

Anti-Inflammatory Properties of *Coriandrum Sativum* L.: A Review

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Abstract— Inflammation is a part of the complex biological response of vascular tissues to harmful stimuli, such as pathogens, damaged cells, or irritants. Natural products are a rich source for the discovery of new drugs because of their chemical diversity. The conventional drug available in the market to treat inflammation produces various side-effects. *Coriandrum sativum* L. is used in many countries as a traditional medicine to treat disorders of the digestive, urinary, and respiratory systems, as well as diabetes, inflammation, and other conditions. However, their important role in anti-inflammatory activity have not been fully explored. The present review is directed towards the compilation of the research articles that have reported on the anti-inflammatory activity of *Coriandrum sativum* L. A literature review was carried out by searching on the electronic databases including PubMed, ScienceDirect, and Google Scholar for studies pharmacological activities of *Coriandrum sativum*. All recent research articles published between 2010 and 2020 were included. Based on eligibility criteria, a total of 8 studies were included in this study, consisting of 3 *in vitro* studies, 5 *in vivo* studies. The set of pharmacological studies reported evidence of the *Coriandrum sativum* L. potential for the treatment of diseases associated with an inflammatory response. The *Coriandrum sativum* L. has been reported to be able to inhibit NO, iNOS, IL-1, IL-6, TNF- α , TNF-R1, ROS, COX-2, NF- κ B, MAPK, and reduce edema, as well as exhibited a membrane stabilization effect by inhibiting hypotonicity-induced lysis of erythrocyte membrane. *In vitro* and *in vivo* studies strongly demonstrated that *Coriandrum sativum* has potential as an anti-inflammatory.

Keywords— *Coriandrum sativum* L.; Anti-inflammatory; Inflammation; Inflammatory mediator.

I. INTRODUCTION

Inflammation is an important immune response that allows for survival during infection or injury and preserves tissue homeostasis under a variety of noxious conditions. Inflammation comes at the expense of a temporary reduction in the function of the tissue, which can, in turn, lead to the pathogenesis of diseases of altered homeostasis [1]. The progression of degenerative diseases such as rheumatoid arthritis, atherosclerosis, asthma, and other inflammatory diseases is due to chronic inflammation [2].

Medicines that are widely used to reduce inflammation are non-steroidal anti-inflammatory drugs (NSAIDs). The use of NSAIDs usually results in lumen ulceration and intestinal mucosal bleeding [3], [4]. On the other hand, prolonged use of NSAIDs is also associated with severe adverse effects such as gastrointestinal bleeding, and new COX-2 selective drugs do not appear to be risk-free either, as several COX-2 inhibitors are associated with cardiovascular problems [5], [6]. Natural medicines have become increasingly used in recent years as alternative treatments for inflammation because of their relatively minimal side effects [7], [8]. Therefore, there is a strong need for the use of natural products with minimum adverse effects. The previous study showed that the different plants have different therapeutic operations, including anti-inflammatory behaviors [9]–[12]. Coriander (*Coriandrum sativum* L.) belongs to the family Apiaceae and it is an annual and herbaceous plant. Due to its use in the Middle East in all of Southern Asia as well as in most areas of Latin America, Coriander has been named the most widely used flavoring in the world. In addition to its traditional use as a spice and medicine plant, the plant has economic significance because it

is used in food goods, perfumes, cosmetics, and soaps as a flavoring agent [13].

Coriandrum sativum L. was shown to contain flavonoids, essential oil, tannins, phenolics, alkaloids, terpenoids, fatty acids, sterols, and glycosides by phytochemical screening. High nutritional values were also included, including proteins, oils, carbohydrates, fibers and a wide variety of minerals, trace elements and vitamins. [14]–[16]. Previous pharmacological studies found that *Coriandrum sativum* L had antibacterial, antifungal, antioxidant, anti-inflammatory, analgesic, antidiabetic, anti-cancer and several other pharmacological impact [14], [17]–[21]. In this review, we provide an updated review on the anti-inflammatory properties of *Coriandrum sativum* L.

II. METHODS

Firstly, the plant name was authenticated using www.theplantlist.org. The present review was based on the data searches conducted in the database of scientific literature, including PubMed, ScienceDirect, and Google Scholar, using the publication from January 2010 to December 2020, using the following keywords: anti-inflammatory, inflammation, *Coriandrum sativum*. These keywords were used as a guide to search for articles in other databases. All abstracts and full-text articles were collected, examined, summarized, and conclusions made accordingly. The most relevant articles were selected for inclusion in this review. Articles from non-reliable journals/conferences and English and non-English articles which could not be accessed or translated in full were not regarded as exclusion criteria for this study.

III. RESULTS AND DISCUSSION

The anti-inflammatory activity of *Coriandrum sativum* has been demonstrated in in vitro and in vivo studies. A total of 8 studies were included in this paper based on our eligibility criteria. Table I and table II show the studies reported for this

review and summarizes the results obtained, indicating the dose/concentration of *Coriandrum sativum* administered, type of extract used, plant part used, cell/specimen used, experimental model, animal and disease models, reported activity, and region.

