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A Comparative Review of Curcumin and Boswellia Serrata as A Potential Therapy for Crohn's Disease

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Abstract

The present narrative comparative assessment discusses the therapeutic potential of both curcumin and Boswellia serrata in CD with specific emphasis on their pharmacological mechanisms, experimental and clinical evidences, efficacy and safety and therapeutic limitations. The Curcuma longa is rich in curcumin, which exhibits multiple anti-inflammatory, antioxidant and immunomodulatory effects, including modulation of the NF-κB, TLR4, MAPK, COX-2, cytokines and intestine barrier pathways. The major anti-inflammatory effect of Boswellia serrata and its boswellic acids is through the inhibition of 5-lipoxygenase and leukotriene synthesis, in addition to other effects on inflammatory signalling. Data from preclinical studies indicate that both agents are biologically plausible, and data from clinical studies are relatively scarce and varied. However, evidence is more robust for the use of curcumin specifically in CD, although its clinical use is less well established, with the bulk of the evidence coming in the context of ulcerative colitis. There are also conflicting results from clinical trials of Boswellia serrata for the treatment of CD. In general both agents appear to have potential as complementary therapies, but there are some limitations in terms of bioavailability, standardisation, formulation, dosage and clear clinical evidence that need further study before they can be used as routine therapies.

Keywords: Crohn's disease, Curcumin, Boswellia serrata, Inflammation, Gut barrier, Phytotherapy, Complementary therapy

Introduction

Crohn's disease (CD) is a chronic, relapsing inflammatory bowel disease (IBD) with inflammation occurring in the entire length of the gastrointestinal tract, most frequently in the terminal ileum and colon. The disease is a complex interplay of genetic susceptibility and dysregulated immune responses, intestinal microbiota and environment **(Caruso et al., 2025).** Abdominal pain, diarrhea (persistent), weight loss, fatigue, and rectal bleeding are the clinical problems encountered by the patients, and later, if the disease is prolonged or severe, it can lead to strictures, fistulas, abscesses, nutritional deficiencies and intestinal surgery. Crohn's disease often has a relapsing and remitting course of disease that is different from acute gastrointestinal disorders, and requires prolonged disease management and surveillance. **(Cockburn et al., 2023)**

IBD is now an important public health problem worldwide, especially in newly industrialised regions, and the burden of Crohn's disease rising, particularly in these areas. It is more common in North American and European populations, but has been reported to be rising in Asian populations. In 2025, a systematic review of over 9,000 adults with IBD from 21 studies in South Asia found that while UC was more common than Crohn's disease at around 2:1, there was a high degree of clinical and phenotypic heterogeneity within Crohn's disease across the region **(Niriella et al., 2025).** Crohn's disease was once regarded as a relatively rare condition in India, but is increasingly being reported. The Indian Society of Gastroenterology survey (of 1,159 analysed patients) showed that 409 patients (35.3%) have Crohn's disease, establishing its existence within the Indian population of IBD. **(Makharia et al., 2012)**

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The current management is to induce and maintain remission, control symptoms and prevent complications, and achieve sustained mucosal healing. Treatment with targeted therapies like corticosteroids, immunomodulators and biologics has significantly enhanced the management of the disease. However, there may be considerable variation in treatment response and long-term therapy may have side effects, resistance, and cost and availability issues. Therefore, there has been an increase in interest in complementary therapies that can be used in conjunction with existing pharmacotherapy, and not as an alternative therapy. **(Yeshi et al., 2024)**

Need for Novel and Complementary Therapeutic Approaches

Crohn's disease is a chronic and recurrent condition which necessitates the development of therapeutic approaches that are able to modulate the inflammation with an acceptable safety and tolerability profile. The action of conventional medicines is mainly focussed on inflammatory and immune pathways, and they might not be sufficient to fully modulate the processes that underlie the connection between oxidative stress, intestinal barrier dysfunction and microbial imbalance. This has led to the research of naturally occurring substances with multiple biological properties. **(Akkoç, 2025)**

In particular, herbal medicines are of great interest as many plant-based compounds have anti-inflammatory, anti-oxidative and immunomodulatory properties. But their clinical use must be evaluated with great caution due to the vastly different quality of evidence, different formulations, doses, and duration of treatment. A systematic review of herbal treatments in the field of IBD revealed that there are 21 RCTs that included 1,484 subjects; however, the current evidence is limited and heterogeneous **(Ng et al., 2013).** Therefore it would be important to keep in mind that the use of complementary therapies may be a valuable additional resource to conventional therapy, and should not be viewed as a substitute for it.

