sativa* plants belonging to Ranunculaceae family. It is a miracle herb or "herb from heaven" and was believed to be effective in every illness except death. It was also found in the tomb of Tutankhamen. The word "*Nigella*" is derived from the latin word "niger" meaning black referring to the colour of seeds. They are known as kalojeere, kalonji, himali jeera in different parts of India. It was used in traditional medicine for the treatment of airway disorders, hypertension, headache and back pain, diabetes etc.

The seed fixed oil from *Nigella sativa* reduced both acute and chronic inflammation in carrageenin induced paw edema, cotton pellet induced granuloma and formalin induced arthritis model in Wistar rats (Pise and Padwal, 2017). The freshly extracted oil from black cumin decreased IL-6 levels while oil extracted from stored seeds decreased IL-1β levels; both the extracts decreased IL-1α but none could reduce other pro-inflammatory cytokines like IL-2, IL-8, IL-12, IL-17A, IFN-γ, TNF-α etc. in both pre-adipocytes and THP1 cells (Bordoni *et al.*, 2019).

Thymoquinone is the principal component obtained from *Nigella sativa* seeds. Of the various types of extracts of *Nigella* (like aqueous, different grades of ethanol extracts, etc.), the oil extract contained the highest amount of thymoquinone, especially the supercritical fluid extract. In staphylococcal enterotoxin b induced human lymphocytes, thymoquinone reduced IL-2, IL-6 and PGE2, IL-6 and PGE2 in human monocytes and PGE2 in A549 human lung cells (Koshak *et al.*, 2018). In LPS stimulated RAW 264.7 cells, thymoquinone inhibited NO, iNOS, COX-2, IL-6, TNF-α etc. This reduction was due to the inhibition of NF-$\kappa\beta$, ERK, JNK and p38. The inhibition of MAP kinase and NF-$\kappa\beta$ pathway was due to the inhibition activator protein 1 (AP-1) and interleukin 1 receptor associated kinase 1 (IRAK 1) respectively. Oral administration of thymoquinone (5-25mg/kg body weight) to C57BL/6 hepatitis mouse and ICR gastritis mouse significantly improved the tissues and reduced disease symptoms (Hossen *et al.*, 2017).

Black pepper

Black pepper is the dried unripe fruit of the plant *Piper nigrum*, belonging to family Piperaceae. It is known as the "King of spices" because of its importance in trade. The word pepper has its roots in the Sanskrit word "pippali" meaning berry. It is known by the names of gol morich, kali mirch, gulki etc. Besides its use as spice, it is also used as pesticides, insecticide and in perfumery. Traditionally they were used to treat menstrual problems, ear-nose-throat related problems, diarrhoea, gastric problems, bed sore etc.

In ovalbumin induced allergic asthma model in BALB/c mice, ethanol extract of black pepper decreased IgE and anti-ova IgG, histamine release in serum, infiltration of mast cells into lung and histopathological changes in the lung tissue. Moreover, the ethanolic extract decreased the cytokines GATA3, IL-1β, IL-4 (Th2), IL-17A (Th17) and TNF-α and elevated levels of IL-10 and IFN-γ thus indicating suppression of Th2/Th17; no change was observed with IL-6 in bronchoalveolar lavage fluid (Bui *et al.*, 2017). The fruit extract also reduced allergic rhinitis by inhibiting NF-$\kappa\beta$ and signal transducer and activator of transcription-3 (STAT3) signalling, downregulation of Th17 and Th2 cytokines and upregulation of Treg and Th1 cytokines (Bui *et al.*, 2017).

