

ETHNO PHARMACOLOGICAL STUDY OF GUAZUMA ULMIFOLIA TRADITIONAL  
USES AND SCIENTIFIC VALIDATION OF ANTIPYRETIC AND ANTI-ARTHRITIC  
PROPERTIESSingh Bipin Mangla Prasad\*, Manju Prajapati<sup>1</sup>, Akhlesh Kumar Singhai<sup>2</sup>\*<sup>1</sup>Professor, School of Pharmacy, LNCT University Bhopal, MP, India.<sup>2</sup>Director, School of Pharmacy, LNCT University Bhopal, MP, India.

\*Corresponding Author: Singh Bipin Mangla Prasad

Professor, School of Pharmacy, LNCT University Bhopal, MP, India.

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## ABSTRACT

**Background:** Fever and inflammatory conditions are frequently treated using medicinal herbs. The current study sought to assess the phytochemical profile, antioxidant activity, and pharmacological effects of *Guazuma ulmifolia*, which has long been recognized for its medicinal potential. **Goal:** Examine the *Guazuma ulmifolia* methanolic extract's antipyretic and anti-arthritis properties. **Materials and Methods:** The Soxhlet method with methanol was used to extract the plant material that was gathered from Bhopal. Quantitative assessment of the total phenolic and flavonoid content as well as phytochemical screening were carried out. The DPPH test was used to assess antioxidant activity. The acute oral toxicity was evaluated. Brewer's yeast-induced pyrexia in rats was used to study antipyretic efficacy, while an arthritis model generated by Freund's Complete Adjuvant (FCA) was used to assess anti-arthritis activity. Biochemical and haematological parameters were examined. **Results:** Alkaloids, glycosides, flavonoids, tannins, phenolics, and saponins were all included in the extract, which had a yield of 6.08%. The total flavonoid concentration was 50.55 mg/g RE, while the total phenolic content was 69.9 mg/g GAE. With an IC<sub>50</sub> value of 44.13 µg/ml, the extract demonstrated strong antioxidant activity. Yeast-induced pyrexia was shown to be reduced in vivo in a dose-dependent manner, with a maximal impact at 400 mg/kg. The extract dramatically decreased paw edema, enhanced hematological parameters (RBC, WBC, Hb), and lowered biochemical indicators (ALP, AST, ALT, CRP) in the FCA-induced arthritic model. The effects were similar to those of diclofenac at 400 mg/kg. **Conclusion:** The study confirms that *Guazuma ulmifolia* possesses significant antipyretic, anti-arthritis, and antioxidant activities, which may be attributed to its phenolic and flavonoid content. The plant shows potential as a natural therapeutic agent for the management of fever and inflammatory conditions.

**KEYWORDS:** *Guazuma ulmifolia*, Antipyretic activity, Anti-arthritis activity, Antioxidant activity, DPPH assay, Phenolic compounds.

## 1. INTRODUCTION

A number of pathological disorders are caused by inflammation, pain, and fever. Synthetic medications, such as NSAIDs, opioids, and corticosteroids, are clinically the most significant medications used to treat inflammatory conditions; nevertheless, prolonged use of these medications can have harmful side effects, such as bleeding, gastrointestinal ulcers, renal problems, etc (Griffin *et al.*, 1998; Cryer & Dubois, 1998). In order to create safe, affordable, and effective medications, efforts are being made worldwide to introduce new

medicinal plants (Vane and Botting, 1995). Inflammation, discomfort, and fever are the causes of many medical conditions. Although synthetic drugs like NSAIDs, opioids, and corticosteroids are clinically the most important drugs used to treat inflammatory conditions, long-term use of these drugs can have negative side effects like bleeding, gastrointestinal ulcers, renal issues, etc.. Worldwide, attempts are being made to introduce novel medical plants in order to develop safe, economical, and effective pharmaceuticals. A species popularly used to treat various diseases

is *Guazuma ulmifolia* Lam. (Malvaceae) (Pereira *et al.*, 2019), which is commonly known as “mutamba” (Lopes *et al.*, 2012) or “guácimo”. It is found in Latin American countries, including Brazil, and it occurs especially in Cerrado formations (Junior *et al.*, 2016). The botanical parts generally used in folk medicine are the stem bark and leaves of *G. ulmifolia*, and they are generally used in the form of infusions or decoctions. Evidence has confirmed the antidiabetic effect of the stem bark and leaves of *G. ulmifolia* (Alonso *et al.*, 2008), and revealed the hypotensive and vasorelaxant effects of the stem bark (Magos *et al.*, 2008), hypocholesterolemic effects of the plant have also been reported. Despite these reported activities, the potential of *Guazuma ulmifolia* in managing inflammation, fever, and arthritic conditions requires further scientific validation. Therefore, the present study was undertaken to evaluate the phytochemical constituents, antioxidant potential, and pharmacological activities of *Guazuma ulmifolia*, with particular emphasis on its antipyretic and anti-arthritic effects.

