



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Research Article

The Anti-Inflammatory Effects of Solanum Surattense Fruit: A Combined Network Pharmacology and Experimental Study

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ARTICLE INFO

Published: 30 July 2025

Keywords:

Solanaceae, Solamargine, inflammation properties, Surratanse

DOI:

10.5281/zenodo.16595820

ABSTRACT

Medicinal plants are special because they can make many different chemicals that have strong effects on the body. A lot of research has been done on these plants, and many useful chemicals with great healing abilities have been found. Traditional medicine often uses a plant called Solanum surattense, which grows in the wild. Different parts of this plant like roots, stems, leaves, fruits, and seeds have chemicals that help the body in many ways. These chemicals have been studied a lot, and they have been shown to protect the liver, heart, and lungs, and even help keep away mosquitoes. After careful study, four special chemicals were found in the plant: diosgenin, campesterol, solasonoine, and solamargine. When these chemicals were tested against standard treatments, they showed strong healing power. Recent studies support the idea that Solanum surattense has real medicinal value. When the body responds to something that might be harmful, it can cause inflammation. Antioxidants stop the process that leads to free radicals. It is important to find anti-inflammatory chemicals that are safe for the future because long-term use of steroids as anti-inflammatory drugs can be dangerous. This study looked at the anti-inflammatory and antioxidant properties of Solanum surattense seeds and leaves in a lab setting. Maceration was used to make the ethanolic extract from the seeds and leaves of Solanum surattense. The percentage inhibition of albumin denaturation, membrane stabilisation, and protease inhibition were used to check the anti-inflammatory effects of the extracts from the seeds (SE) and leaves (LE). The antioxidant activity was tested using the DPPH free radical scavenging assay, which uses 1,1-diphenyl-2-picrylhydrazine. The seeds were extracted using ethanol, ethyl acetate, acetone, and water. The ethanolic extracts from the seeds and leaves of Solanum xanthocarpum showed both anti-inflammatory and antioxidant properties. The acetone extract had stronger anti-inflammatory effects compared to the ethyl acetate and aqueous extracts.

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



The findings show that *Solanum surattense* has both anti-inflammatory and antioxidant abilities.

INTRODUCTION

Inflammation is the body's immediate reaction to infection or irritation. It can be helpful or harmful. On the positive side, it helps fight off germs and starts the healing process. However, it can also cause damage to tissues and cells, lead to ongoing inflammation, long-term health problems, and even turn healthy cells into cancerous ones. Infections like bacteria, viruses, or fungi, physical injuries, and problems with the immune system are common causes of inflammation. The main purpose of inflammation is to find and remove harmful substances and to clear out damaged tissue so the body can heal. To treat inflammatory conditions, doctors often use drugs that reduce inflammation, such as steroidal anti-inflammatory drugs (NSAIDs) and non-steroidal anti-inflammatory drugs (NSAIDs). However, long-term use of these medications can lead to side effects like stomach problems, a weakened immune system, and disruption of the body's natural defenses. Inflammation is a complex reaction that plays an important role in healing. It can be a helpful process, but at times, it can be harmful.

Causes of inflammation:

Inflammation happens when a physical factor triggers an immune response. Inflammation doesn't always mean there's an infection, but an infection can cause inflammation. Acute inflammation can happen when the body comes into contact with something like a bee sting, dust, or another substance, or when there's an injury or infection. When the body senses a harmful pathogen, the immune system starts several reactions. The tissues begin to collect plasma proteins, which causes fluid to build up and leads

to swelling. The body also sends out neutrophils, a type of white blood cell, to the affected area. These cells have molecules that help fight off the harmful pathogen.

Signs of inflammation:

- **Redness (Rubor):** When tissues are inflamed, they turn red because the small blood vessels in the area get bigger (hyperemia), allowing more blood to flow through.

- **Swelling (Tumour):** Tissues swell because fluid builds up in the space around blood vessels.

This happens due to cells moving more and more fluid leaking out of the blood vessels.

- **Heat:** The area feels warmer because there's more blood flowing through it, and the blood is warmer.

This is because the blood vessels widen, allowing warm blood to reach the area.

- **Pain:** Chemicals like bradykinin and certain prostaglandins are released during inflammation and can cause pain.