Rationale for Comparing Curcumin and *Boswellia serrata*

Curcumin and Boswellia serrata are especially interesting since they are thought to possess anti-inflammatory effects and exert their activity through, in part, different mechanisms. The main bioactive polyphenolic compound of Curcuma longa, curcumin, has been shown to possess anti-inflammatory, antioxidant, immune-regulatory and could be microbiota-modulating properties. In IBD, clinical evidence is encouraging, but is much stronger for ulcerative colitis than Crohn's disease. A systematic review and meta-analysis of 13 placebo controlled trials was conducted in 2025 revealing that curcumin showed more efficacy than placebo in ulcerative colitis, but not Crohn's disease for clinical or endoscopic remission. **(Mohseni et al., 2025)**

Boswellia serrata, or Indian frankincense, is a plant that has boswellic acids which have been studied for their anti-inflammatory effects. Importantly, there is evidence for the efficacy of Boswellia serrata resin extracts from double-blind clinical studies in Crohn's disease, although the overall evidence is not as strong for definitive suggestions for therapeutic use. **(Holleran et al., 2020), (Davila & Papada, 2023)**

A direct comparative evaluation is therefore warranted since they both have overlapping anti-inflammatory and anti-oxidative effects but contain different main active components, targets, pharmacological properties and clinical evidence. By comparing their mechanism of action, efficacy, safety, limitations, and applicability to Crohn's disease, one can gain some insight on the therapeutic potential of the compound and areas where there is a lack of scope in evidence, especially in India and the South Asian region.

Research Methodology

In this study, the authors use a narrative comparative review design to compare the published evidence on the use of curcumin and Boswellia serrata in the treatment of Crohn's disease. Peer-reviewed Journal articles, Systematic reviews, Meta-analyses, Clinical trials and Pre-clinical studies were obtained from these databases PubMed, ScienceDirect, Google Scholar and other scientific sources. Literature was

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chosen based on the relevance to Crohn's disease, inflammatory bowel disease, pharmacological mechanisms, therapeutic efficacy and safety. More recent evidence was emphasized and important earlier clinical studies were included where they provided evidence to build on. The literature retrieved was critically analysed and organized thematically into pharmacological mechanisms, Experimental findings, Clinical outcomes, Safety, Bioavailability, Formulation and limitations of therapy. The results for curcumin and Boswellia serrata were then compared to determine similarities, differences and gaps in knowledge and how they could complement each other in treatment of Crohn's disease.

Aim

To comparatively evaluate the pharmacological mechanisms, therapeutic potential, clinical evidence, efficacy, safety, and limitations of curcumin and Boswellia serrata as potential complementary therapies for Crohn's disease.

Objectives

1. To examine the anti-inflammatory, antioxidant, immunomodulatory, gut-barrier and microbiota-related mechanisms of curcumin and Boswellia serrata relevant to Crohn's disease.
2. To critically compare preclinical and clinical evidence regarding their efficacy, symptom improvement, safety and tolerability in inflammatory bowel disease, with particular emphasis on Crohn's disease.
3. To identify the major challenges associated with their therapeutic application, including bioavailability, extract standardisation, dosage, formulation and limitations of existing clinical evidence.

Pathophysiology and Therapeutic Targets in Crohn's Disease

Crohn's disease (CD) is a multifactorial inflammatory disease in which genetic susceptibility, inappropriate immune activation, oxidative stress, imbalance of the intestinal flora and epithelial barrier dysfunction play a role in causing chronic inflammation in the gut. CD is not a single pathological process, but rather one that is a continuous interaction between the intestinal epithelium, gut microorganisms, and innate and adaptive immune systems. This complex pathogenesis is especially important when plant-based compounds such as curcumin and Boswellia serrata are taken into account, as both compounds have biological activities that may effect more than one of these pathways. Recent reviews still pinpoint microbiota dysbiosis, epithelial barrier disruption and abnormal immune signalling as key points of the pathogenesis of CD. **(Jia & Wang, 2026), (An et al., 2026)**

Intestinal Inflammation and Immune Dysregulation

The intestinal immune system is usually tolerant to commensal microorganisms but responsive to pathogens. This balance is disturbed in CD and leads to high and persistent mucosal immune activation. Variants in genes like NOD2, ATG16L1 and IRGM affect the recognition of microbes, the process of autophagy and the function of the Paneth cells, making it easier for the body to have an abnormal immune response in the intestine. Dysfunction of epithelial and innate immune cells can subsequently facilitate excessive activation of macrophages, dendritic cells and other inflammatory cells. **(An et al., 2026)**