## 2. MATERIALS AND METHODS

### 2.1 Plant collection

For the present investigation, approximately 350 g of *Guazuma ulmifolia* plant material was selected local area of Bhopal. The collected plant specimen was taxonomically identified and authenticated by a qualified botanist to ensure its botanical accuracy.

### 2.2 Extraction process

The Soxhlet extraction technique is a widely used method for obtaining bioactive compounds from plant materials. In this process, the dried and powdered *guazuma ulmifolia* is placed into a thimble, which is fitted into the Soxhlet apparatus (Borodulin *et al.*, 2020).

### 2.3 Determination of Total Polyphenol Content

The total polyphenol content of *Guazuma ulmifolia* extract was determined using the Folin–Ciocalteu method. Total polyphenol content was expressed as micrograms of gallic acid equivalents per gram of dried extract ( $\mu\text{g GA-Eq/mg}$ ).

### 2.4 Determination of Total Flavonoid Content (TFC)

The total flavonoid content in the *Guazuma ulmifolia* extract was estimated using the aluminum chloride ( $\text{AlCl}_3$ ) colorimetric method. The flavonoid content was expressed as milligrams of rutin equivalents per gram of dried extract ( $\mu\text{g R-Eq/mg}$ ) (Ghafar *et al.*, 2017).

### 2.5 DPPH Radical Scavenging Assay

The antioxidant potential of the *Guazuma ulmifolia* extract was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay. Ascorbic acid was used as a standard antioxidant to compare the scavenging efficiency of the extract. The percentage of DPPH radical scavenging activity was calculated to quantify the antioxidant capacity of the sample,

providing an estimate of its ability to neutralize free radicals (Marinova & Batchvarov, 2011).

### 2.6 Acute oral toxicity

The acute oral toxicity of the methanolic extract of *Guazuma ulmifolia* was evaluated following the OECD guideline 423, which employs a stepwise dosing procedure. Three animals were used at each step to assess potential toxicity. The treatment groups received a single oral dose of the plant extract at escalating levels of 5, 50, 300, and 2000 mg/kg body weight. The control group was administered an equivalent volume of distilled water as the vehicle. After dosing, the animals were closely monitored for any signs of toxicity, behavioral changes, or adverse effects over the observation period to evaluate the safety profile of the extract (Jothy *et al.*, 2011).

### 2.7 Experimental Work

All experimental procedures involving animals were reviewed and approved by the Institutional Animal Ethics Committee (IAEC) to ensure compliance with ethical standards for animal research. Animals Used Wistar rats of either sex, weighing approximately  $200 \pm 50$  g, were employed for the study.

### 2.8 In-vivo Antipyretic Activity

The study involved dividing rats into five groups to investigate pyrexia induced by a 15% w/v Brewer's yeast suspension administered subcutaneously. Rectal temperatures were recorded before and 18 hours post-injection (Bhowmick *et al.*, 2014). Following this.

**Group I** Normal control (animals received no treatment and served as baseline)

**Group II** Yeast-induced pyrexia (animals received yeast to induce fever, without treatment)

**Group III** Standard treatment: Paracetamol administered at 150 mg/kg body weight

**Group IV** *Guazuma ulmifolia* extract administered at 200 mg/kg body weight (low dose)

**Group V** *Guazuma ulmifolia* extract administered at 400 mg/kg body weight (high dose)

### 2.9 Anti-Arthritic Activity in Rats

#### Freund's adjuvant induced Arthritic Model

Paw volume was measured at intervals of 0, 7, 14, 21, and 28 days using a plethysmometer, and the percentage inhibition of swelling was determined by comparing mean volumes of treated and control groups (Lin *et al.*, 2014).