The swelling also stretches and distorts tissues, adding to the discomfort.

- **Loss of function:** Inflammation can make movement difficult because of pain, and the swelling can physically block movement, leading to a loss of function in the area.

Types of inflammation:

Inflammation is usually divided into two main types: acute and chronic. Acute inflammation is a quick response that usually lasts for a few hours to several days. It happens when the body rapidly sends neutrophils to the site, and there's more blood flow and fluid buildup, leading to the classic



signs of inflammation. This kind of reaction is typically effective in removing the harmful substance and helping the body return to normal. Examples include infections, burns, injuries, and allergic reactions. Chronic inflammation, on the other hand, lasts a long time and often happens when the body can't get rid of the harmful substance, when there's constant exposure to a minor irritant, or when the immune system is not working properly. This type is marked by the presence of white blood cells like macrophages, lymphocytes, and plasma cells, along with damage to tissues, scarring, and the growth of new blood vessels. Chronic inflammation is linked to many non-infectious conditions such as rheumatoid arthritis, inflammatory bowel disease, atherosclerosis, type 2 diabetes, obesity, cancer, Alzheimer's disease, and even depression. Chronic inflammation happens when the body's immune system keeps reacting over a long time. The innate immune system, which is the first line of defense, and the adaptive immune system, which targets specific threats, both get involved. Macrophages, which are a type of immune cell, release chemicals called cytokines like IL-1, TNF- α , and IL-6 that keep the inflammation going. Certain types of T-helper cells, such as Th1 and Th17, help by making proteins like interferon-gamma (IFN- γ) and IL-17 that fuel the inflammation. However, other immune cells like regulatory T cells (Tregs) and cytokines such as IL-10 and TGF- β work to reduce inflammation and keep things in check. If this balance between pro-inflammatory and anti-inflammatory signals breaks down, it can lead to damage in tissues and problems that affect the whole body.



Fig:1- Solanum Surattense Burm. f.

- Animal models to study anti-inflammatory:
- Carrageenan Induced Paw Edema
- Histamine/5-HT Induced Paw Edema
- Bradykinin Induced Paw Edema
- Dextran Induced Paw Edema
- Lipopolysaccharide (LPS) Induced Paw Edema
- Arachidonic Acid-Induced Ear Edema
- Croton Oil / TPA Induced Ear Edema
- Oxazolone Induced Ear Edema
- Vascular Permeability
- Pleurisy Model
- Plant Profile
- Biological source: It is Fruit obtained from the plant, Solanum surattense Burm. f.
- Family: Apiaceae
- Taxonomy
- Kingdom: Plantae
- Phylum: Tracheophyta
- Class: Equisetopsida C. Agardh
- Order: Apiales
- Family: Apiaceae
- Genus: Solanum
- Species: surattense
- Common Name: Assamese: Bilkulitita; English: Bitter brinjal; Other: Gulakai, Sundaka, Mullu Sundai

Morphology and Occurrence



It is a perennial herb. Both stem and leaves have sharp straight prickles also pubescent. Leaves pinnatifid. Flowers distinct and deep blue in few flowered raceme. Calyx lobes recurved. Fruit is globose, yellow when ripe about 1 inch in dia variegated or green when young.

Distribution:

Plains from the coast up to 100 meters. Found in India, the Himalayas, Southeast Asia, Malaysia, Australia, and Polynesia.

Chemical Constituents

The fruit of *Solanum surattense* has many active chemical compounds. Some of the main ones include steroidal alkaloids like solamargine, solasonine, solasodine, solanocarpidine, and solanocarpine. It also contains flavonoids, phenolic acids such as caffeic acid, and coumarins like esculin. Other important plant chemicals include saponins, glycoalkaloids, triterpenoids such as lupeol and diosgenin, and steroids like campesterol, stigmasterol, β -sitosterol, daucosterol, cycloartanol, and carpesterol. The seed oil is high in linoleic, oleic, and arachidonic acids.