The adaptive immune response plays a role as well, especially IL-12/IL-23–Th1/Th17. The production of inflammatory cytokines such as tumour necrosis factor-alpha (TNF-α), IL-1β, IL-6, IL-12 and IL-23 leads to persistent tissue inflammation and mucosal damage. Biological drugs targeting TNF and IL-12/23 are effective in treating IBD, and IL-23 has become a key therapeutic target in modern IBD treatment. **(Neurath, 2024), (Moschen et al., 2019)**

Role of Oxidative Stress and Inflammatory Mediators

Another aspect of the CD pathophysiology is oxidative stress. In the event of active inflammation activated neutrophils and macrophages produce higher numbers of Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS). If the

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production is higher than the body's own antioxidant levels, then there is the possibility of oxidative damage occurring to lipids, proteins, DNA and cell membranes. Both intestinal tissue oxidative stress and systemic oxidative stress have been shown and are closely related to immune dysregulation and microbial imbalance in patients with Crohn's disease. **(Alemany-Cosme et al., 2021)**

One of the more significant pathways is nuclear factor-kappa B (NF-κB). Microbial signals and cytokines, including the inflammatory mediator, TNF-α, can activate NF-κB, which leads to increased transcription of inflammatory mediators. This pathway can be further stimulated by ROS which produces a vicious cycle between inflammation and oxidative stress, and then again between oxidative stress and inflammation. The activation of NF-κB can, in turn, up-regulate expression of the pro-inflammatory cytokines TNF-α, IL-6, IL-8, inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) and can also promote epithelial barrier damage through the action of TNF-α. **(Biasi et al., 2013), (Tian et al., 2017)**

Gut Microbiota and Intestinal Barrier Dysfunction

The gut microbiota plays a crucial role in the regulation of intestinal homeostasis, in the development of immune system and in the synthesis of metabolites like short chain fatty acids (SCFAs), specifically butyrate. For Crohn's disease, dysbiosis has been defined as changes in the composition and function of the microbial community. The reduction of potentially beneficial organisms, like Faecalibacterium prausnitzii and the increase of potentially harmful organisms, such as Enterobacteriaceae and adherent-invasive Escherichia coli (AIEC) have been described in the recent literature. These changes that are made by microbes can amplify inflammatory signalling and aid in the progression of disease. **(Jia & Wang, 2026), (Xu et al., 2025)**

Intestinal epithelial barrier is a physical and immunological barrier that separates intestinal lumen from intestinal tissues. Paracellular permeability is regulated by tight-junction proteins, including occludin, claudins and zonula occludens-1 (ZO-1). In CD, inflammatory cytokines, ROS and microbial products may disrupt the organisation of tight-junctions, leading to increased intestinal permeability. Damage to the barrier leads to increased exposure of immune cells to bacterial products and antigens from the food, further activation of NF-κB and cytokine-mediated inflammation. **(Jia & Wang, 2026)**

Thus, therapeutic targets in CD go beyond just the control of inflammation. Combination therapies that combine anti-inflammatory signalling and anti-oxidative effects with epithelial barrier integrity and possibly some effect on the microbial homeostasis, may have additional therapeutic potential. This mechanistic similarity is important for the study of curcumin or Boswellia serrata in Crohn's disease, given the fact that both are active as anti-inflammatory and antioxidant agents which may be able to directly affect multiple aspects of Crohn's disease processes.

Curcumin: Pharmacological Profile and Therapeutic Potential

Chemical Characteristics and Sources

Curcumin is the yellow-orange polyphenolic compound naturally found in the rhizome of Curcuma longa L. (turmeric). C. longa is a member of Zingiberaceae family and is used in Indian and Asian traditional medicine for a long time. Curcumin is also known as diferuloylmethane or 1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione. It has two aromatic rings linked to each other by a seven carbon chain including a β-diketone functional group, structural features which are responsible for its antioxidant and biological activities. **(Indira Priyadarsini, 2013), (El-Saadony et al., 2025)**

The turmeric powder is a combination of various curcuminoids, including curcumin, demethoxycurcumin and bisdemethoxycurcumin. In the case of therapeutic research, purified curcumin or standardised preparations of the curcuminoids are typically used instead of regular turmeric from the kitchen. One of the limitations of its use as a drug is its poor solubility and rapid metabolism and systemic elimination after oral intake. For this reason, current research has focused on the use of phospholipid

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complexes, nano particles, liposomes, micelles and other delivery systems as a means of enhancing exposure. After a review of human pharmacokinetic studies, 11 bioavailable curcumin formulations were identified, where some formulations exhibited bioavailability greater than 100-fold than conventional curcumin.**(Jamwal, 2018)**