**Formula:**  $\text{Vc-Vt/Vc} \times 100$

#### Group -Treatment Description

**Group I** -Normal control (without treatment)

**Group II** -Negative control (arthritic rats receiving no treatment)

**Group III** -Diclofenac sodium (20 mg/kg), standard anti-arthritic drug (positive control)

**Group IV** -*Guazuma ulmifolia* extract administered orally at 200 mg/kg

**Group V** -*Guazuma ulmifolia* extract administered orally at 400 mg/kg

#### ➤ **Body Weight Assessment**

Body weight changes were monitored as an additional parameter to evaluate the overall health status of the animals and the progression of arthritic symptoms.

#### ➤ **Paw Volume Measurement**

The extent of paw swelling was determined by calculating the difference between the final paw volume and the initial baseline measurement (Shejawal *et al.*, 2014).

#### ➤ **Biochemical Analysis**

At the conclusion of the experimental period (day 28), blood samples were taken from the animals through retro-orbital puncture. The samples, after clotting and

centrifugation, yielded serum for analysis of biochemical markers linked to arthritis, specifically acid phosphatase and alkaline phosphatase. Increased levels of these enzymes reflect heightened bone resorption and inflammation, offering insight into the protective effects of the test compounds against arthritis-related damage.

#### ➤ **Haematological Analysis**

The specific parameters analyzed included red blood cell (RBC) count, hemoglobin concentration (Hb), and total white blood cell (WBC) count, which are widely recognized indicators of blood health and immune status. All measurements were conducted using commercially available Erba diagnostic kits, ensuring standardized and reproducible procedures. The analysis was performed with the aid of a Star 21 Automated Hematology Analyzer, which allowed for precise and rapid quantification of the hematological indices (Mitchell *et al.*, 2011).

### 3. RESULTS AND DISCUSSION

#### 3.1 Percentage Yield

Table 1: Percentage yield.

S. No	Plant name	Solvent	Theoretical weight	Yield(gm)	% yield
1.	<i>Guazuma ulmifolia</i>	Methanol	350	21.3	6.08

#### 3.2 Preliminary Phytochemical study

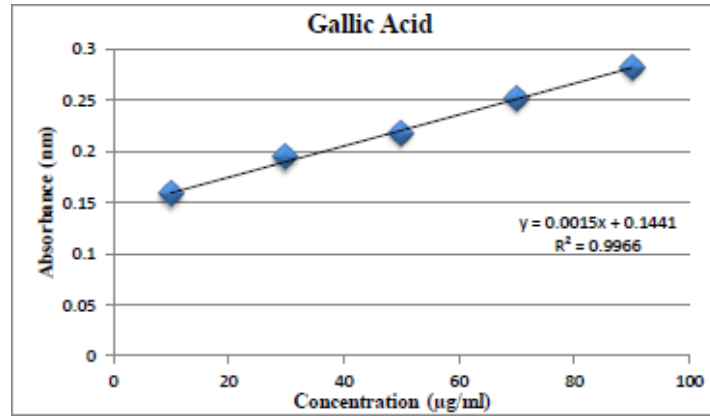
Table 2: Phytochemical testing of the extract of methanol.

Sr.no	Experiment	Presence or absence of phytochemical test
<b>Ethanollic Extract</b>		
1.	<b>Alkaloids</b>	Present
2.	<b>Glycoside</b>	Present
3.	<b>Carbohydrates</b>	Present
4.	<b>Proteins and Amino Acids</b>	Absent
5.	<b>Flavonoids</b>	Present
6.	<b>Tannin and Phenolic Compounds</b>	Present
7.	<b>Saponin</b>	Present
8.	<b>Test for Triterpenoids and Steroids</b>	Absent

#### 3.3 Total Phenolic content (TPC) estimation

Table 3: Standard table for Gallic acid.

S. No.	Concentration (µg/ml)	Absorbance
1.	10	0.158
2.	30	0.194
3.	50	0.217
4.	70	0.252
5.	90	0.282



Total 4: Total Phenolic Content in extract of *Guazuma ulmifolia*.

S. No	Absorbance	TPC in mg/gm equivalent of Gallic Acid
1.	0.164	69.9 mg/gm
2.	0.205	
3.	0.274	

3.4 Total Flavonoids content (TFC) estimation

Table 5: Standard table for Rutin.