Traditional / Ethno Medicinal Uses

Solanum surattense has been used for a long time in Ayurvedic and traditional medicine systems in South and Southeast Asia, especially in India and Pakistan. It is traditionally used to treat asthma, cough, fever, diabetes, skin infections, urinary problems, liver issues, wounds, and toothaches. The fruit is eaten as a digestive aid, blood cleanser, and for treating hernias and constipation. Seeds are sometimes burned and used to ease tooth pain and swollen gums. Decoctions made from the roots and leaves are used for ulcers, inflammation, breathing problems, and kidney stones. The root is

part of famous Ayurvedic medicines like Dashmularishta and Laghupanchamula. Seeds are also used for expelling worms, increasing urine, and fighting infections. The plant is widely used by tribal people and is recognized in rural medicine for its fever-reducing, fertility-regulating, and infection-fighting properties.

Need of Work

Inflammation is a natural way the body protects itself. It helps fight infections, heal wounds, and repair damaged tissues. However, if inflammation is too much or lasts a long time, it can cause serious health problems. Chronic inflammation is linked to diseases like arthritis, heart disease, diabetes, and cancer. Millions of people around the world suffer from inflammatory conditions. While treatments like nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroids are effective, they often come with harmful side effects. Using these medicines for a long time can lead to stomach ulcers, kidney issues, liver damage, and weaken the immune system. Therefore, there is a need to find safer and better treatment options. Two common models used in drug research are the Carrageenan-induced acute inflammation model and the Cotton pellet-induced granuloma model. These models help scientists study both acute and chronic inflammation, making them useful for testing the anti-inflammatory effects of herbal medicines. Acute inflammation involves swelling, redness, and pain, while chronic inflammation causes tissue damage, scarring, and long-term immune responses. This study will test how the hydroalcoholic extract from the fruit of *Solanum surattense* can reduce inflammation in both situations using these animal models. Along with in vivo studies, network pharmacology is a powerful tool that helps understand the molecular pathways involved in plant-based medicines. Medicinal plants contain many active compounds



that work on different pathways in the body. Unlike synthetic drugs that target only one pathway, plant compounds affect multiple pathways, leading to more effective and holistic healing. However, finding these targets manually is difficult. Network pharmacology tools help predict how compounds interact with targets, identify key pathways, and explain how these medicines work. This study will combine network pharmacology with experimental testing to fully understand the anti-inflammatory benefits of *Solanum surattense* fruit.

MATERIAL AND METHOD

Collection and authentication of plant material

Fruits from the plant *Solanum surattense* Burm.

f. were gathered in July 2024 from the Lonavala area in Pune district, Maharashtra, India. A botanist at Sandip University in Nashik confirmed the plant species. A sample was kept as a herbarium specimen and labeled with voucher number SUN2024/07/10.

Preparation and Storage

The collected plant material was washed with water and then rinsed with 95% ethanol to stop microbes from growing and to protect the material during storage and drying. The fruit was cut into small pieces and dried in the shade until all moisture was gone. The dried material was then ground into a fine powder using a sieve numbered 80 to make it ready for further use.

Extraction Methodology

A total of 1000 grams of the powdered and dried fruit was mixed with a hydroalcoholic solution and stirred occasionally at a temperature of $25 \pm 2^\circ\text{C}$ for three days. The mixture was then filtered

through a Buchner funnel with sterile cotton. The solvent was removed using a rotary evaporator under reduced pressure, resulting in 47.65 grams of hydroalcoholic extract. The percentage yield was calculated using the following formula:

$$\text{Percentage yield} = (\text{Weight of Extract} / \text{Weight of powdered drug}) \times 100$$

Experimental Animals

Ethical Approval: All the animal procedures were checked and approved by the Institutional Animal Ethics Committee (IAEC) at Dr. Vedprakash Patil Pharmacy College in Aurangabad, and they followed the guidelines of CPCSEA.

Animals: Wistar albino rats were used in the study.

Animal Identification

Each animal was marked on the tail for individual identification. Different groups and sets were marked with color-coded tags and labeled clearly with cage number, animal number, and group number to keep everything organized and trackable throughout the experiment.

Quarantine and acclimatization

Quarantine is the process of keeping new animals separate from the existing group to check their health and to find out if they carry any microbes. In this study, new Wistar albino rats were kept in quarantine for one week to reduce the risk of spreading diseases to the existing rats and to help the new rats get used to their environment and diet before being used in experiments.

Housing

The animals were kept in a well-ventilated animal facility. The temperature and humidity were kept



steady at 55–65%. They were placed in large polypropylene cages with paddy husk as bedding to make sure they were comfortable and the area stayed clean.

