Abstract

Essential oils (EOs) are natural compounds obtained from algae and different parts of plants. EOs are volatile secondary metabolites and are classified into major groups, including terpenes/terpenoids and aromatic/aliphatic compounds. There are numerous studies about the biological activities of EOs, demonstrating their abilities for the prevention and treatment of diseases. Their biological activities are mainly related to their constituents, such as α-pinene, thymol, 1, 8-cineole, carvacrol, etc. Thus, the use of EOs as pharmaceutical agents for curing several diseases has gained much attraction in recent years. Moreover, inflammatory bowel disease (IBD) is a type of disease that causes chronic inflammation in the intestine. Ulcerative colitis (UC) and Crohn's disease (CD) are two main forms of IBD. Some studies have reported the efficacy of EOs in treating IBD, in particular, UC. This chapter will focus on the biomedical application of EOs in the treatment of IBD.

Keywords: bioactive compounds, essential oils, biological properties, inflammatory bowel disease, ulcerative colitis

1. Introduction

Inflammation is a physiological response against various infection agents, toxins, and injury which are related to several disorders [1]. Inflammatory bowel disease (IBD) and irritable bowel syndrome (IBS) are two common disorders with similar signs of abdominal pain but different pathophysiology and therapeutic methods. IBD causes inflammation of the intestines and is a term for a broad spectrum of diseases and crohn's disease (CD) and ulcerative colitis (UC) are the most common. IBD treatment usually needs a lifetime of medical care, while IBS affects the large intestine without inflammation [2, 3]. Moreover, IBD affects 6.8 million people worldwide, in particular in North America and United Kingdom [4]. The genetic predisposition, gut microbiota, environmental risk factors, and dysfunction of the immune system can be related to IBD. The IBD is characterized by intestinal epithelial injury (excess mucus production), inflammation expansion, and failed control of the inflammatory response [5]. Furthermore, it has been established that the gut microbiota has an important effect on IBD pathology as their close connection to the
host immune system [6]. The usual approach and therapeutic management strategies for IBD are drug treatment by monoclonal antibodies, immunomodulators, corticosteroids, and aminosalicylates which may have some side effects [4]. Therefore, the development of a safe and effective strategy is required for the treatment of IBD patients [7]. The novel treatment of gastrointestinal diseases is utilizing natural bioactive compounds such as crude extracts, essential oils (EOs), and pure isolated compounds from medicinal plants with improving immune function attributes [8]. Thus, natural bioactive compounds with anti-inflammatory effects such as herbal medicine extracts [9, 10] and EOs have attracted much attention to develop new types of anti-inflammatory agents [11]. There are several investigations confirmed the anti-inflammatory effect of the herbal medicine extracts or EOs in different UC models [12–15]. It has been established that EOs can improve the balance of gastrointestinal immunity by their anti-inflammatory activity and downregulation of pro-inflammatory products [16].

EOs are highly volatile secondary metabolites and are known as aromatic substances produced by specific plants [17] or algae species [18]. EOs have considerable potential to be used as a part of pharmaceuticals, nutraceuticals, and functional foods because of their broad range of biological activities [17]. EOs are involved in monoterpenes, sesquiterpenes, and oxygenated derivatives of these and possess synergistic effects in combination together. The usual extraction methods of EOs are steam distillation, hydrodistillation, or solvent extraction. However, there are numerous factors are known to influence the properties of EOs including species and genetic, climate, and geographic origin which caused differences in chemical structures [19]. Moreover, the different chemical structures of EOs exhibit different biological properties [20]. A growing interest in using natural bioactive compounds as medicine or food preservation results in increasing interest in EOs applications. They are characterized by their potential health benefits including antibacterial, antifungal, antiviral, insecticidal, and antioxidant activities. These attributes are related to single or groups of compounds, which play an important role in the defense mechanisms of plants against abiotic stress [21].

This chapter presents an overview of EOs potential effect in promoting health, in particular, IBD.