S. No.	Concentration (µg/ml)	Absorbance
1.	10	0.168
2.	30	0.196
3.	50	0.252
4.	70	0.297
5.	90	0.325

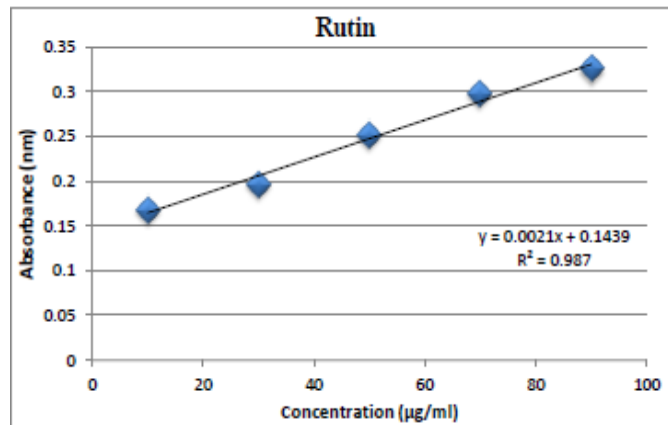


Table 6: Total Flavonoid Content.

S. No.	Absorbance(nm)	TFC in mg/gm equivalent of Rutin
1.	0.191	50.55 mg/gm
2.	0.246	
3.	0.298	

3.5: DPPH 1, 1- diphenyl-2-picryl hydrazyl Assay

Table 7: DPPH radical scavenging activity of Std. Ascorbic acid.

Concentration (µg/ml)	Absorbance	% Inhibition
20	0.475	52.213
40	0.421	57.645
60	0.339	65.895
80	0.281	71.730
100	0.141	85.814
Control 0.994 IC50 19.03		

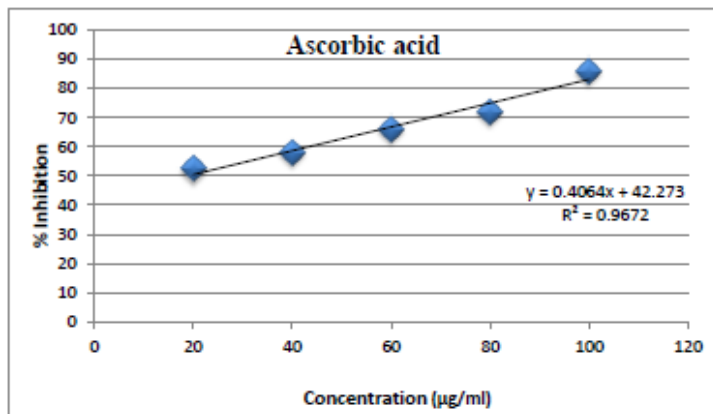
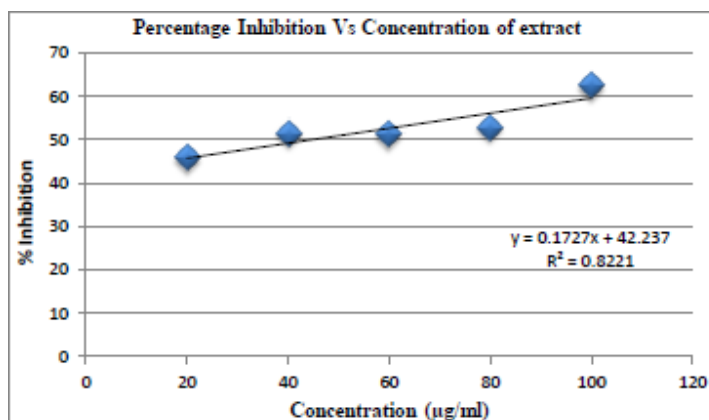


Table 8: DPPH radical scavenging activity of methanol extract of *Guazuma ulmifolia*.

Concentration (µg/ml)	Absorbance	% Inhibition
20	0.508	45.668
40	0.455	51.336
60	0.442	51.027
80	0.402	52.727
100	0.353	62.245
<b>Control 0.935 IC50 44.13</b>		



3.6 *In vivo* acute oral toxicity (OECD 423)

Table 9: Parameter of acute oral toxicity, extract dose 300mg/kg per body weight.