Piperine, an alkaloid obtained from black pepper, showed a dose dependent inhibition of TNF-α, IL-1β, IL-6 and PGE2 production from BV-2 microglial cells at a dose of 25-100μg/ml. This reduction was due to inhibition in NF-$\kappa\beta$ signalling

pathway and upregulation of nuclear factor E2 related factor 2 (Nrf-2) and haem oxygenase-1(HO-1) pathway (Wang-sheng *et al.*, 2017). Piperine provided relief from collagen induced arthritis in male rats by downregulating the inflammatory mediators and upregulating the anti-oxidant system of the body. Piperine brought down levels of NO, TNF- α, IL-1β, PGE2 along with the increase of IL-10. It upregulated the anti-oxidant enzymes like glutathione (GSH), catalase and superoxide dismutase (SOD), reduced thiobarbituric acid reactive substances (TBARS), myeloperoxidase (MPO) and elastase activity along with the reduction in arthritic parameters as confirmed by histopathological studies such as decrease of cartilage erosion, absence of mononuclear infiltration in synovium etc. (Umar *et al.*, 2013). Piperic acid obtained from piperin inhibited acetic acid induced writhing, formalin induced pain, capsaicin induced paw licking, carrageenan induced granuloma and increased latency time in tail flick test. The cytokines TNF-α, IL-1β were also reduced in tissue sections obtained from Swiss Albino mice but piperic acid inhibited both the cycloxygenases COX-1 and COX-2 (Oliveira *et al.*, 2018). Guineensine obtained from *Piper nigrum* inhibited formalin induced paw shaking and pain, carrageenan induced paw edema and LPS induced hypothermia and catalepsy along with an increase in activity. It also interacted with dopamine transporters (DAT), sigma, 5HT2A and 5HT2B (Reynoso-Moreno *et al.*, 2017). Treatment with nonivamide reduced IL-8, IL-6, TNF-α, IL-1β, MCP-1 and MIP-1β production in LPS induced peripheral blood mononuclear cells (PBMCs). Similar results were obtained with U-937 cells. This reduction was not because of inhibition of NF-$\kappa\beta$ pathway but MAP kinase pathway may be involved (Walker *et al.*, 2017). Chabamide, pellitorine and 6,7 dehydrobrachyamide B obtained from *Piper nigrum* inhibited NO production, iNOS and COX-2 in LPS induced RAW264.7 cells. Chabamide also reduced NO in bone marrow derived macrophages and upregulated HO-1, Nrf-2, NAD(P)H:quinone oxidoreductase 1 and γ-glutamyl cysteine synthetase catalytic subunit (Ngo *et al.*, 2017).

Fenugreek

Fenugreek seeds are obtained from the plant *Trigonella foenum graecum* belonging to family Fabaceae/Leguminosae. The triangular shape of the leaves is responsible for the name "Trigonella" and "foenum graecum" in Greek means Greek grass. It is known by different names such as methi, menthya, ventayan, mentulu etc. It was traditionally used for pain relief, as laxative, astringent, to treat depression, hypertension, diabetes etc.

In Wistar rats, ethanol extract of fenugreek seeds reduced complete Freund's adjuvant induced arthritis along with reduction in IL-1α, IL-1β, IL-2, IL-6 and TNF-α level. It also reduced lipid peroxidation and increased anti-oxidant parameters like SOD and GSH (Suresh *et al.*, 2012). The glycoside based standardized seed extract prevented idiopathic pulmonary fibrosis induced by bleomycin by inhibiting alterations in lung tissue along with an increase in peripheral oxygen content of the blood. It also inhibited the markers of inflammation, NO, IL-6, IL-8, TNF-α, IL-1β, TGF- β, collagen-1, ET-1, Muc5ac, NF- $\kappa\beta$, VEGF, Smad-3, Bax and caspase 3 and upregulated Bcl-2 levels; the anti-oxidant markers like SOD and GSH were upregulated (Kandhare *et al.*, 2015). Fenugreek extract also reduced allergic skin inflammation by reducing pro-inflammatory cytokines along with upregulation of Th-1 differentiation (measured by increase in IFN-γ) and downregulation of Th-2 {measured by decrease in IL-4 and GATA binding protein-3 (GATA-3)} (Bae *et al.*, 2012).