2. Inflammatory bowel disease (IBD)

IBD is a group of diseases that caused diarrhea, abdominal pain or discomfort, and even bloody stool. These inflammatory intestinal diseases are involving the ileum, rectum, and colon. The two main forms of IBD are UC and CD with different clinical, pathogenic, and biomolecular properties. Some investigations reported that IBD is a heterogeneous medical condition distinguished by inflammation of the gastrointestinal tract due to the unusual response of aggressive types of T-cells to luminal microbiota in genetically susceptible patients [3]. Several mediators involved in inflammation and immune responses are represented to impact on IBD, including pro-inflammatory cytokines including tumor necrosis factor (TNF), Interferons (IFN-γ), interleukins (IL-6, IL-12, IL-21, IL-23, IL-17) and anti-inflammatory cytokines (IL-10, TGFβ, IL-35, etc.). CD is usually characterized by an increased secretion of IL-12, IL-23, IFN-γ, and IL-17 by Th1 and Th17 cells while Th2 and Th9 cells are considered in UC by secretion of IL-13, IL-5, and IL-9. Several studies were investigated about cytokines effects in initiating, mediating, perpetuating, and controlling intestinal
inflammation and tissue injury because they are the crucial parameters in the pathogenesis of IBD and may have potential therapeutic targets [5]. In addition, NLRP1, NLRP3, NLRC4, absent-in-melanoma 2, and pyrin (types of pattern-recognition receptors (PRRs)), construct inflammasomes. NLRP3, one of the NOD-like receptor family member, has been investigated more than other inflammasomes intimately pertinent to IBD. The principal clinical expressions of most patients with IBD consist of uncommon levels of the NLRP3 inflammasome and pro-inflammatory cytokines [22]. Moreover, oxidative stress has been shown to participate in major mechanisms of some disorders such as IBD. Uncontrolled and persistent oxidative and nitrosative stress with overproduction have an important effect on chronic disorders such as IBD as can be seen in Figure 1 [24]. The principal ROS consist of superoxide anion (O$_2^-$), nitric oxide (NO), hydroxyl radical (·OH), hydroperoxyl radical (O$_2$H), hydrogen peroxide (H$_2$O$_2$), and singlet oxygen (O$_2$) [25]. Antioxidant equilibrium can eliminate the harmful effects of ROSs and RONs. They classify intracellular and plasma antioxidant mechanisms [23].

2.1 Risk factors

There are several risk factors of IBD, including lifestyle, age, genetic and immune response. Diet, in particular, meats and oily foods, and exposure to different contaminations and antibiotics may change the gut microbiota resulting in IBD. While consumption of vegetables, fruits, and fish can reduce the risk of IBD. Indeed, various food products may change gut permeability and cause dysfunctional intestinal mucosa [26]. Patients diagnosed with IBD also have the lower health-related quality of life and risk factor for colon cancer [27]. Meanwhile, it has been established that functional foods rich in grape seed oil [28] extra virgin olive oil, canola oil, and rice bran oil [29] or herbal medicine extract such as *Pistacia atlantica* [27] are preferable means for overcoming the limitations of the current drug treatments of UC. In addition, various intestinal immune cells are responsible against foreign antigens.

![Figure 1](image-url).

*The source of ROS formation and effects of ROS accumulation [23].*
and secret some pro-inflammatory mediators as a result of their activation. However, upregulation of these pro-inflammatory mediators caused perpetuates the intestine’s inflammatory response in these conditions. Therefore, overexpression of pro-inflammatory cytokines plays a crucial role in IBD. However, the types of inflammatory reaction of the immune response are different in CD and UC [30]. Thus, the utilization of anti-inflammatory bioactive compounds is a safe approach for the treatment of IBD by regulating pro-inflammatory mediators.