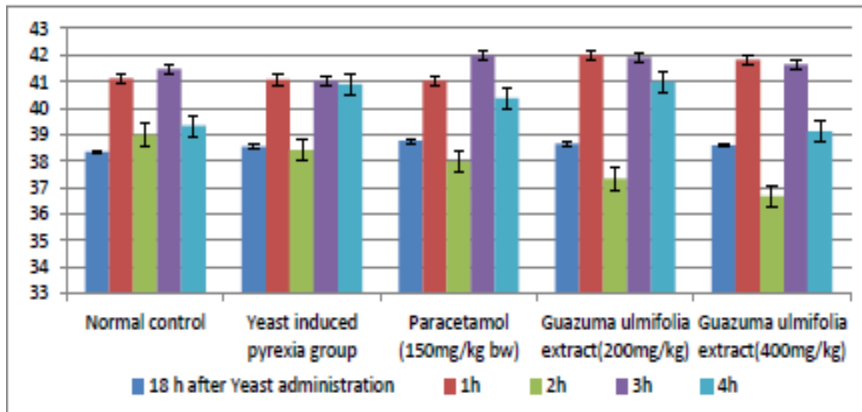
Extract Dose 300 mg/kg							
TC. Parameter	1	3 Day	5 Day	7 Day	9 Day	11 Day	14 Day
Body Weight	154 gm	159 gm	162 gm	167 gm	168 gm	169 gm	170 gm
Skin & Fur	Normal	Normal	Normal	Hairfall	Hairfall	Normal	Normal
Eye	Normal	Normal	Redness	Redness	Normal	Normal	Normal
MUC. Membrane	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Salivation	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Stool	Normal	Hard	Hard	Normal	Hard	Normal	Normal
Urination	Normal	Normal	yellowish	yellowish	yellowish	Normal	Normal
Sleep	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Behaviour	Normal	Aggressive	Aggressive	Normal	Normal	Normal	Normal

3.7 Brewer's Yeast Induced Pyrexia in Rats

Table 10: Brewer's Yeast Induced Pyrexia in Rats.

Rectal temperature (°C)					
Groups		18 h after Yeast administration		Temperature after treatment	
		1 h	2h	3h	4 h
Normal control	38.33±0.1	38.55±0.2	38.75±0.1	38.65±0.2	38.58±0.1

<b>Yeast induced pyrexia group</b>	42.10±0.1	41.96±0.3	41.77±0.2	41.67±0.2	41.96±0.3
<b>Paracetamol (150mg/kg bw)</b>	37.58±0.2	38.39±0.2	38.96±0.2	38.32 ±0.1	38.05±0.2
<b>Guazuma ulmifolia extract(200mg/kg)</b>	41.47±0.1	41.01±0.3	41.98±0.1	41.90±0.2	41.64±0.3
<b>Guazuma ulmifolia extract(400mg/kg)</b>	38.32±0.1	40.90±0.1	40.37±0.2	40.29±0.1	39.10±0.2



Graph 1: Brewer's Yeast Induced Pyrexia in Rats.

3.8 Freund's complete adjuvant induced arthritic Model



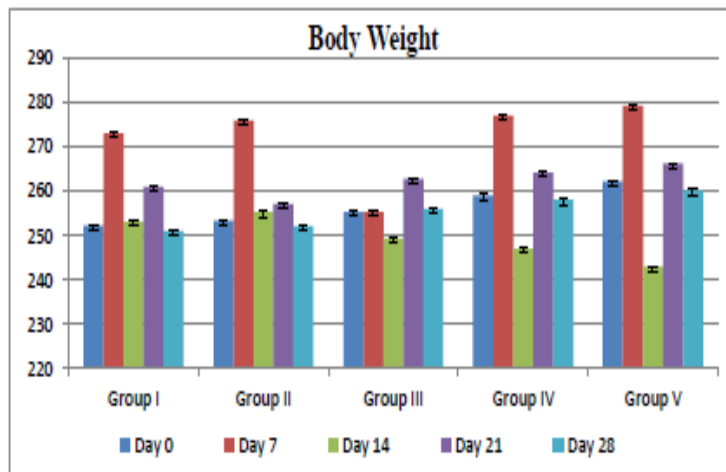
G-1 [normal] G-2 [inducer] G-3 [standard] G-4 [Low dose] G-5 [high dose].

Figure 1: Freund's complete adjuvant induced Model of arthritic (FCA)

3.8.1 Body Weight

Table 11: Body Weight.

	Day 0	Day 7	Day 14	Day 21	Day 28
<b>Group (Normal control)</b>	252.13±0.262	253.24±0.237	255.20±0.221	258.98±0.212	261.99±0.22
<b>Group II (Negative control)</b>	272.88±0.214	275.79±0.138	270.67±0.188	276.88±0.250	279.15±0.263
<b>GroupIII (Diclofenac sodium (20 mg/kg)</b>	252.93±0.249	255.10±0.271	255.203±0.187	257.87±0.204	259.89±0.22
<b>Group IV (low dose 200 mg/kg)</b>	260.90±0.224	256.99±0.264	262.66±0.395	264.02±0.158	266.08±0.22
<b>Group V (high dose 400 mg/kg)</b>	250.91±0.256	252.01±0.208	249.98±0.139	246.87±0.122	242.98±0.29