TABLE I. Summary of anti-inflammatory properties of *Coriandrum Sativum* L.. (In vitro studies).

Type of extract or Formulation	Plant part used	Dose/ concentration	Cell/specimen	Experimental Model	Reported activity	Region	Ref.
Dried fruit extract	fruits	5, 10, 20 μM	RAW 264.7 macrophage cells	LPS-stimulated RAW264.7 macrophage model	The isolated compound showed an anti-inflammatory effect through inhibiting nitrate level, ROS production, and the generation of IL-6 and TNF-α via the NF-κB and MAPK pathways	China	[22]
Ethanollic Extract	stem and leaf	25–150 μg mL ⁻¹	RAW264.7 macrophage cells	LPS-stimulated RAW264.7 macrophage model	Ethanollic Extract exhibited anti-inflammatory properties through inhibiting pro-inflammatory mediator expression by suppressing NF-κB activation and MAPK pathway.	Taiwan	[23]
Dichloromethane extract	seeds	200,400, 600, 800, 1000 μg	Human Red Blood Cell (HRBC)	Hypo tonicity induced human red blood cell (HRBC) membrane stabilization	Coriander extract exhibited membrane stabilization effect by inhibiting hypotonicity-induced lysis of erythrocyte membrane.	India	[24]

A. In Vitro Studies

The isolated compound (coriander lacton C) from *Coriandrum sativum* L. showed anti-inflammatory activity with IC 6.25 μM as an inhibitory effect on nitric oxide (NO) levels. In addition, a decrease in the generation of lipopolysaccharide-stimulated ROS and inflammatory cytokines (IL-6 and TNF-alpha). Mechanism exploration has shown that coriander lacton C suppresses the expression of inflammatory mediators, such as COX-2 and iNOS. Furthermore, the MAPK and NF-κB pathways are involved in the anti-inflammatory process of this compound [22].

Ethanollic extracts of the stems and leaf of *Coriandrum sativum* (CSEE) significantly decreased LPS-induced nitric oxide (NO) and prostaglandin E2 (PGE2) production as well as inducible NO synthase, cyclooxygenase 2 (cox 2), and pro-interleukin-1β expression. In addition, LPS-induced phosphorylation of IκB-α and expression of nuclear p65 protein, as well as protein-DNA nuclear factor-κB (NF-κB) which binds the affinity and activity of reporter genes, were dramatically inhibited by aerial parts of CSEE. The addition of exogenous stems and leaves of CSEE significantly reduced LPS-induced LPS expression of phosphorylated mitogen-activated protein kinases (MAPKs)[25].

In the initiation of pro-inflammatory mediators, macrophage cells have a critical function. Toll-like receptor 4 (TLR4) is activated in LPS-stimulated macrophage cells that can recruit MyD88 and subsequently cause nuclear factor-κB (NF-κB) to be translocated from the cytoplasm into the nucleus[26]. Inflammatory regulators such as interleukin-6 (IL-6), inducible nitric oxide synthase (iNOS), tumor necrosis factor-alpha (TNF-alpha), and cyclooxygenase-2 (COX-2) are initiated by activated NF-κB [27], [28]. The MAPK pathways play a major role in inflammatory development [29]. TLR4 forms a dimer in LPS-stimulated macrophage cells, which can activate the MAPK pathway [30]. The activated MAPKs

mediate the activation of COX-2 and iNOS in macrophage cells induced by LPS and encourage inflammatory responses [31]. Accumulated studies have confirmed that reactive oxygen species (ROS) are involved in the inflammatory response. [32]. The improved ROS generation can intensify inflammation and contribute to tissue injury [33]. Therefore, A possible strategy to reduce inflammatory diseases may be to restrict the NF-κB signaling pathway, MAPK pathways, and ROS generation [33].

In another in vitro study by Kothari et al. used the hypotonicity-induced human red blood cell (HRBC) membrane stabilization method, this study reported that coriander extract exhibited a membrane stabilization effect by inhibiting hypotonicity-induced lysis of erythrocyte membrane. But the positive control Diclofenac has a more efficient anti-inflammatory effect than the coriander [24].

B. In Vivo Studies

To observe potential activity against pro-inflammatory mediators, the carrageenan-induced edema assay was used. This model also has two distinct phases, an early phase that starts immediately after the injection of carrageenan and lasts approximately 6 hours, and a later phase that begins 6 hours after the injection of carrageenan and ends 72 hours after the injection. The inflammation peak is observed between 48 and 72 h [39]. In this assay, histamine, serotonin, and enhanced prostaglandin synthesis in the early stages are primarily mediated by edema (between 1 h and 2 h after injection). The later edema stage is triggered by direct prostaglandin released by damaged tissue, along with bradykinin, leukotrienes, polymorphonuclear cells and prostaglandins formed by macrophages [40].