Trigonelline, an alkaloid isolated from fenugreek improved LPS induced neuroinflammation by downregulating NF- $\kappa\beta$ and TLR-4 and upregulating SOD and GSH. It also improved memory and learning as judged by their retention/ recall time and avoidance to electric shock (Khalili *et al.*, 2018). Diosgenin, another component obtained from fenugreek seeds also reduced TNF-α, COX-2 and NF-κB activation in liver, brain and heart of rats on atherogenic diet (Binesh *et al.*, 2018). Inflammation has been found to be one of the main causes of ischemic stroke and diosgenin/dioscin from fenugreek prevented the same by suppressing the protein expression of TLR4, myeloid differentiation factor 88 (MyD88), NF-κB, transforming growth factor- β1 (TGF-β1), high mobility group protein-1 (HMGB-1), interleukin -1 receptor associated kinase 1 (IRAK1), and TNF receptor associated factor -6 (TRAF-6) in Sprague Dawley rats (Zhu *et al.*, 2017).

Fennel

Fennel seed is obtained from *Foeniculum vulgare* plant belonging to family Apiaceae. The name fennel is derived from latin "*Foeniculum*" which in turn is derived from "faenum" meaning "hay". It is known by different names such as mauri, saunf, hariyal, badi sopu, perun shiragum etc. Besides India, the herb was well known in Ancient Egypt, Rome and China. Traditionally it was used to treat different diseases like abdominal pain, arthritis, conjunctivitis, stomach ache, liver pain, ulcer, diarrhoea, gastritis, insomnia etc.

The ethanolic extract of fennel seeds inhibited

pain induced by formalin and acetic acid alongside inhibiting carrageenan induced paw edema (Elizabeth *et al.*, 2014). It also prevented photo-aging of the skin by reducing MMP-1, MMP-3, IL-6 and an increase in TGF-β1. This was due to upregulation of Nrf-2 and inhibition of p38 and ERK signalling pathways (Sun *et al.*, 2016).

Coumarins from *Foeniculum vulgare* reduced LPS induced inflammation in RAW264.7 macrophages. Of the four coumarins tested, 8-methoxypsoralen, bergapten and imperatorin reduced NO and iNOS; scopoletin and imperatorin decreased COX-2 and PGE2; imperatorin reduced the cytokines TNF-α, IL-1β and IL-6 but 8-methoxypsoralen and bergapten reduced only IL-1β, none of the four inhibited IL-10, an anti-inflammatory cytokine; imperatorin and bergapten strongly inhibited NF-κB translocation into the nucleus. Imperatorin also reduced ear thickness and the proinflammatory mediators like TNF-α, IL-1β, IL-6 and COX-2 in ears of 12-O-tetradecanoylphorbol-13-acetate (TPA) stimulated mice (Yang *et al.*, 2015). Anethole inhibited adhesion of HT-1080 tumour cells and reduced the inflammatory mediators like MMP-2, 9 and signalling pathways like NF-κB, ERK and p38 to inhibit metastasis of fibrosarcoma tumour cells (Choo *et al.*, 2011). The anti-inflammatory activity of fenchone and limonene mediates wound healing activity as studied by wound contraction and regeneration of epithelial tissue, increase in collagen synthesis and decrease in the infiltration of inflammatory cells in the region of wound (Keskin *et al.*, 2017).

Garlic

Garlic is actually the bulb of *Allium sativum* belonging to family Amarylilidaceae. It is derived from the word "garleac" meaning "spear shaped leek". It is known as rosun, lasan, lahsun, romahan, purunvar etc. in different parts of India. It is one of the oldest cultivable plants known to man for more than ten thousand years. The medicinal value of garlic was known to man since ancient times as it finds mention in different ancient scriptures including the oldest preserved book on medicine, Papyrus Ebers. It was used for the treatment of parasitic infections, toothache, arthritis, leprosy etc.

Water soluble garlic extract was effective in reducing NO, PGE2, COX-2, IL-1β, leukotriene D4 and E4 (LTD4 and LTE4) in LPS induced RAW264.7 cells. The fresh raw garlic extract was more effective in reducing the above pro-inflammatory mediators than aged black garlic extract though both exhibited their activity by reducing the NF-κB signalling pathway (Jeong *et al.*, 2016). Garlic extract also inhibited pro-inflammatory cytokines like IL-12, TNF-α, IL-1α, IFN-γ, IL-6, IL-8 and upregulated anti-inflammatory cytokine IL-10 in monocytes (Hodge *et al.*, 2002).