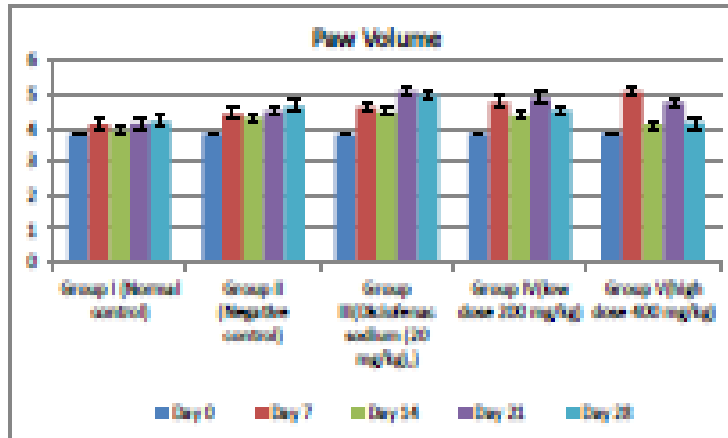


Graph 2: Body Weight.

3.8.2 Paw Volume

Table 12: Effect of *Guazuma ulmifolia* paw volume of Freund’s adjuvant induced arthritic rats.

Paw volume of the rats in ml Mean ± SD (% inhibition)					
Groups	Day 0	Day 7	Day 14	Day 21	Day 28
Group I(Normal control)	0.30 ± 0.05	0.31 ± 0.08	0.30 ± 0.06	0.31 ± 0.10	0.30 ± 0.8
Group II(Negative control)	0.37 ± 0.03	0.84± 0.011	0.80± 0.03	0.74± 0.013	0.77 ± 0.07
Group III (Diclofenac sodium (20 mg/kg),)	0.33 ± 0.01	0.34 ± 0.03	0.36 ± 0.05	0.47± 0.06	0.34 ± 0.05
Group IV(low dose 200 mg/kg)	0.35 ± 0.07	0.38 ± 0.05	0.41 ± 0.01	0.43 ± 0.10	0.40± 0.04
Group V(high dose 400 mg/kg)	0.34 ± 0.07	0.36 ± 0.06	0.39 ± 0.04	0.38 ± 0.06	0.38± 0.02

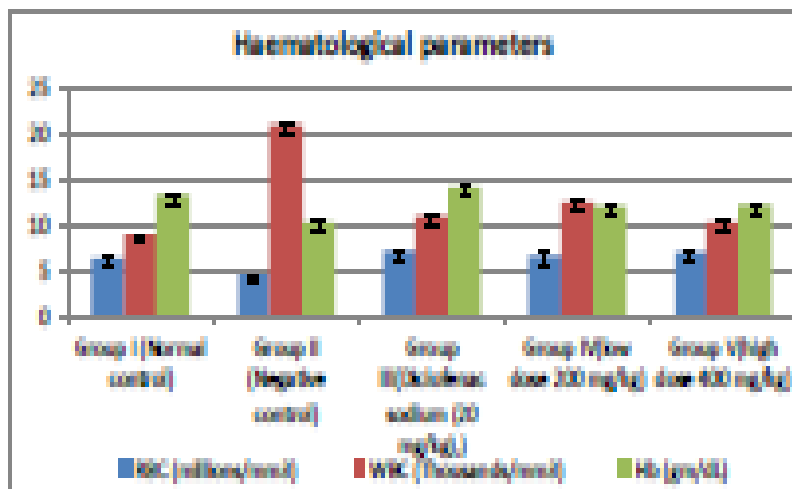


Graph 3: Paw volume in rats with *Guazuma ulmifolia*.

3.8.3 Haematological Parameter

Table 13: Effect of *Guazuma ulmifolia* on the haematological characteristics of rats with adjuvant-induced arthritis and control.