TABLE II. Summary of anti-inflammatory properties of *Coriandrum Sativum* L. (In vivo studies)

Type of extract or Formulation	Plant part and source used for studies	Dose/ concentration	Experimental Model	Animal and disease models	Reported activity	Region	Ref.
Ethyl acetate fractions from Dichloromethane extract	Stem and leaves	30, 100 or 300 mg/kg	Carrageenan-induced paw edema	Male Swiss mice	The ethyl acetate fraction (FAC) of <i>Coriander sativum</i> Linn. exhibits anti-edema and anti-inflammatory properties.	Brazil	[34]
Hydroalcoholic extract	Seeds	8,16,32 mg/kg BW	1. Carrageenan - induced rat paw edema model 2. Subcutaneous cotton pellet implantation-induced granuloma formation 3. Complete Freund's adjuvant (CFA)-induced arthritis	Wistar albino rats	<i>Coriandrum sativum</i> (CSHE) hydroalcoholic extract showed anti-inflammatory, anti-granuloma activity, and suppressed IL-1, IL-6 beta, and TNF-R1.	India	[35]
Ethanol extract	Fruits	200 mg/kg	Carrageenan - induced rat paw edema	Wistar albino rats	Ethanol extracts exhibited significant anti-inflammatory activity	India	[36]
Coriander seed oil	Seed	400 mg/kg	Carrageenan-induced rat paw edema	Female albino rats	Coriander seed oil (COO) showed an insignificant reduction in paw edema	Egypt	[37]
Aqueous and ethanolic extracts	seeds	250mg/kg and 500mg/kg	1. Carrageenan-induced paw edema 2. Cotton-pellet induced granuloma	Wistar albino rats	The aqueous and ethanolic extracts of <i>Coriandrum sativum</i> seeds demonstrated analgesic and anti-inflammatory activities.	India	[38]

A study by Begnami et al. (2018) was reported the ethyl acetate fraction (FAC) of *Coriander sativum* Linn. Leaf exhibits anti-edema and anti-inflammatory properties. This study evaluated anti-edema properties of fractions of *Coriandrum sativum* Linn (Apiaceae/Umbelliferae) leaves in mice. In this experiment, the leaf extract Ethyl acetate fractions (FAC) were obtained from dichloromethane extracts prepared from dried *Coriandrum sativum* L. leaves and stems. The effects of different concentrations (30, 100 or 300 mg/kg) of FAC on mice were observed using carrageenan-induced paw edema tests. This study showed that FAC induced significantly less edema than the control throughout the experiment. However, no differences between lines during the later phase were observed, except for dexamethasone, indicating that the effect was only observed during the early phase. Thus, the anti-inflammatory activity exhibited by FAC may be due to the inhibition of the synthesis or release of inflammatory mediators or even the direct inhibition of mediators of carrageenan-induced inflammation [34].

Nair et al. conducted the study relating the anti-inflammatory activity *Coriandrum sativum* hydroalcoholic extract (CSHE). Serum tumor necrosis factor- α (TNF- α), IL-6, IL-1 β levels, and peritoneal macrophage expression of TNF-R1 were evaluated as markers of global inflammation. This study reported that CSHE at the highest dose tested (32 mg/kg) produced a significant reduction ($P < 0.05$) in paw edema after carrageenan administration. CSHE treatment also reduced dry granuloma weight in all treated animals. Serum IL-6 and IL-1 β levels were significantly ($P < 0.05$) lower in the

CSHE (32 mg/kg)-treated group as compared to the control. Although there was an increase in serum TNF- α level in the CSHE treated group as compared to control, TNF-R1 expression on peritoneal macrophages was found to be reduced [35].

Similarly, In a study conducted by Sonika et al. relating anti-inflammatory activity of *Coriandrum sativum* at dose 200 mg/kg. These ethanolic extracts were tested for anti-inflammatory activity by carrageenan-induced rat paw edema. The study reported that *Coriandrum sativum* L. extract exhibited 40.81% inhibition of edema after the third hour at a dose of 200 mg/kg [36].

Furthermore, the anti-inflammatory evaluation in albino Wistar rats of the *Coriandrum sativum* L. seeds ethanol extract at a dose of 250 mg/kg and 500 mg/kg showed significant anti-inflammatory activity in Carrageenan-induced paw edema while only the high-dose aqueous group exhibited significant results in the Cotton-pellet granuloma model when compared to the respective control group [38].

In contrast, administration of coriander seed oil (COO) at a dose of 400 mg/kg showed an insignificant reduction in paw edema as compared with the carrageenan-treated animals and was significantly ($p < 0.05$) higher than indomethacin treated groups [37].

IV. CONCLUSIONS AND FUTURE PROSPECTS

In vitro and in vivo studies of *Coriandrum sativum* have provided strong evidence of its anti-inflammatory activity. In vitro and in vivo studies have revealed that *Coriandrum*

sativum L. regulates various mediators of inflammation and alters various signaling pathways involved in inflammation. However, further investigations into the receptor interactions associated with inflammation provide clues for new anti-inflammatory drugs in the future. Future studies of the anti-inflammatory activity of *Coriandrum sativum* L. must provide a clear source and specifications of material used, especially when plant extract is used. Moreover, the methods and conditions used in in vitro and in vivo studies must be validated to avoid bias and ensure the anti-inflammatory activity of *Coriandrum sativum* L.. Much work remains to ensure the safety, quality, and efficacy of *Coriandrum sativum* L. before it can be used to treat inflammation-related diseases in humans.

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