Anti-inflammatory and Immunomodulatory Mechanisms

Curcumin possesses a wide and multi-target anti-inflammatory activity related to the pathogenesis of Crohn's disease. One of its most thoroughly studied activities is its ability to inhibit the NF-κB signalling pathway. Curcumin is able to block IκB degradation and IKKβ activity, leading to decreased NF-κB nuclear translocation and inflammatory gene transcription. This is important as NF-κB is responsible for the activation of many mediators associated with intestinal inflammation. **(Lin et al., 2022), (Burge et al., 2019)**

It is also found that experimental studies have shown that curcumin affects TLR4/MyD88/MAPK/NF-κB signalling which also has the capability of dampening down inflammatory downstream activation. Anti-inflammatory effects reported include: suppression of TNF-α, IL-1β, IL-6, IL-8, COX-2 and inducible nitric oxide synthase. Curcumin could also interact with other pathways that regulate activation of inflammatory cells and epithelial responses such as PPAR-γ, MAPK, STAT3 and others. **(Lin et al., 2022), (Sahoo et al., 2023)**

These are a number of actions that endow curcumin with a significant immunomodulatory property: it does not act on only one cytokine, but can potentially affect multiple parts of the inflammatory cascade. In CD, the interactions between the epithelial cells, innate immune cells, adaptive immune responses and microbial signals cause inflammation, making this multi-target activity particularly interesting.

Antioxidant and Gut-Protective Effects

Curcumin also has anti-inflammatory signalling properties and direct and indirect antioxidant properties. It might be able to act as a scavenger of reactive oxygen species through its phenolic groups and can affect the antioxidant systems of cells, which can help reduce oxidative damage. Some experimental research on the treatment of IBD has shown that curcumin has the ability to reduce the levels of lipid peroxidation and inflammatory tissue damage. **(Blagov et al., 2023)**

Curcumin can also act as a protectant of the intestinal barrier. It has been shown to affect tight-junction proteins and epithelial signalling, such as ZO-1 and claudins, as well as pathways like MAPK, AMPK, and NF-κB. These effects may contribute to decreasing epithelial permeability and limit additional exposure of intestinal immune cells to luminal microbial products. **(J. Peng et al., 2023)**

Interaction with the intestinal microbiota is another mechanism that could be relevant. While the systemic absorption is limited, a significant amount of curcumin may remain in the gastrointestinal tract affording a chance for local activity in the gut and modulation of the gut flora. In this context, the present research investigates the microbiota regulation and protection and anti-inflammatory activity of curcumin as parallel elements of its possible therapeutic application in the case of IBD. **(Zhu & He, 2024), (Wu et al., 2026)**

Evidence from Preclinical and Clinical Studies

Curcumin has been shown to have potential in intestinal inflammation in preclinical studies. Chemically induced colitis models have been used to report decrease in inflammatory activity, infiltration of neutrophils, NF-kB signalling and inflammatory cytokines. These results provide biological plausibility, but the results of animal models do not automatically translate to Crohn's disease patients.

In the case of clinical evidence, more caution is needed. The majority of the human data on the use of curcumin in IBD is for ulcerative colitis, not Crohn's disease. For instance, in patients with ulcerative colitis, an 8 RCTs study published in the systematic review/meta-analysis from 2024 demonstrated that curcumin treatment provided better clinical remission (RR 2.33, 95% CI 1.25–4.34; P=0.008). This evidence should not be taken directly to CD, however. **(Z. Peng et al., 2025)**

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More importantly for the present review, a recent systematic review of 13 placebo-controlled RCTs revealed that curcumin had clinical benefits especially in ulcerative colitis, while curcumin was not superior to placebo in Crohn's disease, either clinically or endoscopically, for remission. The authors thus judged the evidence for CD as inconclusive. This distinction is important to take into consideration when considering the use of curcumin as a possible treatment for Crohn's disease. **(Mohseni et al., 2025)**

Table 1: Pharmacological Actions and Evidence Relevant to Curcumin in Crohn's Disease.

Pharmacological aspect	Principal mechanism/effect	Relevance to Crohn's disease	Supporting reference
Chemical profile	Polyphenolic diferuloylmethane from Curcuma longa	Provides the principal bioactive basis for turmeric-derived preparations	**(El-Saadony et al., 2025)**
Anti-inflammatory activity	Inhibition of NF-κB, MAPK and inflammatory mediators	May reduce excessive intestinal inflammatory signalling	**(Wu et al., 2026)**
Immunomodulation	Regulation of cytokines and immune-cell signalling	Potential modulation of abnormal intestinal immune responses	**(Burge et al., 2019)**
Antioxidant activity	ROS reduction and enhancement of antioxidant defence	May limit oxidative injury associated with intestinal inflammation	**(Blagov et al., 2023)**
Barrier protection	Regulation of tight-junction proteins and epithelial pathways	May improve epithelial integrity and reduce permeability	**(J. Peng et al., 2023)**
Clinical evidence	Benefit demonstrated more consistently in UC than CD	Evidence for Crohn's disease remains insufficient	**(Mohseni et al., 2025)**
Bioavailability	Poor solubility, absorption and rapid metabolism	Major obstacle to translating pharmacological activity into clinical efficacy	**(Jamwal, 2018)**

