



ANTI- INFLAMMATORY ACTIVITY OF ETHANOLIC EXTRACT OF *TAMARINDUS INDICA* FRUITS ON WISTAR ALBINO RATS

Kamlesh Kumar Yadav*, Brijesh Prajapati, Suman Bansal, Manoj Kumar

R. K. Pharmacy College Azamgarh, (276406) UP, India.



*Corresponding Author: Kamlesh Kumar Yadav

R. K. Pharmacy College Azamgarh, (276406) UP, India.

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ABSTRACT

Objective: To determine the **anti- inflammatory activity** of ethanolic extraction of *tamarindus indica* fruits by CARRAGEENAN model. **Materials and methods:** Fruits of *tamarindus indica* was collected, dried and crushed. The fruits were extracted with ethanolic by using soxhlet apparatus at 60°C of extraction. After the extraction phytochemical screening were performed. The ethanolic extract **fruits of tamarindus indica** was studied at dual dosage level (200mg/kg and 400mg/kg, in p.o. administration) in rats by using CARRAGEENAN model. The animals are shared into five sets and every group contain 6 rats. Group I: The control group received oral administration of normal saline. Group II received Carrageenan (0.1 ml of 1% solution, sub plantar inj., right hind paw) for negative control. Group III: Rats oral administration of Diclofenac standard (10mg per kg p.o) and Carrageenan. Set IV: Rats receive a low dosage of extract (200 mg/kg) orally, and Carrageenan. Group V: Animals receive a high dosage of extract (400 mg/kg) orally and Carrageenan. Anti- inflammatory activity action of ethanolic extract of *tamarindus indica* was estimated by CARRAGEENAN induced test. Ethanolic extracts of *tamarindus indica* fruits were investigated for **anti- inflammatory activity**. Commonly utilized CARRAGEENAN to assess anti- inflammatory in animals. **Results:** Phytochemical investigation of *tamarindus indica* ethanol excerpt exposed the existence of alkaloids, flavonoids, triterpenoids, chemicals. Administration of Diclofenac (10 mg/kg p.o.) produced a significantly decrease the Inflammatory behaviour when matched by control treated group. Admin of *tamarindus indica* excerpt (200mg/kg & 400mg/kg) to rats significantly decrease the Inflammation like behaviour when matched through Diclofenac cured group and it was found that extract dose 400mg/kg show higher anti- inflammatory activity than 200mg/kg dose of excerpt of *tamarindus indica*. **Conclusion:** Results suggest that fruits of *tamarindus indica* possess significantly anti- inflammatory activity.

KEYWORDS: *Tamarindus indica*, Diclofenac, anti- inflammatory, Carrageenan.

1. INTRODUCTION

Inflammation is a difficult biological response that body's immune system initiates when tissue is injured, infected, or irritated. It is a defense mechanism that helps the body eliminate harmful stimuli, initiate the healing process, and return to normal tissue function. Inflammation can occur in blood vessels, joints, organs, and other body parts. The concept of inflammation involves several cellular and molecular mechanisms. The site of infection or tissue damage attracts WBCs and other immune cells. Additional immune cells are drawn

to the swollen area by the cytokines and chemokines produced via these immune cells.

Neutrophils and macrophages, in particular, are main players in the inflammatory reaction of the immune system. Chemicals that promote tissue repair are released, damaged cells and other debris are eliminated, and invasive pathogens are consumed and eliminated. The common symptoms of swelling, including redness, inflammation, heat, discomfort, even intentional injury, may be caused by this process.

Acute swelling is an immediate reaction that often lasts a few days to a few weeks. The abrupt onset of symptoms and the preponderance of neutrophil involvement are its distinguishing characteristics. Chronic inflammation, on the other hand, is a long-lasting inflammatory reaction that may last for weeks, months, or even years. In addition to causing tissue damage and the start of several diseases like rheumatoid arthritis, asthma,

atherosclerosis, and COPD, it involves the accumulation of immune cells like lymphocytes and macrophages. Although swelling is an essential part of the body's defenses, it can cause tissue damage and disease if it continues or is not controlled.