Groups	RBC (millions/mm3)	WBC (Thousands/mm3)	Hb (gm/dL)
Group I (Normal control)	6.23 ± 0.052	8.89 ± 0.022	13.21 ± 0.042
Group II (Negative control)	4.42 ± 0.047	20.92 ± 0.154	10.09 ± 0.043
Group III(Diclofenac sodium 20 mg/kg),)	6.09 ± 0.020	10.88 ± 0.012	11.16 ± 0.072
Group IV(low dose 200 mg/kg)	6.48 ± 0.688	12.38 ± 0.060	11.96 ± 0.153
Group V(high dose 400 mg/kg)	6.99 ± 0.024	10.106 ± 0.213	12.16 ± 0.052

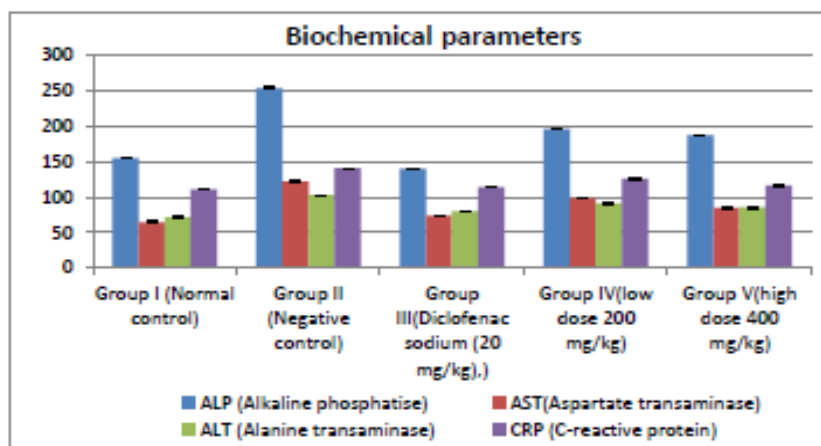


Graph 4: Biochemical Parameters.

### 3.8.4 Biochemical Parameters

Table 14: Effect of *Guazuma ulmifolia* Adjuvant-induced arthritis and control rats' biochemical characteristics.

Groups	ALP (Alkaline phosphatase)	AST (Aspartate transaminase)	ALT (Alanine transaminase)	CRP (C-reactive protein)
Group I (Normal control)	155.12 ± 0.015	64.49 ± 0.181	71.61 ± 0.249	110.9 ± 0.191
Group II (Negative control)	254.15 ± 1.378	122.07 ± 0.111	103.30 ± 0.080	141.09 ± 0.143
Group III (Diclofenac sodium (20 mg/kg),)	140.08 ± 0.473	73.46 ± 0.201	79.66 ± 0.161	114.08 ± 0.299
Group IV (low dose 200 mg/kg)	186.09 ± 0.891	98.55 ± 2.059	91.25 ± 0.148	126.06 ± 0.145
Group V (high dose 400 mg/kg)	152.09 ± 0.411	84.37 ± 0.196	85.05 ± 0.264	119.09 ± 0.214



Graph 5: Biochemical Parameters.

### DISCUSSION

The ethnopharmacological potential of *Guazuma ulmifolia* was assessed in this study, with a focus on its antipyretic and anti-arthritic properties. Important phytoconstituents as alkaloids, glycosides, flavonoids, tannins, phenolics, and saponins were found in the 6.08% methanolic extract. Strong antioxidant capacity was shown by the high quantities of total phenolics (69.9 mg/g GAE) and flavonoids (50.55 mg/g RE) found through quantitative analysis. In the DPPH experiment, the extract demonstrated strong dose-dependent free radical scavenging activity ( $IC_{50} = 44.13 \mu\text{g/ml}$ ), indicating its antioxidant potential. The extract significantly reduced yeast-induced pyrexia, according to in vivo investigations, with the 400 mg/kg dose exhibiting the strongest antipyretic effect. The extract considerably decreased paw edema and inflammation, enhanced hematological parameters, and decreased biochemical markers as ALP, AST, ALT, and CRP in the FCA-induced arthritic model. At 400 mg/kg, the effects were similar to those of the common medication diclofenac. These results confirm *Guazuma ulmifolia*'s potential as a natural source of anti-inflammatory, antioxidant, antipyretic, and anti-arthritic agents by indicating that the observed pharmacological effects may be linked to the presence of phenolic and flavonoid chemicals.

### CONCLUSION

From this study, it is concluded that *Guazuma ulmifolia* has significant therapeutic potential, particularly in reducing fever and inflammation. The methanolic extract showed the presence of important phytochemicals, especially phenolics and flavonoids, which contributed to its biological activity. The extract demonstrated strong antioxidant activity and produced a clear dose-dependent reduction in fever in the pyrexia model. It also showed effective anti-arthritic activity by reducing inflammation, improving hematological parameters, and lowering biochemical markers associated with tissue damage.