Diet and Water

The animals were given a standard pellet food and purified water all the time, except during specific fasting times. The bedding was changed regularly to keep the area clean and hygienic throughout the study.

Drug Administration

The drugs were given by mouth using a tube connected to a syringe. This method helped give

the right amount of medicine each time. The amount of each drug was carefully followed according to the plan for the experiment.

Preparation of Dose

The fruit extract from *Solanum surattense* was tested at three different doses: 100, 250, and 500 mg per kilogram of body weight. Each dose was made by carefully measuring the extract and mixing it with a solution of 0.3% carboxymethyl cellulose in distilled water.

In-vivo study

Experimental set

Table No :1 Set (A) Carrageenan induced Acute inflammation model

Groups	Treatment	No of Animals	Route
Group 1	Control Group	6	Orally
Group 2	Carrageenan Induced Group	6	Subplantar region
Group 3	Standard 5 mg/Kg of Indomethacin	6	Orally
Group 4	Lower Dose of <i>Solanum surattense</i> Fruit Hydroalcoholic Extract (100 mg/Kg)	6	Orally
Group 5	Moderate Dose of <i>Solanum surattense</i> Fruit Hydroalcoholic Extract (250 mg/Kg)	6	Orally
Group 6	Higher Dose of <i>Solanum surattense</i> Fruit Hydroalcoholic Extract (500 mg/Kg)	6	Orally



Fig:2-Carrageenan Induced in Rat Paw

Set (B) Cotton pellet induced granuloma model for chronic inflammation

Each set contains 6 experimental groups.

Set A - Acute Inflammation Model

Carrageenan-induced rat paw edema

Seven groups of rats were given different treatments by mouth: saline (control), indomethacin at 5 mg/kg (standard), and Solanum surattense fruit extract at doses of 100, 250, and 500 mg/kg. One hour after treatment, each rat received a subplantar injection of 1% carrageenan in normal saline into the right hind paw to cause inflammation. Before the inflammation started, the volume of both hind paws was measured using a plethysmometer. Measurements were taken every hour for six hours after the injection to track changes in paw volume. The increase in volume of the carrageenan-injected paw was used to measure the level of swelling, while the other paw (left) was injected with saline to serve as a control for measuring normal swelling. (Battu et al., 2011; Ganga et al., 2012)

Evaluation Parameter: Paw thickness

Set - [B] Chronic Inflammation Model:

Cotton Pouch - Induced Granuloma

The rats were divided into six groups randomly.

After removing the fur, each rat was anesthetized, and a sterile cotton pellet weighing 10 mg was placed into each axilla. The treatment groups received Solanum surattense fruit extract at doses of 100, 250, and 500 mg/kg, while the standard group was given indomethacin at 5 mg/kg. A control group received only the vehicle. All treatments were given by mouth once a day for seven days, starting from the day of pellet implantation. On the eighth day, the animals were anesthetized, and the cotton pellets were removed and cleaned of extra tissue. The pellets were first kept at 37°C for 24 hours and then dried at 60°C until they reached a constant weight. The increase in the dry weight of the pellets was used to measure granuloma formation. (Arivazhahan, 2022; Banerjee et al., 2021; Madan et al., 2020)

Evaluation Parameter:

Wet weight of the pellets, % inhibition

$$\% \text{ inhibition} = 100 \times [1 - (Y_t / Y_c)]$$

Where Y_t = average increase in weight of the pellets in groups treated with test compounds

Y_c = average increase in weight of the pellets in the control group

Dry weight of the pellets, % inhibition

$$\% \text{ inhibition} = 100 \times [1 - (Y_t / Y_c)]$$

Where Y_t = average increase in weight of the pellets in groups treated with test compounds

Y_c = average increase in weight of the pellets in the control group

Yc= Average increase in weight of the pellets in control.