Therefore, it is vital for general fitness to preserve a balanced and regulated inflammatory action.^[1-2]

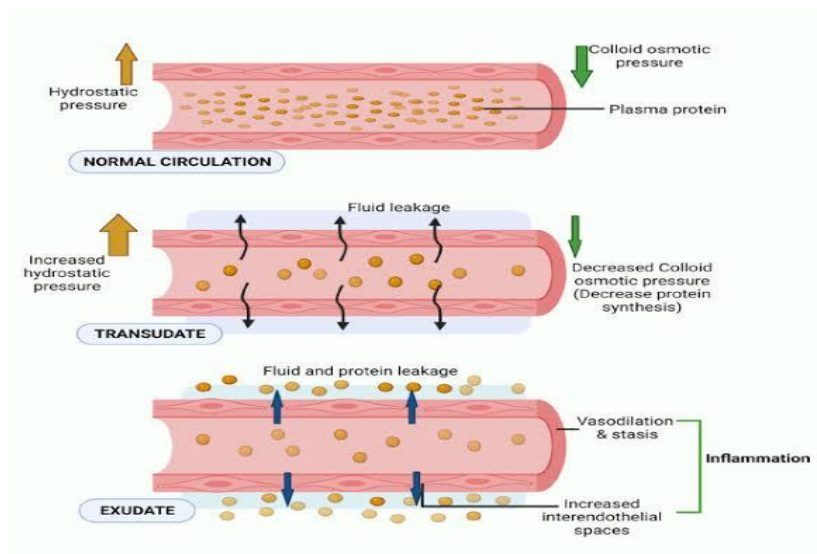


Figure 1: Inflammation.

1.2. Types of Inflammation

1.2.1 Acute Inflammation

The immune system's rapid and transient response to harmful stimuli including tissue damage, infection, or

outside factors is known as acute inflammation. It is an essential.

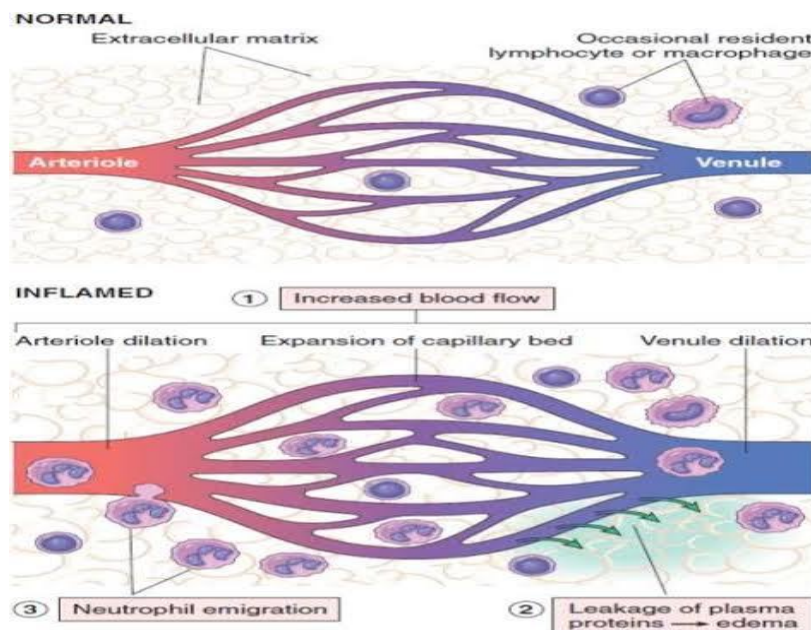


Figure 2: Acute Inflammation.

defense mechanism that seeks to eliminate the cause of the damage or infection, initiate the healing process, and restore normal tissue function. Acute swelling is associated with a number of symptoms, including

redness, swelling, heat, discomfort, and a loss of function in the affected area. Here is a general breakdown of the stages of acute inflammation and its main causes.