Overall, curcumin has a strong mechanistic and preclinical rationale especially in terms of anti-inflammatory, antioxidant and epithelial-protective properties. However, the clinical evidence specifically for Crohn's disease is limited and should be separated from the much better evidence for ulcerative colitis. It has also low bioavailability, and there is significant difference in bioavailability between formulations, which further hinders comparison between studies. Therefore, the use of curcumin is more likely to be used as a potential adjunctive therapy, which needs to be further studied in relation to its efficacy for the treatment of Crohn's disease than it is to be considered as a proven alternative treatment.

Boswellia serrata: Pharmacological Profile and Therapeutic Potential

Botanical Characteristics and Boswellic Acids

Boswellia serrata Roxb. ex Colebr. (Salai/Indian frankincense) is a resin-producing tree of Burseraceae family native of the Indian subcontinent.

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Traditionally the oleo-gum-resin from the trunk and branches are used in Ayurvedic medicine for inflammatory and musculoskeletal diseases. The resin is composed of several biologically active components such as triterpenes, boswellic acids, essential oils and polysaccharides. These include boswellic acids, which are thought to be the main pharmacologically active compounds. **(Davila & Papada, 2023)**

The significant boswellic acids are β-boswellic acid, acetyl-β-boswellic acid, 11-keto-β-boswellic acid (KBA), and acetyl-11-keto-β-boswellic acid (AKBA). AKBA has been of special interest as it interferes with inflammatory pathways. Importantly, the concentration of boswellic acids may vary significantly with different extracts as a result of the source of the plant, the extraction methods and standardisation. Thus, the results of one Boswellia preparation may not be extrapolated to another preparation. This variation is especially crucial for clinical research as standardised preparations are needed to ensure reproducible doses and therapeutic effects. **(Kosolapov et al., 2025)**

Anti-inflammatory Mechanisms

The anti-inflammatory activity of Boswellia serrata is mostly related to its influence on 5-lipoxygenase (5-LOX) and leukotriene biosynthesis. Leukotrienes are lipid-derived inflammatory mediators that play a role in recruitment of leukocytes, vascular response and amplification of inflammation. The boswellic acids, specifically AKBA, may be able to inhibit 5-LOX and thus leukotrienes formation. This mechanism gives a pharmacological basis to explore Boswellia in various inflammatory disorders like small intestinal inflammation. **(Davila & Papada, 2023), (Triantafyllidi et al., 2015)**

Experimental studies indicate that boswellic acids also possess other anti-inflammatory properties such as the ability to modulate NF-κB signalling, cytokine production, neutrophil activity and responses of immune cells. This produces effects which may be more widespread than merely inhibiting leukotriene synthesis. Boswellia may have possible anti-inflammatory actions on a number of inflammatory mediators, therefore it is possible to hypothesize that it can decrease the recruitment and activation of inflammatory cells in the intestinal mucosa. **(C. Peng et al., 2025)**

But the distinction between mechanistic evidence and clinical efficacy should be made. Blocking an inflammatory pathway in cell or animal disease models is not always correlated with useful patient benefit in Crohn's disease. This distinction is significant as the results of clinical trials with Boswellia in the treatment of CD have been inconsistent. **(C. Peng et al., 2025)**

Effects on Intestinal Inflammation and Immune Responses

The possible connection between Boswellia serrata and Crohn's disease is based on its ability to regulate the pathways that participate in inflammation in the gut. In CD, excessive activation of innate immune cells and production of inflammatory mediators, leads to mucosal injury. Boswellic acids can affect leukotriene production and other inflammation pathways, which could decrease inflammatory-cell recruitment and the severity of local inflammation. **(Nischang et al., 2024)**

Preliminary research has shown that Boswellia extracts have anti-inflammatory effects in the intestine in experimental models, and can have an impact on oxidative and inflammatory processes within the intestinal tissue. However, there is much less research available on the subject compared to the experimental literature on curcumin. A comprehensive search for plant-based treatments for IBD also states that the findings of Boswellia serrata in human IBD continue to be inconclusive. **(Davila & Papada, 2023)**