### REFERENCES

- Alonso-Castro, A. J., & Salazar-Olivo, L. A. (2008). The anti-diabetic properties of *Guazuma ulmifolia* Lam are mediated by the stimulation of glucose uptake in normal and diabetic adipocytes without inducing adipogenesis. *Journal of ethnopharmacology*, 118(2): 252-256.
- Bhowmick, R., Sarwar, M. S., RahmanDewan, S. M., Das, A., Das, B., NasirUddin, M. M., ... & Islam, M. S. (2014). In vivo analgesic, antipyretic, and anti-inflammatory potential in Swiss albino mice and in vitro thrombolytic activity of hydroalcoholic extract from *Litsea glutinosa* leaves. *Biological research*, 47(1): 56.
- Borodulin, D., Prosin, M., Bakin, I., Lobasenko, B., Potapova, M., & Shalev, A. (2020). The use of

- Soxhlet extractor for the production of tinctures from plant raw materials. In *E3S Web of Conferences* (175: 08010). EDP Sciences.
4. Cryer, B., & Duboisø, A. (1998). The advent of highly selective inhibitors of cyclooxygenase—a review. *Prostaglandins & other lipid mediators*, 56(5-6): 341-361.
  5. Ghafar, F., Nazrin, T. T. N. N., Salleh, M., Hadi, N. N., Ahmad, N., Hamzah, A. A., ... & Azman, I. N. (2017). Total phenolic content and total flavonoid content in *Moringa oleifera* seed. *Galeri Waris. Sains*, 1(1): 23-35.
  6. Griffin, M. R. (1998). Epidemiology of nonsteroidal anti-inflammatory drug-associated gastrointestinal injury. *The American journal of medicine*, 104(3): 23S-29S.
  7. Jothy, S. L., Zakaria, Z., Chen, Y., Lau, Y. L., Latha, L. Y., & Sasidharan, S. (2011). Acute oral toxicity of methanolic seed extract of *Cassia fistula* in mice. *Molecules*, 16(6): 5268-5282.
  8. Junior, J. T. C., de Moraes, S. M., Gomez, C. V., Molas, C. C., Rolon, M., Boligon, A. A., ... & Douglas, M. C. H. (2016). Phenolic composition and antiparasitic activity of plants from the Brazilian Northeast “Cerrado”. *Saudi Journal of Biological Sciences*, 23(3): 434-440.
  9. Lin, B., Zhao, Y., Han, P., Yue, W., Ma, X. Q., Rahman, K., ... & Han, T. (2014). Anti-arthritic activity of *Xanthium strumarium* L. extract on complete Freund's adjuvant induced arthritis in rats. *Journal of ethnopharmacology*, 155(1): 248-255.
  10. Lopes, G. C., Longuini, R., Klein, T., & Mello, J. C. P. (2009). Preliminary assessment of the chemical stability of dried extract from *Guazuma ulmifolia* Lam. (Sterculiaceae). *Planta Medica*, 75(09): PG59.
  11. Magos, G. A., Mateos, J. C., Páez, E., Fernández, G., Lobato, C., Márquez, C., & Enríquez, R. G. (2008). Hypotensive and vasorelaxant effects of the procyanidin fraction from *Guazuma ulmifolia* bark in normotensive and hypertensive rats. *Journal of ethnopharmacology*, 117(1): 58-68.
  12. Marinova, G., & Batchvarov, V. (2011). Evaluation of the methods for determination of the free radical scavenging activity by DPPH. *Bulgarian Journal of Agricultural Science*, 17(1): 11-24.
  13. Mitchell, A. J., Chan, M., Bhatti, H., Halton, M., Grassi, L., Johansen, C., & Meader, N. (2011). Prevalence of depression, anxiety, and adjustment disorder in oncological, haematological, and palliative-care settings: a meta-analysis of 94 interview-based studies. *The lancet oncology*, 12(2): 160-174.
  14. Pereira, G. A., Araujo, N. M. P., Arruda, H. S., de Paulo Farias, D., Molina, G., & Pastore, G. M. (2019). Phytochemicals and biological activities of mutamba (*Guazuma ulmifolia* Lam.): A review. *Food Research International*, 126: 108713.
  15. Shejawal, N., Menon, S., & Shailajan, S. (2014). A simple, sensitive and accurate method for rat paw volume measurement and its expediency in preclinical animal studies. *Human & experimental toxicology*, 33(2): 123-129.
  16. Vane, J. R., & Botting, R. M. (1995). New insights into the mode of action of anti-inflammatory drugs. *Inflammation research*, 44(1): 1-10.