1.2.1.1 Tissue repair and resolution: Once the cause of the injury or illness has been addressed, the inflammatory response begins to decrease. The release of specialized pro-resolving intermediates and inflammatory antagonist cytokines helps reduce swelling and initiates the healing process for wounded tissues.

1.2.1.2. Phagocytosis and elimination: Phagocytosis, neutrophils and other phagocytic cells, such as macrophages are ingest and destroy pathogens and cellular excess. To counteract and get rid of the destructive stimuli, they induce antimicrobial drugs.

1.2.1.3. Immune cell recruitment: Chemokines attract immune cells, especially neutrophils, to site of swelling. As the first responders, neutrophils play a crucial role in eliminating pathogens and cellular waste. They go from the bloodstream to the site of inflammation through a mechanism known as chemotaxis.

1.2.1.4. Vasodilation and increased vascular permeability: The cytokine and chemokine production triggers the vasodilation of the affected area's blood vessels, which increases blood flow. This results in redness and warmth. Additionally, the cytokines impair the connections between endothelial cells in the walls of blood vessels, increasing vascular permeability.^[3]

1.2.2 Chronic Inflammation

Chronic inflammation is the term used to describe this kind of inflammatory response that lasts for at least a few weeks, months, or even years.

The concept and key characteristics of chronic swelling are summarized as follows.

1.2.2.1. Sustained immunological reaction: The immune system's continuous response to long-term stimuli, such as infections, autoimmune diseases, or prolonged exposure to irritants or poisons, causes chronic inflammation. If the first inflammatory response is unable to eliminate the trigger, a prolonged immunological response may result.^[4]

1.2.2.2. Infiltration of immune cells: In chronic swelling, immune cells, including plasma cells, macrophages, and lymphocytes, infiltrate and gather near the site of swelling.

These cells emit a variety of cytokines and pro-inflammatory intermediaries that cause tissue injury and inflammation.

1.2.2.3. Tissue deterioration and remodelling: Ongoing tissue deterioration is frequently caused by chronic inflammation. Immune cells emit cytokines, reactive oxygen species, and enzymes that aid in the destruction of healthy tissue structure. Long-term inflammation can induce tissue damage and compromise.^[5]

1.2.2.4. Angiogenesis: In an effort to boost the blood supply to the damaged area, chronic inflammation causes the development of new blood vessels (angiogenesis). However, it's possible that the newly created blood vessels are aberrant, leaky, and help to keep the inflammation going.^[6]

1.2.3. Systemic Inflammation

Systemic inflammation, sometimes called systemic inflammatory response syndrome (SIRS), is a widespread inflammatory response that affects the entire body. Unlike localized inflammation, which is limited to a particular tissue or organ, systemic inflammation happens when pro-inflammatory mediators are released throughout the body. Numerous organ systems may be significantly impacted by this kind of inflammation.

An outline of the idea and salient characteristics of systemic inflammation is provided below.

1.2.3.1. Factors that trigger: Systemic inflammation can result from a variety of disorders, such as severe infections (like sepsis), trauma, burns, autoimmune diseases, and certain types of cancer. These circumstances may result in significant amounts of pro-inflammatory substances being released into the bloodstream.

1.2.3.2. Organ malfunction: In extreme circumstances, systemic inflammation may result in organ failure or dysfunction. The excessive production of pro-inflammatory mediators can harm tissues, interfere with normal cellular processes.

1.2.3.3. Hypercoagulability: Systemic inflammation can raise the risk of blood clots in addition to producing hypercoagulability. Blood clots may form in blood arteries as a result of pro-inflammatory cytokines' stimulation of the coagulation system. This could make issues and organ damage more likely.^[7]

1.3. Causes of Inflammation

1.3.1. Microbes and Infection: Infections are often caused by microorganisms, such as bacteria, viruses, fungus, or parasites. In an attempt to fight the illness, pro-inflammatory chemicals are released when the immune system perceives these infections as foreign invaders.