Table 2: Distribution of Experimental animals for Chronic Inflammation Model

Groups	Treatment	No of Animals	Route
Group 1	Control Group	6	Orally
Group 2	Carrageenan Induced Group	6	subplantar region
Group 3	Standard 5 mg/Kg of Indomethacin	6	Orally
Group 4	Lower Dose of Solanum surattense Fruit Hydroalcoholic Extract (100 mg/Kg)	6	Orally
Group 5	Moderate Dose of Solanum surattense Fruit Hydroalcoholic Extract (250 mg/Kg)	6	Orally
Group 6	Higher Dose of Solanum surattense Fruit Hydroalcoholic Extract (500 mg/Kg)	6	Orally

Experimental animals: Male Wistar Albino Rats

The animals were split into six different groups to test how well the Solanum surattense Fruit Hydroalcoholic Extract works against inflammation. A total of 36 rats were used in the study, and each group had 6 rats. The groups were set up like this:

Control Group (Group 1):

These rats did not get any treatment, not even the Extract or anything that causes inflammation. They were used as a baseline to compare other groups against.

Inflammation-Induction Group (Group 2):

These rats were made to have inflammation using a special substance but did not get the Extract. This group helps see how inflammation develops naturally.

Inflammation + Indomethacin Group (Group 3):

These rats were made to have inflammation and then given a standard dose of indomethacin (a common anti-inflammatory drug) to see how it affects inflammation.

Inflammation + Low-Dose Extract Group (Group 4):

These rats were made to have inflammation and then given a low dose of the Extract to check how it might help reduce inflammation.

Inflammation + Moderate-Dose Extract Group (Group 5):

These rats were made to have inflammation and then given a moderate dose of the Extract to see if it has a better effect on reducing inflammation.

Inflammation + High-Dose Extract Group (Group 6):

These rats were made to have inflammation and then given a high dose of the Extract to study how the amount of the Extract affects its ability to reduce inflammation.

Surgical Procedures

The surgeries were done in a clean and disinfected area to prevent infections.



Before the operation, all hard surfaces, like tables and tools, were cleaned and disinfected properly. Each rat was given an anesthetic to help them sleep during the procedure. The fur around the surgery area was carefully removed to get a clear view. A numbing cream called lignocaine gel was applied to the area to help reduce pain and discomfort before surgery. The area was then cleaned with Betadine, a type of antiseptic that kills many types of germs. To stop the rat from getting too cold during the operation, a warm heating pad was used. All tools and instruments used during the surgery were sterile to avoid spreading infection. Any implants used were also kept sterile. The wounds were closed with Ethilon stitches, which are often used for closing skin wounds. After the surgery, the rats were moved to a warm, clean, and dry area to recover. They were given a numbing cream and a topical antibiotic cream to help with pain and prevent infection. Post-operative monitoring included regular assessment of body weight, behavior, and hydration status to ensure animal welfare and detect any signs of distress or complications.

RESULTS

Collection and authentication of plant material

Fruits of *Solanum surattense* Burm.

f. were gathered in July 2024 from the Lonavala area in Pune district, Maharashtra, India. The plant material was checked by a botanist at Sandip University in Nashik. A sample was made into a herbarium specimen and kept with the voucher number SUN2024/07/10.

Extractive Values

A total of 1000 grams of plant material was soaked in a hydroalcoholic solution, which is a mix of 70%

alcohol and 30% water, for three days. The mixture was stirred occasionally at a temperature of $25 \pm 2^\circ\text{C}$. After that, the mixture was filtered using a Buchner funnel and a clean cotton filter. The solvent was taken out using a rotary evaporator, and 47.65 grams of hydroalcoholic extract was obtained. These extracts were then used to study their hepatoprotective activity.

Yield of hydroalcoholic extract – 4.76%

Set A - Acute Inflammation Model

Carrageenan-induced rat paw edema

Set A - Acute Inflammation Model

Carrageenan-induced rat paw edema

In the carrageenan-induced inflammation model, checking the size of a rat's paw is a common and effective way to measure acute inflammation. This model helps scientists understand how inflammation works in the body and is widely used to test how well drugs and natural products can reduce inflammation. Carrageenan is a type of seaweed-based compound found in *Chondrus crispus*. When injected under the skin of a rat's paw, it causes two stages of inflammation. In the first stage, which happens within the first two hours, the body releases chemicals like histamine, serotonin, and bradykinin. In the second stage, which starts around three to six hours later, the body produces more substances like prostaglandins, nitric oxide, and certain proteins called cytokines, such as $\text{TNF-}\alpha$ and $\text{IL-1}\beta$. It also leads to the movement of white blood cells into the area. This process causes blood vessels to leak fluid, which results in swelling of the paw, making it easier to measure the effect of treatments.