3. Essential oils (EOs)

EOs are volatile compounds that are found in different parts of medicinal and herbal plants. Most of the EOs are known as generally recognized as safe (GRAS) and can be used as food preservatives or flavoring agents. EOs consist of various active constituents with numerous biological properties that are influenced by their chemical diversity and quantities [31]. EOs are more complex and comprise several components at different concentrations. They are defined by some main constituents at relatively high concentrations (> 20%) compared to other components present in trace amounts. EOs are classified into two main groups including terpenes/terpenoids and aromatic/aliphatic compounds. The various biological attributes of EOs are related to their major compounds [32]. In addition, phenolic compounds, plant secondary metabolites which consist of a minimum aromatic ring with at least one or more hydroxyl groups, are sub-classified into two groups: flavonoids and non-flavonoids. Flavonoids are subdivided into many groups comprising flavones, flavan-3-ols, dihydrochalcones, dihydroflavonols, flavonols, flavanones, proanthocyanins, anthocyanins, chalcones, isoflavones, and aurones. Non-flavonoids comprise phenolic acids, stilbenes, lignans, coumarins, curcuminoids, and tannins. The important source of phenolic compounds are nuts, soy products, cocoa, vegetables, cereals, red wine, soy products, whole grains, and olive oil. Cardio-protective and anti-inflammatory traces of polyphenolics have been studied and probably have a positive effect on IBD and IBS [4]. Figure 2 depicts the chemical structure of some constituents of EOs.

EOs have recently gained increasing attention with their potential biological activates and have been largely used in the pharmaceutical industry as safe and natural

Figure 2.
Some of the main bioactive constituents of EOs.
medicines. They are well recognized to possess antioxidant, anti-inflammatory, antimicrobial, antiviral, and anticarcinogenic properties [33]. Recently, some investigations confirmed that EOs from various plants have anti-inflammatory activity by reducing or inhibiting the production of pro-inflammatory mediators [34]. EOs exhibit their anti-inflammatory mechanisms by reducing the gene expression of pro-inflammation cytokines (TNF-α, IL-1β, IL-6 and IFN-γ) and enzymes such as inducible nitric oxide synthase (iNOS), cyclooxygenase (COX-2) and Myeloperoxidase (MPO) which caused upregulation of inflammatory responses.