1.3.2. Bodily Damage and Trauma: Swelling can be got on via tissue injury brought on by physical damage, trauma, or surgery. The immune system is inspired, which causes inflammatory reaction through the issue of cellular components and the breaking of blood vessels.

1.3.3. Autoimmune Reactions: In autoimmune disorders, the immune system misinterprets the body's own tissues as foreign and initiates an immunological attack on them. Chronic immunological activation causes tissue damage and continuous inflammation.

1.3.4. Allergic reactions: When the immune system overreacts to innocuous elements like pollen, dust mites, or certain foods, allergic responses take place. An immunological response, which includes the production of inflammatory chemicals like histamine, is brought on by this hypersensitivity.

1.3.5. Environmental Issues: Inflammation may be brought on by exposure to poisons, pollutants, and other irritants. Cigarette smoke, air pollution, certain chemicals, and allergies are a few examples. These compounds have the potential to cause tissue harm directly or to stimulate immune cells, which would cause inflammation.^[8]

1.4. Signs and symptoms of Inflammation

1.4.1. Redness (Rubor): Due to dilated blood vessels and increased blood flow, inflammation can produce localised redness in the afflicted region.

1.4.2. Swelling (Tumour): During inflammation, there is an increase in vascular permeability, which causes fluid to collect in the surrounding tissues and cause swelling or edema.

1.4.3. Heat (Calor): Due to increased blood flow and metabolic activity in the afflicted tissues, inflamed regions may feel warm to the touch.

1.4.4. Pain (Dolor): Inflammation can result in mild to severe pain or discomfort. Different mediators, produced during the inflammatory process might activate pain receptors in the damaged tissues.

1.4.5. Loss of Function: Due to discomfort, swelling, or tissue damage, inflammation in some places, such as joints, can cause a loss of function or a limited range of motion.

1.4.6. Fatigue: Inflammatory processes can cause a systemic reaction that fruits one feeling worn out or unwell. This is frequently seen in systemic or chronic inflammation.

1.4.7. Fever: The body may increase its temperature in reaction to inflammation, resulting in a fever. Certain cytokines generated during inflammation are responsible for mediating this systemic reaction.

2. METHODOLOGY

2.1. Assembly of herb resources

Plant was picked for proposal view of its customary, phytochemical profile was assembled from wild source, sathiaon Azamgarh, Uttar Pradesh.

2.2. Authentication of plant

Section of Botany, B.H.U. Varanasi, India, permitted the plant was set at the herbarium of BHU Varanasi.

2.3. Requirements

Table No. 1: Requirements.

Instruments	Chemicals	Drugs
❖ Incubator	Mayer's, Wagner's,	Diclofenac
❖ Hot air oven	Shinoda, Benedict test	Carrageenan
❖ Weighing balance	Hager's, Molisch's test reagents	
❖ Condenser	Lead acetate	
❖ Desiccator	Biuret, ethanol Reagents and Distilled Water	
❖ Grinder	Ninhydrin	
❖ Soxhlet extractor	Foam test, Ethanol Reagents and Distilled Water	
❖ Syringe	Ferric chloride test	
❖ Oral cannula	Keller-killiani test	

2.4. Preparation of extracts

Powdered (500g) fruits of the plant was defatted with ethanol (60-80° C), and then completely extracted with hydroalcoholic (ethanol+water 70:30) using soxhlet apparatus at 60°C for 72 hour. Extract was sifted on whatman No. 1 filter paper. Solvent was completely eliminated underneath reduced pressure in a rotator vacuum evaporator to get a powdery mass. The concentrated extract was stored in vacuum desiccators for further use.

2.5. Experimental Animals

For this experiments utilize male wistar albino rats balancing 150-200 gms. In polypropylene cages (38 x 23 x 10 cm) with paddy husk as bedding was arrangement for all rats treatment groups. Organization Temperature

of 25±2°C, comparative humidity of 50±5 percent rats housed. Monitored light (12 h dim / 12 h sunny period). Fresh water ad libitum, fed using normal pellet nutrition allowed to all animals. The experiments was performed following animals ethics guidelines of "Institutional Animals Ethics Committee".