Table No:3 Observation of Paw Volume for Experimental Animals After Treatment

Animal	Control		Carrageenan induced group		Indomethacin		100 mg/kg of Extract		250 mg/kg of Extract		500 mg/kg of Extract	
	3 hrs	6 hrs	3 hrs	6 hrs	3 hrs	6 hrs	3 hrs	6 hrs	3 hrs	6 hrs	3 hrs	6 hrs
1	0.4174	0.4174	0.7126	0.906	0.4785	0.4377	0.5701	0.5192	0.5497	0.5294	0.4886	0.4581
2	0.4276	0.4276	0.5599	0.9569	0.4479	0.4276	0.5599	0.509	0.5599	0.509	0.509	0.4886



3	0.4072	0.407 2	0.865 3	0.967 1	0.498 8	0.458 1	0.590 4	0.559 9	0.529 4	0.498 8	0.498 8	0.4886
4	0.397	0.397	0.682 1	0.855 1	0.468 3	0.437 7	0.580 3	0.559 9	0.570 1	0.539 5	0.458 1	0.4479
5	0.3767	0.376 7	0.804 2	1.252 1	0.559 9	0.447 9	0.549 7	0.529 4	0.559 9	0.519 2	0.498 8	0.4785
6	0.4072	0.407 2	0.763 5	0.956 9	0.509	0.549 7	0.559 9	0.539 5	0.580 3	0.559 9	0.478 5	0.4683

Table no:4 Mean Paw volume for experimental animals after treatment

Group	Treatment	Mean $\pm$ SEM	
		3 hrs	6 hrs
1	Control Group	0.4052 $\pm$ 0.0071	0.4052 $\pm$ 0.0071
2	Carrageenan Induced Group	0.7244 $\pm$ 0.0433	0.9749 $\pm$ 0.0566
3	Indomethacin Group	0.4924 $\pm$ 0.0159	0.4580 $\pm$ 0.0184
4	100 mg/kg Extract	0.5682 $\pm$ 0.0061	0.5358 $\pm$ 0.0085
5	250 mg/kg Extract	0.5579 $\pm$ 0.0071	0.5255 $\pm$ 0.0089
6	500 mg/kg Extract	0.4883 $\pm$ 0.0074	0.47142 $\pm$ 0.0067

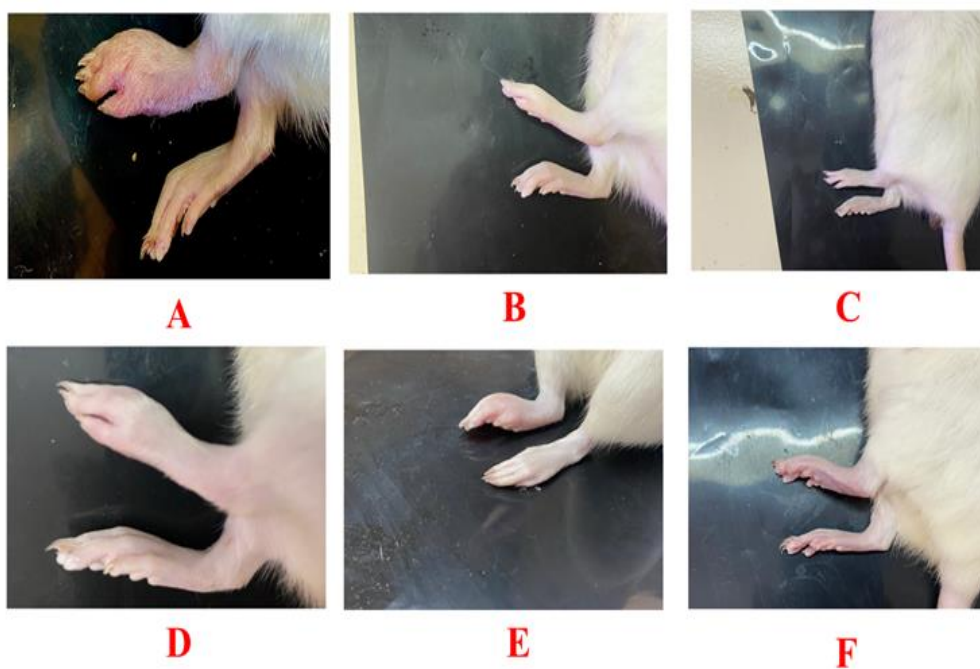


Fig :3-Acute inflammation: (A) Model Control; (B) Normal control; (C) Indomethacin; (D) 100 mg/kg of Extract; (E) 250 mg/kg of Extract; (F) 500 mg/kg of Extract