3.1 Essential oils anti-inflammatory activity

Numerous investigations reported that intake of EOs appeared to have protective activity against pro-inflammatory products. For instance, Amorim et al. [35] suggested that Citrus species EOs possess anti-inflammatory activity. This study showed that the C. limon, C.latifolia, Citrus aurantifolia and C. limonia (10–100 mg/kg, p.o.) EOs caused reducing the cytokines mediators such as TNF-α, interleukin-1β (IL-1β), and interferon-γ (IFN-γ) in carrageenan-induced inflammation in a subcutaneous air pouch (SAP) model. The anti-inflammatory activity of C. limon and C. limonia might be related to the high amounts of limonene. Another study suggested significantly decreased IL-6 secretion by Pinus EOs. They explained that the low concentration (0.01%) of Pinus heldreichii Christ (Pinaceae), Pinus peuce Griseb and Pinus mugo EOs can decrease the IL-6 production up to 60%. The EOs of Pinus mainly consist of α-pinene [34]. The chemical structure of EOs from leaves of Ocimum basilicum, Ocimum americanum, Hyptis spicigera, Lippia multiflora, Ageratum conyzoides, Eucalyptus camaldulensis and Zingiber officinale was also investigated. α-terpineol (59.78%) and β-caryophyllene (10.54%) for O. basilicum; 1, 8-cineole (31.22%) and camphor (12.730%) for O. americanum; β-caryophyllene (21%) and α-pinene (20.11%) for H. spicigera; p-cymene (25.27%), β-caryophyllene (12.70%), thymol (11.88) for L. multiflora; precocene (82.10%) for A. conyzoides; eucalyptol (59.55%) and α-pinene (9.17%) for E. camaldulensis; arcurcumene (16.67%) and camphene (12.70%) for Z. officinale were determined as the main compositions of EOs which have impact on their antioxidant and anti-inflammatory attributes. Among all EOs, Z. officinale (0.4 mg/ml) showed the highest anti-inflammatory activity by 50.9% of inhibition of lipoxygenase. The anti-inflammatory activities were investigated according to the prevention effect of lipoxygenase which plays a significant role in several human cancers [36]. A study also investigated the anti-inflammatory attributes of Thymus vulgaris EOs. They found that EOs can cease the 5-lipoxygenase activity and lower the TNF-α, IL-1β, and IL-8 secretion in THP-1 cells [37]. Siani et al., [38] also investigated the anti-inflammatory activity of Syzygium cumini and Psidium guajava EOs in lipopolysaccharide (LPS)-induced pleurisy model. Both types of EOs showed anti-inflammatory properties via prevention influence on eosinophil and, to a lesser extent, neutrophil and mononuclear cell migration. This effect of Syzygium cumini and P. guajava mainly is contributed to their compositions including limonene, ocimeses, α-pinene, and Caryophyllene-type sesquiterpenes. Furthermore, some substances have synergistic effect in combination together such as α-pinene and mono- or sesquiterpenes [38]. Thymus EOs decreased the gene expression of nuclear factor-kappa (NF-k)B, COX-2 and iNOS, consequently causing lower production of NO and TNF-α [39]. The carvacrol and thymol are two main constituents of thyme EOs which are responsible for thyme anti-inflammatory attributes by inhibiting of cyclooxygenase activity and NO production [40]. Similar observations were revealed
about the anti-inflammatory properties of *T. caespititius* [41] and *Thymus pulegioides*, *T. praecox* subsp. *polytrichus*, *T. vulgaris*, *Thymus serpyllum* subsp. *serpyllum*, *T. longicaulis*, *T. striatus* extracts [42]. Moreover, EOs isolated from algae have anti-inflammatory activity as Dhara and Chakraborty [43] reported that xenicane-type diterpenoid from *Sargassum ilicifolium* exhibit the inhibitory effect against pro-inflammatory enzymes such as 5-lipoxygenase and COX-2.

### 3.2 Protocols of inflammatory bowel disease treatment by essential oils

There are several studies about the therapeutic and pharmaceutical attributes of EOs related to various diseases [43]. An alternative approach to the treatment of IBDs in the administration of EOs and several investigations are presented in Table 1.