Table No. 2: Grouping of Animals.

Sr. No.	Groups	No. of Animals
1	Normal control given normal saline.	6
2	Negative Carrageenan (0.1 ml of 1% solution, sub plantar inj., right hind paw)	6
3	Standard (Diclofenac 10mg per kg p.o.)+ Carrageenan	6
4	Test-1 (EETI 250 mg per kg p.o) +Carrageenan	6
5	Test-2 (EETI 500 mg per kg p.o)+ Carrageenan	6

2.6. Anti-inflammatory activity**Carrageenan induced acute inflammation**

The animals are separated into five groups, with six creatures in each group. Rats were given a sub-plantar injection of 0.1 ml of a 1% (w/v) suspension of carrageenan to induce paw edema in their right hind paw. The animal paws were subjected to five distinct treatment options after the carrageenan injection: Group I was the normal control, Group II was the negative control (carrageenan), Group III was the standard (Diclofenac 10mg) p.o., and Group IV and V were the test groups (plant extract) p.o. Following oral administration of 200 mg, 400 mg, carrageenan 0.1 ml of a 1% (w/v) suspension injected subplantarily into the paw all animal except normal control.

The paw volume was measured using a plethysmometer prior to the carrageenan injection and then again at intervals of 1 hours, 2 hours, 3 hours, and 4 hours. By contrasting the oedema substance's percentage inhibition with the control, anti-inflammatory action was ascertained. The percentage inhibition of edema was determined using the formula.

Group 1- Normal Control (Normal saline),

Group 2- Negative control carrageenan sub-plantar injection of 0.1ml of a 1% (w/v)

Group 3- Test-1 (EETI 200mg/kg).

Group 4- Test- 2 (EETI 400mg/kg).

Group 5- Standard (Diclofenac 10 mg/kg).

All drugs administered oral route except carrageenan
Percentage of edema inhibition = $(V_o - V_t) / T_o \times 100$

Where;

- ☐ V_t stands for the paw volume of the rat administered the test extract at the corresponding time.
- ☐ V_o for the rat in the control group's paw volume at the same time.

2.7. Statistical investigation

Every in vitro experiment was conducted in triplicate, and the results were displayed as mean $\pm$ S.D. The mean $\pm$ S.E.M. was used to compare the ER and EI data between the treatment groups and the vehicle group in the in vivo investigation. Graph Pad Prism software was used to analyze the significant difference (p0.05) using a one-way ANOVA.

3. RESULTS**3.1. Phytochemical Screening**

Early subjective analysis of *Tamarindus indica*.revealed occurrence of, proteins and amino acids, alkaloids, flavonoids, tannins and coumarin. In order to address the existence of numerous phenolic mixes, such as Alkaloids, flavonoids, Proteins and Amino acids, Coumarin etc.

Table No. 3: Preliminary phytochemical investigation of *Tamarindus indica*.

Phytochemicals	Name of the test	Observation	Result
Alkaloids	Mayer's	Creamy white ppt.	+
	Wagner's	Deep chocolate ppt.	+
	Hager's	Yellow crystalline precipitate	+
Flavonoids	Shinoda	Development pink colour	+
	Specific	Orange to red	+
	Lead acetate	Yellow coloured	+
Proteins and Amino acids	Biuret	A pink coloured	+
	Millon's	A white precipitate develop	+
	Ninhydrin	No precipitate	-
Coumarin	NaOH	A develop yellow colour	+
Triterpenoid	Salkowski's test	No precipitate	-
Tannins	Gelatin test	No precipitate	+
Steroid	Liebermann-Burchard's test	No precipitate	-

3.2. Anti-inflammatory activity (Carrageenan induced acute inflammation)

Table No 4: Effects of ethanolic extracts of Tamarindus indica. fruits and diclofenac on carrageenan-induced paw edema in rats.