Caffeic acid, S-allyl cysteine and uracil obtained from *Allium sativum* reduced UVB induced wrinkle formation by inhibiting MMP-3, 9, 12, collagen degradation and ROS production besides showing anti-inflammatory property by reducing COX-2, iNOS, NF-κB and Akt activity (Kim *et al.*, 2013). S-allyl cysteine prevented acute kidney injury induced by LPS in C57BL/6 mice by inhibiting serum blood urea nitrogen and creatinine, upregulating anti-oxidant markers like GSH, SOD and mitochondrial membrane potential besides downregulating inflammatory and apoptotic mediators like NO, COX-2, TLR4, TNF-α, IL-1β, IL-6, NF-κB, Annexin-V, along with upregulation of Nrf-2 (Khajevand-Khazaei *et al.*, 2019). AGE-1 (2-linoleoylglycerol) inhibited NO, iNOS, COX-2, PGE2, TNF-α, IL-1β and IL-6 by inhibiting p38 MAPK and c-Jun terminal kinase pathway (Kim *et al.*, 2013). Allicin prevented osteoarthritis in mice by reducing NO, iNOS, COX-2, PGE2, TNF-α, IL-6 and by inhibiting PI3K/Akt / NF-κB pathway (Qian *et al.*, 2018). A 14 kDa protein isolated from garlic by gel filtration chromatography, reduced pro-inflammatory mediators induced by LPS in J774A.1 macrophages. The isolated protein reduced NO, iNOS, TNF-α, IL-1β, COX-2 production and activation of NF-κB signalling pathway (Rabe *et al.*, 2015).

Clove

Clove is actually the reddish brown dried flower bud obtained from the evergreen tree *Syzighium aromaticum* belonging to family Myrtaceae. They were one of the earliest spices in trade used for flavouring meat and bread due to their hot taste and strong aroma. They are known as laung, lobongo, laving, rong, grambu etc. Clove was traditionally used for the treatment of diarrhoea and other ailments of the bowel, liver diseases, as anti-bacterial, anti-fungal agents but mainly known for their use in dental care primarily for the treatment of toothache.

Syzigium aromaticum flower buds significantly inhibited formalin induced paw edema in Wistar rats at doses of 50-100 mg/kg body weight (Tanko *et al.*, 2008). Clove extract inhibited LPS induced inflammatory cytokines like IL-1β, IL-6 and IL-10 in peritoneal macrophages (Bachiega *et al.*, 2012).

Acetate and ester derived compounds of oleanolic acid, a triterpenoid compound, isolated from ethyl acetate extract of clove, were tested for their anti-inflammatory activity against albumin injected Wistar rats. Both the derived compounds besides having analgesic effects inhibited right hind paw

inflammation, the acetyl derivatives being more potent (Rali *et al.*, 2016). Eugenol obtained from clove oil inhibited collagen induced arthritis in DBA1/J mice by inhibiting infiltration of mononuclear cells and reducing inflammatory cytokines like TNF-α, IFN-γ and TGF- β in the knee and ankle joints respectively (Grespan *et al.*, 2012). Eugenol also inhibited IL-6 and IL-10 but was ineffective against IL-1β secreted by LPS induced peritoneal macrophages. Eugenol prevented IL-6 production both before and after the addition of LPS, but in case of IL-10, reduction was observed only after the addition of LPS (Bachiega *et al.*, 2012). Biflorin isolated from cloves inhibited ear edema induced by croton oil and paw edema induced by carrageenan in rat model of inflammation. It also reduced NO, iNOS, PGE2, COX-2 and inflammatory cytokines like TNF-α and IL-6. This reduction was due to the reduction of signal transducer and activator of transcription 1 (STAT-1) and p38 but not NF-κB pathway (Lee *et al.*, 2016).

