International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3447-3456 www.ijprajournal.com ISSN: 2249-7781

Anti-Inflammatory Plants Found in North-East India: A Review

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Submitted: 20-06-2023 Accepted: 29-06-2023

ABSTRACT: Inflammation is a complex physiological response of the body to injury or infection, which, if left unregulated, can contribute to the development of various chronic diseases. Traditional systems of medicine, such as Ayurveda and traditional practices of Northeast India, have long relied on plant-based remedies to manage inflammation. This review aims to provide a comprehensive overview of the anti-inflammatory plants of Northeast India and their biological extracts involved in anti-inflammatory mechanisms. The rich flora of this region has been explored for its therapeutic potential, offering a diverse range of natural remedies for combating inflammation. This review highlights the importance of documenting and scientifically validating the traditional knowledge associated with these plants, which could lead to the development of novel anti-inflammatory agents.

KEYWORDS: Inflammation, Traditional, Plants, Northeast India, Anti-Inflammatory.

I. INTRODUCTION

Inflammation is known as a complex biological that has been linked to several medical conditions, including chronic diseases. It is essential for the body's defense system against damage, infection, and tissue infection. However, prolonged or untreated inflammation can speed up the onset and spread of several diseases, including cancer, neurological disorders, and cardiovascular diseases [1,2]. The therapeutic potential of plant-based medicines in treating inflammation and related diseases has long been acknowledged by traditional medical systems. Herbal medicine offers an extensive variety of therapeutic herbs recognized for their anti-inflammatory properties and is based on the traditional knowledge and practices of various civilizations. These plants have a variety of bioactive substances that can control inflammatory pathways and treat inflammation-related symptoms[3,4].

Northeast India, encompassing the states of Assam, Meghalaya, Nagaland, Arunachal Pradesh, Manipur, Mizoram, Tripura, and Sikkim, is renowned for its exceptional biodiversity. The area is host to a wide variety of ecosystems, such as forests, grasslands, and woods, all of which are host to several plant species with medical properties. The native people of Northeast India have an in-depth understanding of the local flora and how to use it traditionally to treat a variety of conditions, including inflammation [5,6].

Types of inflammation:

a) Acute inflammation:

Acute inflammation is a localized response of the body's tissues to harmful stimuli, such as injury or infection. It is a common response of the immune system of the body and is characterized by redness, heat, swelling, pain, and occasionally loss of function in the affected area [7].

The immune system of the body releases chemicals during acute inflammation which helps in boosting blood flow to the affected area. This causes redness and heat. Swelling results from the specific blood vessels becoming more permeable, this enables fluid, proteins, and immune cells to circulate from the bloodstream into the tissues [8].

The increased blood flow and accumulation of fluid and immune cells contribute to the characteristic swelling and pain. White blood cells in particular, which are immune cells, are important in acute inflammation. They assist in beginning the healing process by removing the injury or infection's origin.[9] The first immune cells to reach the site of inflammation are neutrophils, which are then followed by other varieties of white blood cells, like macrophages, that assist in the removal of debris and the defense against pathogens.

b) Chronic inflammation:

Chronic inflammation refers to a prolonged or persistent inflammatory response in the body. Inflammation is a normal immune response that occurs when the body is injured or exposed to harmful stimuli, such as pathogens or toxins.[10] It can be recognized by pain, heat, swelling, and

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Volume 8, Issue 3 May-June 2023, pp: 3447-3456 www.ijprajournal.com ISSN: 2249-7781

redness at the injury or infection site. Even when there is no noticeable injury or infection, the immune system still releases inflammatory mediators in cases of chronic inflammation.[11]
Over time, this ongoing inflammatory response can harm healthy tissues and organs. Numerous medical conditions, such as autoimmune diseases, cardiovascular diseases, diabetes, arthritis, and some types of cancer, have been linked to chronic inflammation.[12] In some cases, nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroids, disease-modifying ant rheumatic drugs (DMARDs), or biological therapies are given to treat chronic inflammation.

Synthetic anti-inflammatory drugs:

Nonsteroidal anti-inflammatory drugs (NSAIDs), also referred to as anti-inflammatory medications, are frequently used to treat fever, pain, and inflammation. While these drugs are typically effective and secure if used as prescribed, some people may experience side effects.[13]
Here are some possible side effects associated with the use of anti-inflammatory drugs:

a) Digestive issues: NSAIDs have the potential to irritate the lining of the stomach and intestines, which can result in side effects like stomach pain, heartburn, indigestion, nausea, vomiting, and even the emergence of stomach ulcers or gastrointestinal bleeding. People who have a history of stomach ulcers, gastrointestinal bleeding, high doses, or prolonged use of NSAIDs are more likely to experience these side effects.[14]
b) Cardiovascular effects: Some NSAIDs, especially those classified as selective COX-2 inhibitors, have been linked to a higher risk of cardiovascular events like heart attacks and stroke. People who already have cardiovascular disease or those who take these drugs frequently or in high doses may be at higher risk.[15]
c) Kidney issues: Long-term use of NSAIDs can impair kidney function and result in fluid retention, high blood pressure, and in rare instances, kidney failure. People taking other medications that can affect the kidneys or those who already have kidney disease may be at a higher risk.[16]
d) Allergic reactions: Some people who take NSAIDs may experience allergic reactions, which include skin rashes, itching, hives, swelling (especially of the face, lips, tongue, or throat), wheezing, or breathing difficulties. Anaphylaxis, a potentially fatal allergic reaction, can happen in extreme circumstances.[17]Liver toxicity: Although it is uncommon, NSAIDs have been linked to liver damage, including elevated liver enzymes and, in extremely rare circumstances, liver failure. People taking high doses of NSAIDs or those who already have liver conditions may be at a higher risk.[18]
e) Effects on the central nervous system: Some people who take anti-inflammatory medications may experience headaches, vertigo, drowsiness, or confusion. Typically, these symptoms are transient and mild.
f) Blood conditions: In a small percentage of cases, NSAIDs can interfere with blood clotting and raise the risk of bleeding. They might also contribute to other blood-related conditions like anemia (low red blood cell count).

II. PLANT AS AN ANTI-INFLAMMATORY AGENT

Plants have been utilized for their medicinal properties for thousands of years, and their role in managing inflammation is well recognized.[19] Plants are widely utilized as anti-inflammatory agents in traditional medical systems all over the world, including Ayurveda, Traditional Chinese Medicine, and Indigenous healing methods. Plants possess a remarkable diversity of bioactive compounds that exhibit anti-inflammatory properties.[20] These substances can inhibit inflammatory mediators, modulate the immune response, and lessen oxidative stress.[21]

Additionally, plant-based anti-inflammatory drugs frequently have benefits over synthetically produced ones, such as a reduced risk of side effects and a more comprehensive approach to healing.

This review paper aims to provide a comprehensive overview of the anti-inflammatory plants found in Northeast India, focusing on their traditional uses, phytochemical constituents, and scientific evidence supporting their anti-inflammatory benefits. This review will contribute to the study of natural resources and traditional knowledge for the development of new anti-inflammatory medicinal medicines by pulling together the existing knowledge. It will also shed insight into the potential of Northeast Indian plants in the area of current medicine and serve as a basis for further research and growth in this field.

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Table 1. Traditionally Used Anti-Inflammatory Plants By The People Of North-East India

Sl no.	Botanical name	Local name	Family	Parts used	Reference
1.	Amomum subulatum Roxb.	Bara elachi (Bengali)	Zingiberaceae	Pods	[22]
2.	Ageratum conyzoides (L.)	Imchenriza	Asteraceae	Leaves and roots	[23]
3.	Artemisia nilagirica (C.B. Clarke) Pamp.	Makampi	Asteraceae	Leaf	[22],[24]
4.	Bombax ceiba Linn.	Simul	Malvaceae	Bark	[25]
5.	Curcuma amada Roxb.	Amada (Assamese);	Zingiberaceae	Rhizome	[26]
6.	Curcuma domestica (Medik) Valh.	Haldi (Assamese);	Zingiberaceae	Rhizome	[27]
7.	Elettaria cardamomum Maton	Elassi (Assamese)	Zingiberaceae	Seeds and pods	[28]
8.	Eria pannea Lindl.	Seppu	Orchidaceae	Leaf	[29]
9.	Hedychium coccineum	Aichhia (Mizoram); Mansila, Arunacahal Pradesh)	Zingiberaceae	Rhizome	[30]
10.	Homalomena aromatic Schott.		Araceae	Rhizome	[31]
11.	Jatropha curcus Linn.	Randgula	Euphorbiaceae	Leaf/bark	[32]
12.	Kaempferia pulchra Ridl	. Khanjanburah (Assamese)	Zingiberaceae	Rhizome leaves and stem	[33]
13.	Marchantia palmate Nees	Matakain (Arunachal Pradesh)	Marchantiaceae	Whole plant	[34]
14.	Ricinus cammunis Linn.	Kunkaw	Euphorbiaceae	Leaf/seed	[35]
15.	Stephania glandulifera Miers.	Bhimraj	Menispermaceae	Tuber	[36]
16.	Zingiber cassumunar Roxb.	Bura-ud (Assamese); Naga-shing (Manipuri);	Zingiberaceae	Rhizome	[37]
17.	Zingiber	Banada	Zingiberaceae	Rhizome	[38]

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	montanum (Koen.) Link ex A. Dietr.	(Assamese)			
18.	Zingiber zerumbet Rosc. EX SM.	Gathian (Assamese); Yaiimu (Manipuri)	Zingiberaceae	Rhizome	[39]

Table 2. List of traditionally used anti-inflammatory plants which have scientific evidence