Group	Dose (mg/kg)	Paw Volume in ml			
		1hr	2 hr	3 hr	4 hr
Normal	5ml(p.o.)				
Negative (carrageenan)	0.1ml of a 1% sub-plantar injection	0.80 ± 0.05	1.09 ± 0.03	1.19 ± 0.07	1.25 ± 0.04
Test-I (EETI)	200 (p.o.)	0.79 ± 0.08 a*b*	0.90 ± 0.05 a*b*	1.02 ± 0.04 a@b@	0.93 ± 0.08 a@b#
Test-II (EETI)	400 (p.o.)	0.75 ± 0.06 a*b*c *	0.88 ± .15 a*b*c *	0.92 ± 0.02 a@b# c *	0.86 ± 0.09 a@b*c *
Standard (Diclofenac)	10 (p.o.)	0.69 ± 0.08 a*	0.80 ± 0.08a#	0.81 ± 0.06 a@	0.75 ± 0.06 a@

Data are expressed as Mean ± SEM, $n=6$ animals in each group. One-way ANOVA was carried out using Turkey's multiple comparison tests. Comparisons were made between:

a: Control versus Standard, EETI 200, and EETI 400.

b: Standard versus EETI 200, and EETI 400.

c: EETI 200, and EETI 400.

Symbols represent statistical significance: * $P < 0.05$, # $P < 0.01$, @ $P < 0.001$.

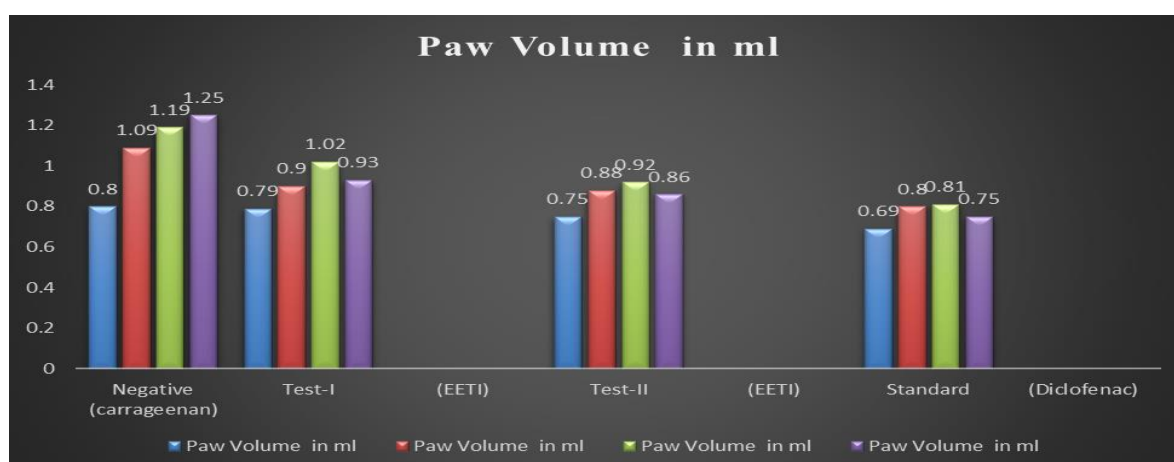


Figure 3: Paw volume in ml.

Table 5: Rate of inhibition of edema (%).

Group	Dose (mg/kg)	1hr	2 hr	3 hr	4 hr
Normal	5ml(p.o.)	-	-	-	-
Negative (carrageenan)	0.1ml of a 1% sub-plantar injection	-	-	-	-
Test-I (EETI)	200 (p.o.)	09.22 ± 0.20 b#	31.33 ± 0.46 b#	34.55 ± 0.40 b#	41.41 ± 0.38 b#
Test-II (EETI)	400 (p.o.)	23.22 ± 0.09 b# c @	37.75 ± 0.08 b# c @	40.22 ± 0.24 b# c @	54.55 ± 0.23 b# c @
Standard (Diclofenac)	10 (p.o.)	48.13 ± 0.07	57.14 ± 0.39	59.22 ± 0.72	71.11 ± 0.18

Data are expressed as Mean ± SEM, $n=6$ animals in each group. One-way ANOVA was carried out using Turkey's multiple comparison tests.