<table>
<thead>
<tr>
<th>Essential oil</th>
<th>Study design</th>
<th>Major results</th>
<th>Reference</th>
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</table>
| Lavender EO (LEO)                 | DSS- induced colitis in mice              | • Alleviate DSS-induced colonic, adjust the rate of inflammatory factors.  
• Alleviate UC mice mucosal injury and prevent inflammatory reactions.                      | Wang, et al. [16] |
| Crude & Bran-Processed            | LPS- induced inflammatory injury of human | • Anti-inflammatory trace of ALEO on LPS-induced HCoEpiC.  
• Bran-processed AL essential oil was more effective.  
• Mechanism: IKK/NF-κB signaling pathway.                | Yu, et al. [44]  |
| Atractylodes lancea EO (ALEO)     | colonic epithelial cells                  |                                                                                                                                             |
| Satureja Khuzestanica Jamzad EO   | Acetic acid-induced colitis in mice       | • SKEO possesses antioxidant, antimicrobial, anti-inflammatory, and antispasmodic effect.  
• Protects animals against experimentally induced IBD.                                         | Ghazanfari, et al. [45] |
| (SKEO)                            | *In vitro* study in human Peripheral Blood Mononuclear Cells | • The two phophytins inhibited the production of NF-Kb.  
• They have the anti-inflammatory activity of the Huacatay extracts and their use in the treatment of stomach and intestine discomfort.  
• Aqueous and hydroalcoholic extracts possessed anti-inflammatory activity in vitro.  
• The hydroalcoholic extract was the most active (IC50 between 59.72 and 66.42 μg/mL) in all cell lines. | Ticona, et al. [46] |
| Hydroalcoholic extract of          |                                             |                                                                                                                                             |
| Tagetes minuta *L.*               |                                             |                                                                                                                                             |
| Rosmarinus officinalis L. EO      | TNBS-induced colitis in rats               | • Both the RHE and ROEO had an anti-colicitic effect.  
• Can be applied for remedy of inflammatory bowel diseases in traditional medicine.  
• Alpha-pinene had an inhibitory effect on the nuclear translocation of factor-kappa B (NF-kappa B). | Minaiyan, et al. [47] |
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<th>Essential oil</th>
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<tr>
<td>Cinnamon EO (CEO)</td>
<td>DSS-induced colitis in mice</td>
<td>• Improving the intestinal flora imbalance by the inhibitory trace of CEO on IBD.&lt;br&gt;• TLR4 and TNF-α were positively correlated with Helicobacter modified.</td>
<td>Li, et al. [48]</td>
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<td><em>Cuminum carvi</em> L. EO (CCEO)</td>
<td>TNBS-induced colitis in rats</td>
<td>• CCEO (hydroalcoholic extract and EO) own anti-colitis activity.</td>
<td>Keshavarz, et al. [49]</td>
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<tr>
<td><em>Ocimum basilicum</em> L. EO (OBOEO)</td>
<td>Acetic acid-induced colitis in rats</td>
<td>• 200 and 400 μL/kg of OBOEO decreased the enhancement of myeloperoxidase.&lt;br&gt;• OBOEO possessed anti acetic acid-induced colitis effect.</td>
<td>Rashidian, et al. [50]</td>
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<tr>
<td><em>R. officinalis</em> EO (ROEO)</td>
<td>TNBS-induced colitis in mouse model</td>
<td>• ROEO is able to influence several variables of murine experimental inflammatory models depending on the concentration used.&lt;br&gt;• The anti-inflammatory effects of ROEO should be interpreted carefully due to its time and dose-related effects.</td>
<td>Juhás, et al. [51]</td>
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<tr>
<td><em>Pelargonium graveolens</em> EO (PGEO)</td>
<td>Acetic acid-induced UC in rats</td>
<td>• Significantly lower score values of macroscopic and microscopic characters when compared to the acetic acid-treated group.&lt;br&gt;• Deproherb® inhibited the acetic acid toxic reactions in the rat bowel.</td>
<td>Bastani, et al. [52]</td>
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<td><em>Origanum onites</em> L. EO</td>
<td>TNBS-induced colitis in the rats</td>
<td>• Significant protective effect on the colonic injury.</td>
<td>Dundar, et al. [53]</td>
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<tr>
<td>Limonene from <em>Agastache mexicana</em></td>
<td>Oxazolone-induced colitis in mice</td>
<td>• Antioxidant and anti-inflammatory effect of limonene.&lt;br&gt;• Limonene diminish signaling pathway of iNOS, COX-2, PGE2, TGF-β, and ERK1/2.&lt;br&gt;• Agastache mexicana EO impedes intestinal tissue damage.&lt;br&gt;• Agastache mexicana EO diminishes the myeloperoxidase activity.&lt;br&gt;• Prevention of cytokines such as IL-1, IL-6, TNF-α, and INF-γ expression&lt;br&gt;• Lessening pain in the UC in humans.</td>
<td>Estrella, et al. [8]</td>
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<tr>
<td><em>Foeniculum vulgare</em> EO (FVEO)</td>
<td>Acetic acid-induced colitis in rat</td>
<td>• Diminish the macroscopic and microscopic injuries compared to the acetic acid group.&lt;br&gt;• Diminish the MPO activity and the TNF-α positive cells expression in the colon tissue contrasted to the acetic acid group.&lt;br&gt;• Prevent expression of p-NF-κB p65 protein induced by acetic acid.&lt;br&gt;• Anti-inflammatory activity effect on colitis induced by acetic acid in rats which prevents the NF-κB pathway.</td>
<td>Rezayat, et al. [54]</td>
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</table>
Yu, et al. [44] investigated the anti-inflammatory effect of *Atractylodes lancea* EOs against UC in vitro. They proved that Atractylodes lancea EOs can downregulate the level of IL-6, IL-8, IL-12, IL-1-β, TNF-α, NO, p-IKK-α, p-IKK-β, and NF-κB human colonic epithelial (HcoEpiC) cells induced by LPS- epithelial cells. IKK/NF-κB signaling pathway was the in vitro mechanism.