Another is that Boswellia may have a multi-target effect; anti-inflammatory and immunomodulatory. This could be beneficial in CD as there are multiple connected inflammatory pathways rather than one molecular target. However, at present, the mechanisms do not yet suggest whether mucous healing does occur, whether they lead to a sustained remission or even to preventing the complications. **(Laudadio et al., 2024)**

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Comparative Mechanisms of Curcumin and *Boswellia serrata*

Both curcumin and Boswellia serrata have anti-inflammatory and immunomodulatory properties and are currently being explored as potential phytogenic therapies for the management of inflammatory bowel disease, but they have different main molecular targets. Curcumin has a relatively wide range of effects that include pathways related to NF-κB, MAPK, TLR4 and oxidative stress pathways, while boswellic acids are associated with inhibition of 5-lipoxygenase (5-LOX) and leukotriene synthesis, particularly acetyl-11-keto-β-boswellic acid (AKBA). This is a distinction that gives an important basis for comparison with regard to their potential relevance in Crohn's disease (CD).

Molecular Targets and Signalling Pathways

Curcumin has a multi-target mechanism of action. It is one of the main inhibitors of the NF-κB pathway that controls the transcription of many inflammatory genes. Curcumin may inhibit IκB phosphorylation and degradation, which prevents NF-κB activation. It may also modulate MAPK/ERK, PI3K/AKT, JAK/STAT and TLR4 signalling. These effects may lead to diminished cellular responses induced by microbial products and inflammatory cytokines. **(Burge et al., 2019), (Karthikeyan et al., 2021)**

Boswellia serrata, on the other hand, has a special connection with the 5-LOX pathway. The 5-LOX activity is inhibited by Boswellic acids and hence there is a reduction in the biosynthesis of leukotrienes. Leukotrienes are involved in the recruitment and amplification of inflammatory cells and exacerbation of gut inflammation. The activity of the Boswellic acids also seems not to be limited to the lipoxygenase pathway, since they have been reported to affect NF-κB activation as well. (Algieri et al., 2015a)

Therefore, the big difference in mechanism is the effect of curcumin on the signalling networks, while Boswellia has a more singular, 5-LOX/leukotriene-centred mechanism, with further effects on NF-κB and inflammatory signalling.

Effects on Cytokines and Inflammatory Mediators

Both agents have shown the capability to modulate inflammatory cytokines, but the evidence provided is mostly experimental. Curcumin has been reported to downregulate or inhibit the expression or production of inflammation markers such as TNF-α, IL-1β, IL-6, IL-8, IL-12 and IFN-γ through NF-κB and MAPK-related signaling pathways. It could also affect the activation of macrophages and other immune cells. **(Ganji-Arjenaki & Rafieian-Kopaei, 2019), (Caban & Lewandowska, 2022)**

The anti-inflammatory effect of Boswellia has been attributed mainly to its inhibition of leukotrienes formation and also others inflammatory mediators have been suggested. More specifically, blocking 5-LOX may reduce the inflammatory environment downstream that leads to recruitment of leukocytes. The plant could thus impact both the lipid-derived mediators and cytokine-associated inflammatory responses. (Algieri et al., 2015a)**, (Triantafyllidi et al., 2015)**

Importantly, these mechanisms can be additive, not alternative. Curcumin might be able to have a more general regulatory effect on transcription and cells, while Boswellia may have more specific effects on leukotriene-related inflammation. At this time, however, there is not enough clinical data to determine that one mechanism is better suited for CD in particular.

Antioxidant and Immunomodulatory Actions

Another point of common mechanism is oxidative stress. Curcumin may directly bind to ROS and directly modulate the endogenous antioxidant defence systems. Experimental studies of the role of IBD suggest that it may have anti-inflammatory properties in addition to antioxidant properties. Curcumin has additionally proven effects on macrophage activation and inflammatory-cell reactions, supplying an added immunomodulatory part. **(Caban & Lewandowska, 2022)**

Moreover, Boswellia also exhibits antioxidant properties in experimental intestinal inflammatory conditions. It has been reported by studies that Boswellia treatment led to a decrease in lipid peroxidation and increase in the activity of the anti-

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oxidant enzyme, superoxide dismutase (SOD). All of these observations indicate that its intestinal activities might be mediated through inflammatory and oxidative mechanisms. (Algieri et al., 2015a)

The key difference, then, is the emphasis given to the pharmacological activities – curcumin has strong evidence to demonstrate multiple regulation of inflammatory transcription factors, cytokines, and oxidative pathways, whereas the antioxidant evidence is more clearly experimental models for Boswellia.