Set - [B] Chronic Inflammation Model

Cotton Pouch - Induced Granuloma (Wet Weight of the Pellets)

The cotton pellet-induced granuloma model is a common and dependable way to study chronic inflammation and the fibrotic stage of the body's inflammatory response in living animals. This model shows how the body deals with the repair phase of inflammation, which includes tissue healing, activation of fibroblasts, buildup of

collagen, and the movement of macrophages. When sterile cotton pellets are placed under the skin, they act as a long-lasting foreign object that causes a continuous inflammatory reaction. Over the course of 7 days, the body starts forming granulation tissue around the pellets, causing the mass to grow slowly because of fluid buildup, active fibroblasts, and new blood vessels that form. Observation of weight of cotton pellet (mg) for experimental animals after treatment

Table no:5 Observation of weight of cotton pellet (mg) for experimental animals after treatment

Animal	Cotton Pallate Induced (Sham Control)	Indomethacin	100 mg/kg of Extract	250 mg/kg of Extract	500 mg/kg of Extract
	46.79	22.85	41.16	37.22	27.86
	45.03	21.62	43.31	36.09	29.38
	48.27	22.83	42.08	38.12	28.44
	45.36	20.71	40.67	36.1	27.11
	46.36	23.96	41.4	38.22	28.06
	47.83	22.61	42.2	36.59	30.09

Table No:6 Mean for Observation of weight of cotton pellet (mg) for experimental animals after treatment

Group	Treatment	Mean $\pm$ SEM
1	Cotton Pallate Induced	46.59 $\pm$ 0.5290
2	Indomethacin group	22.40 $\pm$ 0.5290
3	100 mg/kg of Extract	41.79 $\pm$ 0.5290
4	250 mg/kg of Extract	37.04 $\pm$ 0.5290
5	500 mg/kg of Extract	28.47 $\pm$ 0.5290