Ginger

Ginger is the rhizome of the monocotyledonous perennial plant *Zingiber officinale* belonging to Zingiberaceae family. The name "*Zingiber*" was derived from the Sanskrit word "shringavera" meaning the antlers of the deer. They may be used as whole or as dried powder and are used in baking cakes and biscuits, pickles etc. It is known by various names such as adrak, ada, allam, alha etc. in India. It is also known for its medicinal value. In traditional system of medicine they are used in the treatment of rheumatism, asthma, stroke, migraine, diabetes etc.

The aqueous extract of ginger inhibited carrageenin induced paw edema in Sprague Dawley rats at doses of 25-200 mg/kg b.w. It also inhibited the inflammatory markers like NO, PGE2, inflammatory cytokines like TNF-α, IL-1β, IL-6, IFN-γ, chemokines such as MCP-1, MIP, RANTES and increased the total antioxidant capacity as measured in inflammatory exudates obtained from carrageenan injected hind paws of rats. Significant histopathological changes from control group were observed in rats treated with 200 mg/kg b.w. ginger extract (Ezzat *et al.*, 2018).

Gingerols, one of the most pungent compounds of ginger, exhibited potent anti-inflammatory activity by reducing the signalling pathways like COX-2, NF-κB, MAPK, Akt, PI3K and AP-1 (Yusof, 2016). 12-dehydrogingerdione reduced NO, PGE2, IL-6 in LPS induced RAW264.7 cells, the most effective dose being 200ng/ml. It also reduced COX-2 and iNOS mRNA levels but had no effect on TNF-α and IL-1β (Han *et al.*, 2013). The anti-inflammatory and anti-oxidant levels of 6-shaogol, 6, 8 and 10 gingerol were studied. It was found that 6-shaogol has the greatest scavenging activity and inhibited oxidative burst in polymorphonuclear neutrophils (PMNs) followed by 10-gingerol. Similar trends were obtained in nitrite and PGE2 reduction in RAW264.7 cells (Dugasani *et al.*, 2010). 6-shaogol was also effective in reducing inflammation induced by LPS in BV-2 microglial cells by inhibiting TNF-α, IL-1β, IL-6 and PGE2 production. This decrease was due to inhibition of NF-κB signalling pathway and activation of peroxisome proliferator-activated receptor-γ(PPAR-γ) by 6-shaogol (Han *et al.*, 2017). Zingerone reduced the cytokines TNF-α, IL-6, IL-8 by inhibiting p38 MAPK and JNK pathways in SW1353 cell line. It also reduced the level of MMP-13 and degeneration of cartilage explants induced by IL-1β (Ruangsuriya *et al.*, 2016). It reduced LPS induced acute kidney injury by reducing the markers of inflammation like TLR-4, MyD88, TIR-domain-containing adapter-inducing interferon-β (TRIF) and NF-κB in C57BL/6 mice. Inflammatory cytokines like TNF-α, IL-1β, IL-6 were also reduced and the normal architecture of the kidney tissues restored but zingerone had no effect on Nrf-2 activity (Song *et al.*, 2016).

CONCLUSION

Consumption of spices in our daily life is associated with various health benefits, reduction of inflammation being one of them. The common spices like cloves, ginger, cumin etc. possess anti-inflammatory activity. The crude extract as well as the active principles reduced inflammation by downregulating the potent mediators of inflammation and signalling pathways. Besides, the ones described above, there are a myriad of other spices having anti-inflammatory activity like asafoetida, the dried latex obtained from *Ferula assa-foetida* or bay leaves obtained from *Cinnamomum tamala* plants. Herbal therapy can be used to treat inflammatory diseases instead of market available synthetic drugs or in combination with them. Limited regular use of spices can also be used as a preventive measure against inflammation and its associated diseases as outlined in the text. This can reduce our dependence on synthetic drugs associated with side effects but detailed study in molecular level and large scale human trials are needed to achieve this goal.

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Conflict of interest

There are no conflicts of interest.

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