Potential Effects on Gut Barrier and Microbiota

The intestinal barrier is an important point to consider as inflammatory signalling and epithelial barrier permeability are closely coupled. There is relatively strong experimental support for the benefits of curcumin on maintaining the integrity of epithelial surfaces. Curcumin suppressed inflammatory responses and disruption in intestinal epithelial models by LPS. It has also been linked to the preservation of ZO-1, claudins and occludin, which could help to prevent abnormal paracellular permeability. **(Ghosh et al., 2018), (Wang et al., 2017)**

Recent experiments also indicate that curcuminoids have an impact on the gut microbiome and production of short-chain fatty acids. A 2025 mouse study found that curcumin improved tight junction proteins and increased the relative abundance of butyrate-producing bacteria in a mouse model of DSS-induced IBD. This was an animal study and cannot be used to directly extrapolate clinical efficacy in CD. **(Hsu et al., 2025)**

The specific effect of Boswellia on the gut microbiota and epithelial tight junctions, is relatively less established. The anti-inflammatory and anti-oxidative effects it has demonstrated are more clearly established as a potential intestinal benefit, when compared to its microbiome restructuring. Thus, while Boswellia is currently more well established in the literature with respect to its effects on inflammatory mediators, curcumin has a wider range of experimental data suggesting a role in the microbiota–barrier interaction.

Table 2: Comparative Molecular Mechanisms of Curcumin and *Boswellia serrata*

Mechanistic domain	Curcumin	Boswellia serrata	Comparative interpretation	Key reference
Principal molecular targets	NF-κB, TLR4, MAPK, PI3K/AKT and JAK/STAT pathways	Primarily 5-LOX; also NF-κB-related signalling	Curcumin has broader signalling activity; Boswellia has a prominent 5-LOX target	**(Karthikeyan et al., 2021), (Algieri et al., 2015b)**
Cytokine modulation	TNF-α, IL-1β, IL-6, IL-8, IL-12 and IFN-γ	TNF-α and other inflammatory mediators indirectly influenced through leukotriene suppression	Both can reduce inflammatory signalling through different mechanisms	**(Ganji-Arjenaki & Rafieian-Kopaei, 2019), (Triantafyllidi et al., 2015)**
Lipid mediators	Can influence LOX pathways	Strong association with 5-LOX inhibition and reduced leukotriene synthesis	Boswellia has a more characteristic leukotriene-related action	**(Algieri et al., 2015b)**
Oxidative stress	ROS modulation and antioxidant defence	Reduced lipid peroxidation and increased SOD in experimental models	Both show antioxidant potential, but evidence differs in depth	**(Algieri et al., 2015b), (Caban & Lewandowska, 2022)**

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Intestinal barrier	Evidence for ZO-1, claudins and occludin preservation	Comparatively limited direct evidence	Current experimental evidence favours curcumin	**(Ghosh et al., 2018), (Wang et al., 2017)**
Gut microbiota	Evidence of microbiota modulation and increased butyrate-producing bacteria in experimental IBD	Limited direct evidence	Curcumin has a more developed microbiota-related evidence base	**(Hsu et al., 2025)**
Overall mechanistic profile	Multi-target anti-inflammatory, antioxidant, barrier and microbiota effects	Predominantly 5-LOX/leukotriene-mediated with additional anti-inflammatory effects	Mechanisms are overlapping but pharmacologically distinct	**(Davila & Papada, 2023**)

In conclusion, the comparison suggests that curcumin and Boswellia serrata cannot be viewed as mechanistically similar anti-inflammatory drugs. While Boswellia is significant for its 5-LOX inhibition and modulation of leukotriene mediated inflammation, curcumin seems to have a wider spectrum that also includes inflammatory signalling, oxidative stress, epithelial integrity and possibly microbiota composition. It is important for subsequent comparison of their clinical evidence, because a relationship between molecular activity and clinical effectiveness is not always guaranteed: not all molecular activity is equal in clinical effectiveness, especially in Crohn's disease.

Comparative evidence from experimental and clinical studies.