In vivo experimental studies have shown the therapeutic effects of EOs on UC inflammation. In 2016, Rashidian, et al. [50] conducted a study of the meliorative effect of *O. basilicum* L. EO after two doses in acetic acid-induced rat model. The results showed that the treatment with 200 and 400 μL/kg of EO caused a significantly reduction in the ulcer severity, ulcer area, and ulcer index and confirmed the protective activity of EOs. Moreover, *Lavender* EO has also been shown to improve colonic mucosal injury in dextran sulfate sodium (DSS)-induced UC mice by reducing the inflammatory cytokines levels such as in serum and colon tissue’s EGFR, TNF-α, and IFN-γ. The key pathway in the UC treatment is the Th17 cell differentiation, PI3K-Akt signaling pathway, and Th1 and Th2 cell differentiation of lavender EOs [16]. Estrella, et al. [8] also demonstrated that Limonene from *Agastache mexicana* EO has a potential effect on improving the UC in Swiss Webster mice. They investigated the *A. mexicana* ssp. *mexicana* EO (3–300 mg/kg) activity in an oxazolone-induced colitis model. According to the results, limonene possessed antioxidant and anti-inflammatory bioactivity that caused downregulation of the iNOS, COX-2, PGE2, TGF-β, and ERK1/2 signaling

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### Table 1.