Sl. No.	Botanical name	Family	Study type	Study model	Extract	Reference
1.	**Plantago erosa**	Plantaginaceae	In vivo	Carrageenan-induced paw edema in rats and mice, formalin-induced paw licking in rats, and cotton pellet-induced granuloma in rats	Methanolic extract	[40]
2.	**Parkia timoriana**	Fabaceae	In vivo	Carrageenan-induced paw edema in rat	Methanolic extract	[41]
3.	**Alocasia macrorrhizos**	Araceae	In vitro	Inhibition of protein denaturation	Methanolic extract	[42]
4.	**Paederia foetida**	Rubiaceae	In vivo	Experimentally induced colitis in rats	Ethanolic extract	[43],[44]
5.	**Oroxylum indicum**	Bignoniaceae	In vivo	Carrageenan-induced paw edema in rat	Hydroalcoholic extract	[45],[46]
6.	**Anisomeles indica**	Lamiaceae	In vitro	Inhibition of protein denaturation	Methanolic extract	[47],[48]
7.	**Costus speciosus (koen.) Sm.**	Costaceae	In vivo	Carrageenan-induced paw edema and cotton pellet-induced granuloma formation	Ethanolic extract	[22],[49]
8.	**Drymaria cordata**	Costaceae	In vivo	Carrageenan-induced paw edema model in rat	Aqueous extract	[50]

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9.	**Hyptis suaveolens**	Lamiaceae	In vivo	Carrageenan-induced paw edema model in rat	Ethanolic extract	[51],[52]
10.	**Piper betle**	Piperaceae	In vivo	Carrageenan-induced hind paw edema model in rat	Aqueous extract	[53],[54]
11.	**Sida acuta**	Malvaceae	In vivo	Carrageenan induced hind paw edema model in rat	Methanolic extract	[55]
12.	**Verbena officinalis L.**	Verbenaceae	In vivo	Carrageenan induced hind paw edema model in rat	Methanolic extract	[56]
13.	**Vitex negundo L.**	Lamiaceae	In vivo	Carrageenan induced hind paw edema model in rat	Aqueous extract	[57]
14.	**Litsea cubeba**	Lauraceae	In vitro	Protein denaturation assay	Aqueous extract	[58],[59]
15.	**Curcuma caesia Roxb.**	Zingiberaceae	In vitro	Protein denaturation assay	Aqueous extract	[60],[61]
16.	**Enhydra fluctuans**	Asteraceae	In vivo	Carrageenan-induced paw edema and cotton pellet-induced granuloma formation	Aqueous extract	[62],[63]
17.	**Acorus calamus**	Acoraceae	In vitro	Protein denaturation assay	Aqueous extract	[64],[65]
18.	**Alpinia galanga**	Zingiberaceae	In vitro	Protein denaturation assay	Methanolic extract	[66],[67]
19.	**Spondias mangifera**	Anacardiaceae		Protein denaturation assay and protease inhibitory activity	Ethanolic extract	[68],[69]
20.	**Oryza sativa**	Poaceae	In Vitro	Protein denaturation assay, protease inhibitory activity, and HRBC membrane stabilization	Ethanolic extract	[70]

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				method		
21.	**Garcinia lanceifolia**	Clusiaceae	In Vivo	Carrageenan-induced paw edema model	Methanolic extract	[71]

III. CONCLUSION AND FUTURE DIRECTIONS

In conclusion, the review of anti-inflammatory plants from Northeast India highlights the rich botanical diversity and traditional knowledge of the region. The Northeastern region of India is known for its vast array of medicinal plants, many of which have been traditionally used for their anti-inflammatory properties.

The review identified several plants that showed promising anti-inflammatory activity, including Paederia foetida, Oroxylum indicum, Plantago erosa, Hyptis suaveolens, etc. which show good in vitro as well as in vivo anti-inflammatory activity.

The traditional use of these plants in Ayurveda and other traditional healing systems provides a historical foundation for their anti-inflammatory properties. The knowledge and practices of the local communities have contributed to the identification and utilization of these plants for managing inflammatory conditions.

The efficacy and safety of the reviewed anti-inflammatory plants have been supported by a growing body of scientific evidence. In vitro studies have demonstrated their ability to inhibit pro-inflammatory mediators, while in vivo and clinical studies have provided promising results in terms of their anti-inflammatory properties. However, it is essential to acknowledge the need for further research, including well-designed clinical trials, to establish their efficacy and safety in specific inflammatory conditions.

However, further research is needed to fully understand the mechanisms of action, optimize dosages, and evaluate the safety and efficacy of these plants as anti-inflammatory agents. Clinical trials and studies focusing on these plants in the context of specific inflammatory conditions will provide more reliable data and guide their potential integration into the general healthcare system.

Overall, the review highlights the potential of Northeast India's rich botanical resources in providing natural and sustainable solutions for inflammation-related health issues. It draws attention to the importance of preserving traditional knowledge and exploring the therapeutic potential of plant-based remedies.

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