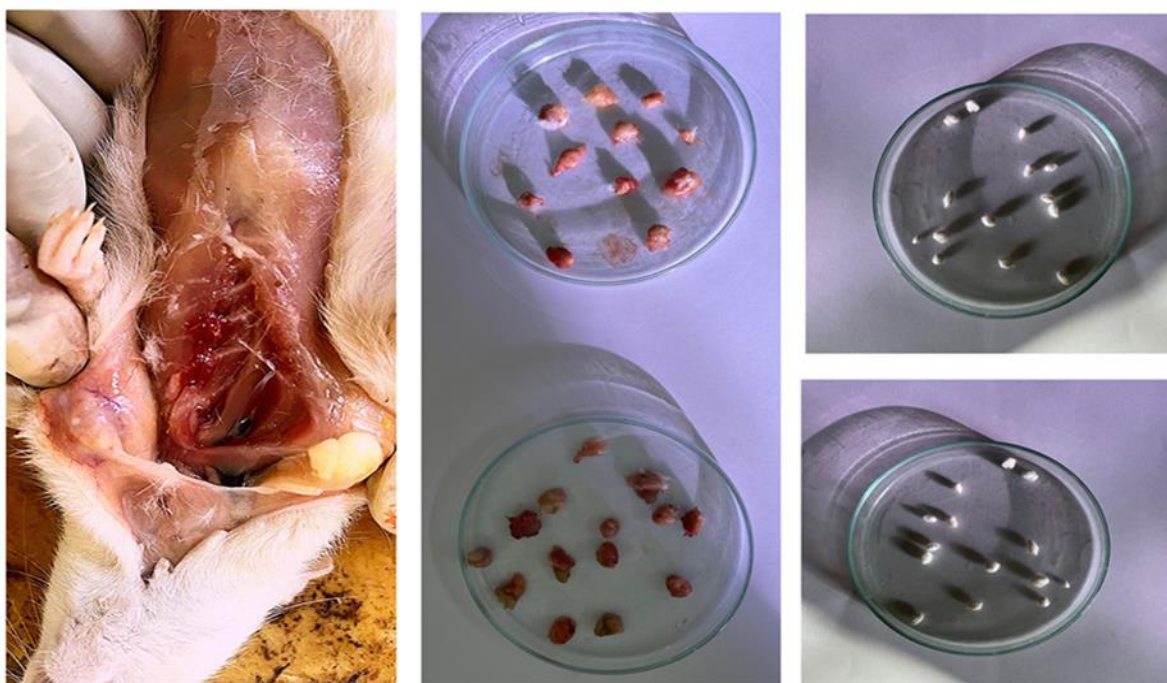


Fig:4-Experimental process for Cotton Pouch - Induced Granuloma (Wet Weight of the pellet

CONCLUSION

The anti-inflammatory potential of *Solanum surattense* fruit extract was meticulously evaluated through a dual experimental strategy encompassing both acute (carrageenan-induced paw edema) and chronic (cotton pellet-induced granuloma) models, complemented by network pharmacology and molecular docking. This integrative pharmacological approach provided robust insights into the extract's multi-mechanistic efficacy and its potential as a phytotherapeutic agent. In the carrageenan-induced paw edema model, the extract significantly inhibited paw swelling in a dose-dependent manner. At 3 hours post-injection—corresponding to the early phase of inflammation dominated by histamine, serotonin, and bradykinin—the 250 mg/kg dose produced a notable reduction in paw volume (0.5579 ± 0.0071), significantly lower than the carrageenan-induced control (0.7244 ± 0.0433). This suggests early interference with mediator release or receptor signaling, possibly via stabilization of mast cells or antagonism of

histaminergic/bradykinin pathways. By 6 hours—corresponding to the late phase, mediated by prostaglandins, cytokines (e.g., $\text{TNF-}\alpha$, $\text{IL-1}\beta$), and neutrophil infiltration—the same dose continued to suppress inflammation (0.5255 ± 0.0089), showing comparable efficacy to indomethacin (0.4580 ± 0.0184). This temporal consistency indicates sustained anti-inflammatory activity likely through COX-2 inhibition, as suggested by the reduction in prostaglandin-mediated edema progression. Notably, the 500 mg/kg dose, though numerically effective (0.4883 ± 0.0074 at 3 h and 0.4714 ± 0.0067 at 6 h), did not yield a statistically significant improvement over 250 mg/kg, implying a pharmacodynamic plateau or dose saturation. This pattern suggests that the extract exhibits optimal efficacy at mid-range doses, a common trait in botanical pharmacology due to receptor desensitization or homeostatic feedback at higher doses. The two-way ANOVA confirmed the predominant effect of treatment ($F(5,60) = 94.98$, $P < 0.0001$), accounting for 79.18% of total variance in paw volume, emphasizing the pharmacological impact

of the extract. Although the time effect alone was non-significant ($P = 0.0914$), the significant interaction term ($F(5,60) = 12.39$; $P < 0.0001$) highlights that the extract's efficacy varied dynamically over time across doses—a hallmark of time-dependent therapeutic response.

ACKNOWLEDGEMENT

First of all, I want to thank God for giving me the strength, direction, and confidence to complete this work. I am deeply grateful to my beloved parents for their love and support at every stage of my life. It brings me a lot of happiness to express my heartfelt thanks to my guide, Dr. Karna B Khavane, Assistant Professor at Dr. Vedprakash Patil Pharmacy College, Aurangabad, for his valuable suggestions, support, encouragement, and continuous help throughout the entire project. I also want to extend my deepest thanks to Dr. Vikas G. Rajurkar, the Principal of Dr. Vedprakash Patil Pharmacy College, Aurangabad, for his guidance, inspiration, and encouragement during different stages of the work, which helped ensure the smooth progress of my project..

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HOW TO CITE: Sonali Borde*, Dr. Karna Khavane, Aditi Jyotishi, The Anti-Inflammatory Effects of *Solanum Surattense* Fruit: A Combined Network Pharmacology and Experimental Study, *Int. J. of Pharm. Sci.*, 2025, Vol 3, Issue 7, 4000-4014.
<https://doi.org/10.5281/zenodo.16595820>