Preclinical Evidence

There is a strong biological rationale, especially for curcumin and Boswellia serrata, to investigate both in inflammatory bowel disease (IBD) based on the preclinical evidence available, albeit to varying extents and types. In chemically induced inflammation models, it has been shown that curcumin can decrease intestinal inflammatory damage, oxidative damage, and epithelial dysfunction. It has been linked to modulation of NF-κB, MAPK and other inflammatory pathways, and experimental studies have indicated that it may have effects on intestinal permeability and the composition of the microbiota. The study by Fallahi et al. pointed out that evidence moves from in-vitro and animal studies to clinical studies, and there were a lot of differences among experimental models and formulations. **(Fallahi et al., 2021)**

Similarly Boswellia serrata has been shown to have activity in experimental models. In mouse models of chemically induced colitis, the anti-inflammatory effects of extracts containing boswellic acids have been examined. However, there were reports on the beneficial effects of Boswellia preparations in experimental colitis which encouraged further clinical research **(Kiela et al., 2005).** Notably, experimental studies have also shown that Boswellia extract has been protective against inflammatory damage to intestinal epithelial cells, which indicates that the potential activity of Boswellia extract may not be limited to just inhibiting inflammatory mediators. **(Catanzaro et al., 2015)**

Clinical Evidence in Inflammatory Bowel Disease

There are significant differences in the clinical evidence available for the two agents with respect to both the quantity of evidence and specificity of the disease. There are several trials of curcumin in IBD, but many of the clinical publications relate to

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ulcerative colitis (UC) and not Crohn's disease. A systematic review of clinical trials in 2025 has suggested that curcumin holds potential as an adjunctive therapy in IBD, but existing clinical trials are limited in quality and diversity of formulation, dosage and clinical results. **(Mohseni et al., 2025)**

One study in particular for Crohn's disease looked at Theracurmin, a highly bioavailable curcumin formulation, in patients who had active mild-to-moderate CD. Sugimoto and colleagues reported clinical and endoscopic effectiveness and good safety results. This study becomes important as it indicates formulation and bioavailability could significantly impact the clinical performance of curcumin. **(Sugimoto et al., 2020)**

However, there is less clinical evidence for Boswellia serrata. There have been inconsistent results in available trials of both active disease and maintenance of remission. In a systematic review of natural products derived from plants for the treatment of IBD, it was found that Boswellia has clinical potential, but there was insufficient evidence to draw specific therapeutic conclusions. As such, there is no evidence like that seen with proven biologic or small molecule therapies for Crohn's disease in either of these two compounds. **(Davila & Papada, 2023)**

Effectiveness and symptom relief

Based on the available data curcumin has a better clinical potential when a suitable bioavailable formulation is used. Especially since, this was a time when the bioavailability of curcumin (a beneficial compound found in turmeric) was low, so that negative results might be due to lack of exposure to the compound, rather than its lack of efficacy. The 2025 systematic review of curcumin trials suggested that the benefits were more consistently shown for UC as compared to CD, so that evidence from UC may not necessarily be extrapolated to CD. **(Mohseni et al., 2025)**

In previous clinical studies, Boswellia has been shown to improve symptoms, while subsequent randomized studies with placebos failed to demonstrate this effect. The results of the different studies are inconsistent meaning the composition of the extracts, disease stage and treatment goal may affect the results. Thus it seems that both compounds are candidates to be used as adjunctive treatment, not as proven alternatives to standard therapy. **(Utz et al., 2024)**

Safety, Tolerability and Adverse Effects

When assessing long-term complementary therapies, safety is an important factor. Curcumin has generally proven to be well-tolerated in clinical studies. In a review of 6 placebo-controlled trials of curcumin in patients with IBD, the researchers found no serious oral adverse effects from curcumin, and all of the studies indicated curcumin's tolerability **(Coelho et al., 2020).** But tolerability does not necessarily mean long-term safety of any formulation or dose, and bioavailability variations can affect systemic exposure.

Boswellia preparations exhibit a good tolerability in clinical trials as well. A Crohn's disease trial conducted in a placebo controlled manner showed good tolerability in long term treatment, but not efficacy in long term maintenance. A placebo controlled trial of Boswelan in Crohn's disease specifically confirmed good tolerability in long term treatment, but not efficacy in long term maintenance **(Holtmeier et al., 2011).** Gastrointestinal complaints are the most common reported adverse effects of Boswellia preparations, but a more specific safety assessment is still required as per formulation. **(C. Peng et al., 2025)**

Conclusion

Curcumin and Boswellia serrata have shown significant pharmacological potential as complementary management of Crohn's disease. Curcumin has a wide range of anti-inflammatory, antioxidant, immunomodulatory and gut-protective properties, while Boswellia is best known for its 5-lipoxygenase inhibitory and leukotriene-modulating anti-inflammatory effects. The preclinical data for both are promising, and the clinical data is limited and variable in terms of its effect, especially in Crohn's disease. Bioavailability, standardisation of extracts and formulation variations and inconsistent clinical outcomes are challenges. At the present time, however, no evidence exists to support either agent as

a substitute for conventional therapy. Standardized preparation, dose, larger randomized trials in Crohn's disease, objective endoscopic outcomes and long-term safety assessment should be focused on for future studies. Comparative trials are also required to ascertain their relative therapeutic values.

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