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<td><em>Zanthoxylum bungeanum</em> Pericarp EO (ZBEO)</td>
<td>DSS-induced colitis in mice</td>
<td>• ZBEO increased levels of the commensal bacteria containing <em>Lactobacillus</em> and <em>Bifidobacteria</em>.</td>
<td>Zhang, et al. [55]</td>
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<td></td>
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<td>• ZBEO reduced <em>E. coli</em> levels in the feces of mice.</td>
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<td></td>
<td></td>
<td>• Supplementation with ZBEO might provide a new dietary strategy for the prevention of UC.</td>
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<td>Thyme EO (TEO)</td>
<td>TNBS- induced colitis in mice</td>
<td>• Caused a significant inhibition of total mRNA IL-1β expression in the - mouse colon.</td>
<td>Juhás, et al. [56]</td>
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<td></td>
<td></td>
<td>• Decreased the macroscopic and microscopic scores of colitis.</td>
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<td>• In 1250 ppm concentration in the diet increased ear edema induced by oxazolone application in mice.</td>
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<td></td>
<td></td>
<td>• Can affect murine experimental inflammatory models depending on the concentration used.</td>
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<tr>
<td>Garden thyme EO (GTEO)</td>
<td>Intestinal inflammatory status of rainbow trout (<em>Oncorhynchus mykiss</em>)</td>
<td>Dietary GTEO supplementation:</td>
<td>Ghafarifarsani, et al. [57]</td>
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<td></td>
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<td>• Ameliorated the increased TNF-α.</td>
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<td>• Transforming growth factor-β and interleukin-8 expression induced by dietary AFB1 contamination.</td>
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<tr>
<td></td>
<td></td>
<td>• Significantly enhanced interleukin-1β expression.</td>
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pathway. Thus, EOs prevented intestinal tissue damage and reduced myeloperoxidase activity, macroscopic damage reducing and inhibition of cytokines expressions such as IL-1, IL-6, TNF-α, and INF-γ. Moreover, EOs have antinociceptive attributes resulting in lower pain in the UC in human. It has been suggested that 200 and 400 mg/kg of F. vulgare EOs decrement the TNF-α positive cells expression of colon tissue. They have a considerable effect on rat inflammatory of acetic acid-induced colitis by the prohibition of NF-kB pathway [54]. Furthermore, it has been reported that both Carum carvi L. (caraway) EOs and hydroalcoholic extract own anti-inflammatory properties in colitis induced by trinitrobenzene sulfonic acid (TNBS) in rats. The ulcerative lesion index would be prevented by 100–400 μl/kg orally administration of C. carvi L. EOs. The inflammatory cytokines and chemokines can be reduced by the caraway terpenoid, flavonoids, fatty acids, triacylglycerols, polysaccharides, lignin, and polycyacylenic compounds, resembling the glucocorticoids mechanism. It seems that caraway reduces the production of prostaglandin E2 and increases the production of leukotriene B4 in human polymorphonuclear leucocytes [49]. A similar observation was reported by Minaian, et al. [47] who study the anti-colitis activity of Rosmarinus officinalis L. EOs (100, 200, and 400 μl/kg) and extract (100, 200, and 400 mg/kg) in rats colitis induced by TNBS. Moreover, 100–400 mg/kg of Pelargonium graveolens EOs own dose-independent anti-inflammatory potential in acetic acid-induced rat UC induced by acetic acid thus P. graveolens EOs diminish the oxidative stress by inhibiting the production of free radicals, and in the end preventing the increase of inflammation [52]. By adjustment of intestinal microflora, EOs effect on IBD. For example, cinnamon EOs administration amends the diversity and richness of the intestinal microbiota, reduces in Helicobacter and Bacteroides, and increase in Bacteroidales_S24–7 family in mouse colitis induced by DSS. There is a positive correlation between TNF-α with Helicobacter. It seems that the protective attributes of cinnamon EOs against IBD is attributed to cinnamaldehyde [48]. EOs of R. officinalis also is full of terpenes and 1.8-cineole is the main compound of its EO by antinociceptive and anti-inflammatory trace. This terpene remarkably prevents the production of cytokines in lymphocytes and monocytes [51].

4. Conclusion

EOs are a blend of volatile, aromatic, and natural substances extracted as secondary metabolites from different parts of plants or algae. EOs have a great potential to be used as a part of pharmaceuticals, nutraceuticals, and functional foods because of their broad range of biological activities. In the recent years, EOs have gained much attention due to their antioxidant and anti-inflammatory attributes. The present chapter revealed encouraging results about numerous EOs being used in different IBD and UC animal models. IBD and its attributed disorders such as CD and UC dramatically increase in recent years because of various reasons such as age, genetics, immune response, and lifestyle, in a particular diet. While several studies confirmed that the EOs exhibit anti-inflammatory effects via in downregulation of gene expression of cytokines pro-inflammatory and related enzymes. This chapter suggests the utilization of EOs as healthy food ingredients or dietary supplements with anti-inflammatory characteristics.

Conflict of interest

The authors declared no conflict of interest.
Author details

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References


[14] Almeer RS et al. Ziziphus spinacristi fruit extract suppresses oxidative stress and p38 MAPK expression in ulcerative colitis in rats via induction of Nrf2 and HO-1 expression. Food and Chemical Toxicology. 2018;115:49-62


[16] Wang Y et al. The mechanism of lavender essential oil in the


[25] Ferreira ICdV. Pharmacological screening of essential oils for identification of lead compounds to target inflammatory bowel disease; 2011


[33] Shaaban HA, El-Ghorab AH, Shibamoto T. Bioactivity of essential oils


[39] Lorenzo JM et al. Understanding the potential benefits of thyme and its derived products for food industry and consumer health: From extraction of value-added compounds to the evaluation of bioaccessibility, bioavailability, anti-inflammatory, and antimicrobial activities. Critical Reviews in Food Science and Nutrition. 2019;59(18):2879-2895