Comparisons were made between:

b: Standard versus EETI 200, and EETI 400.

c: EETI 200, and EETI 400.

Symbols represent statistical significance: # $P < 0.01$, @ $P < 0.001$.

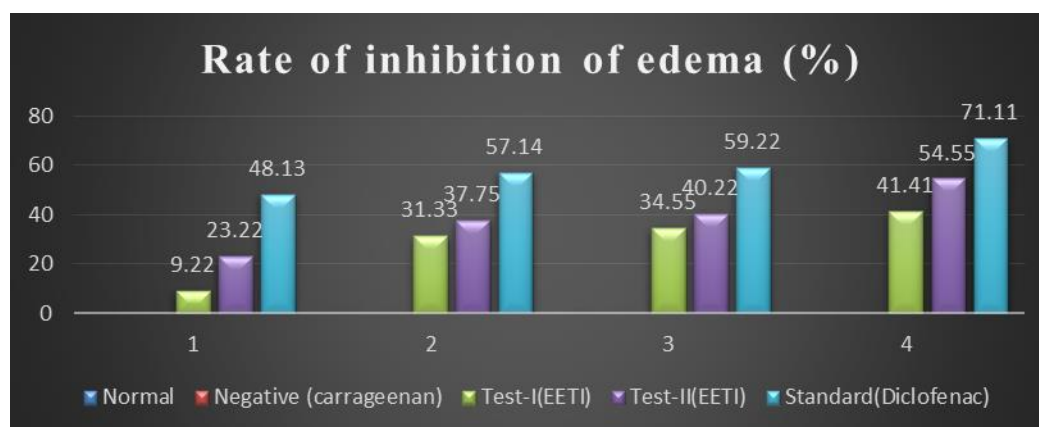


Figure 4: Rate of inhibition of edema (%).

4. DISCUSSION

The yield of the ethanolic extract of *Tamarindus indica* fruits showed that the amount of useful raw material lost was little, and the price was similarly affordable. The phytochemical content of *Tamarindus indica* fruits, which contained proteins, amino acids, alkaloids, phenol, flavonoids, tannin, saponin, and glycosides, was revealed through fruit extraction. The studies indicate that our extract's anti-inflammatory properties are due to flavonoids.

Test-II significantly decreased the inflammation to 40.22 ± 0.24 % at 3 hours and 54.55 ± 0.23 percent at 4 hours, respectively, whereas the standard medication reduced the inflammation by 59.22 ± 0.72 percent at 3 hours and 71.11 ± 0.18 % at 4 hours. In the carrageenan-induced rat paw edema model, the ethanolic extract of the *Tamarindus indica* fruits showed an anti-inflammatory activity. Herbal extract enhanced the mediators' inhibitory actions. There was no significant difference ($p < 0.05$) in the anti-inflammatory effects of the ordinary commercial diclofenac and the herbal extract (Test-II). The extract had no negative effects and was merely taken orally.

The ethanolic extract of the *Tamarindus indica* fruits showed analgesic and anti-inflammatory effects, according to the results of the carrageenan-induced rat paw edema model. Plant extract enhanced the mediators' inhibitory effects.

The *Tamarindus indica* Flavonoids, saponins, and tannin components were found in the fruit's ethanolic extract, which may support the fruit's analgesic and anti-inflammatory properties.

5. CONCLUSION

The main finding of this study showed how well the ethanolic extract from *Tamarindus indica* fruits may be used to treat inflammation. For long-term use, herbal medicines may be a safer and more effective alternative to NSAIDs for the treatment of pain and inflammation.

Future Prospects

Despite this, *Tamarindus indica* fruits have been used to relieve inflammation. The present study therefore set out to assess the anti-inflammatory properties of the fruit extract of *Tamarindus indica* in an experimental animal model and contrast such properties with those of the standard medication, diclofenac sodium.

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