STUDY OF PHYTOCHEMICAL AND ANTIARTHRITIC ACTIVITY OF ETHANOLIC EXTRACT OF *MIMUSOPS ELENGI* LEAVES

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Abstract

The present study was undertaken to investigate the phytochemical profile and anti-arthritic potential of the ethanolic leaf extract of *Mimusops elengi* using an FCA-induced arthritic rat model. The leaves were subjected to fluorescence analysis and extraction with ethanol, followed by preliminary phytochemical screening and quantitative estimation of total phenolic and flavonoid contents. The ethanolic extract showed a percentage yield of 6.20% w/w and revealed the presence of alkaloids, glycosides, flavonoids, phenols, tannins, and carbohydrates, while saponins, proteins, diterpenes, and sterols were not detected. The total phenolic and flavonoid contents were found to be 0.523 and 0.641 mg/100 mg of extract, respectively. The anti-arthritic activity was evaluated by assessing paw volume and biochemical inflammatory and antioxidant markers in FCA-induced arthritic rats. Arthritic control animals showed a marked increase in paw volume and elevated levels of PGE_2, IL-1β, and TNF-α, accompanied by a significant reduction in GSH and SOD levels. Treatment with *Mimusops elengi* extract produced a dose- and time-dependent reduction in paw volume and significantly decreased PGE_2, IL-1β, and TNF-α levels. The high-dose extract produced greater effects, reducing paw volume to 0.29 ± 0.03 mL on day 28, PGE_2 to 55.8 ± 3.0 pg/mL, IL-1β to 46.2 ± 2.7 pg/mL, and TNF-α to 48.9 ± 2.8 pg/mL. It also improved antioxidant status, with GSH and SOD levels increasing to 6.96 ± 0.28 µmol/mg and 12.9 ± 0.51 U/mg, respectively. The findings indicate that the ethanolic leaf extract of *Mimusops elengi* possesses promising anti-inflammatory and antioxidant properties and may have potential as a natural therapeutic agent for the management of inflammatory arthritic conditions.

Keywords: *Mimusops elengi*, ethanolic leaf extract, anti-arthritic activity, FCA-induced arthritis, inflammation, PGE_2, IL-1β, TNF-α, GSH, SOD, phytochemical screening.

Introduction

Rheumatoid arthritis and other inflammatory arthritic disorders are chronic conditions characterized by persistent inflammation of the joints, progressive tissue damage, pain, swelling, and impaired physical function. Arthritis can significantly affect mobility, daily activities, and overall quality of life (Jahid et al., 2023).

The pathogenesis of inflammatory arthritis involves a complex interaction of immune, inflammatory, and oxidative processes, resulting in the release of several inflammatory mediators and cytokines. Among these, prostaglandin E_2 (PGE_2), tumor necrosis factor-alpha (TNF-α), and interleukin-1 beta (IL-1β) play important roles in the initiation and progression of inflammatory responses and joint damage (Shrivastava et al., 2013).

The development of arthritis is also associated with an imbalance between oxidant generation and endogenous antioxidant defense mechanisms. Increased oxidative stress can promote inflammatory responses and contribute to cellular and tissue injury (Bilski et al., 2024). Antioxidant enzymes such as superoxide dismutase (SOD), together with non-enzymatic antioxidants such as reduced glutathione (GSH), constitute an important defense system against oxidative damage (Jomova et al., 2024). Reduction in GSH and SOD levels during inflammatory conditions may therefore contribute to the progression of tissue injury. Consequently, modulation of inflammatory mediators and restoration of antioxidant defense mechanisms are considered important approaches in the investigation of potential anti-arthritic agents (Umar et al., 2012).

The currently available pharmacological treatments for arthritis include non-steroidal anti-inflammatory drugs, corticosteroids, disease-modifying antirheumatic drugs, and other targeted therapies (Guo et al., 2018). Although these agents can provide substantial therapeutic benefits, their prolonged use may be associated with adverse effects and limitations in certain patients. This has encouraged continued research into medicinal plants and their bioactive constituents as potential sources of effective anti-inflammatory and anti-arthritic agents (Singh et al., 2020).

Plant-derived preparations contain diverse classes of phytoconstituents, including flavonoids, phenolic compounds, tannins, alkaloids, glycosides, and other secondary metabolites, many of which have been investigated for their antioxidant and anti-inflammatory properties (Elshafie et al., 2023).

Mimusops elengi Linn., commonly known as Bakul and belonging to the family Sapotaceae, is a medicinally important plant traditionally used in various systems of medicine. Different parts of the plant, including the leaves, bark, flowers, fruits, and seeds, have been investigated for their pharmacological and phytochemical properties. The plant has been reported to contain several biologically active secondary metabolites and has demonstrated a range of traditional and pharmacological applications (Baliga et al., 2011).

Phytochemical investigations of *Mimusops elengi* have reported the presence of phenolic compounds, flavonoids, tannins, alkaloids, glycosides, and other secondary metabolites. These constituents may contribute to the biological activities of the plant, particularly those associated with antioxidant and anti-inflammatory effects (Srivastava et al., 2024). Pharmacognostic and phytochemical investigations have further supported the presence of bioactive constituents in different parts of *Mimusops elengi*, providing a basis for its continued investigation as a medicinal plant (Kadam et al., 2012).

The leaves of *Mimusops elengi* represent a readily available plant material and may serve as a useful source of bioactive phytoconstituents. Ethanolic extraction is frequently employed for the extraction of polar to moderately polar phytochemicals, including phenolic and flavonoid compounds. Preliminary phytochemical screening provides information regarding the major classes of secondary metabolites present in the extract, while quantitative estimation of total phenolic and flavonoid contents provides further insight into its phytochemical profile. Such characterization is important for establishing a relationship between the chemical composition of the extract and its observed biological activity (Kadam et al., 2012).

Experimental models of arthritis are widely used for the preliminary evaluation of potential anti-arthritic agents. Complete Freund's adjuvant (FCA)-induced arthritis in rats is a commonly employed experimental model because it produces persistent inflammatory changes accompanied by paw swelling and alterations in inflammatory and oxidative stress markers. Such models are useful for assessing the effects of plant extracts and bioactive compounds on experimentally induced inflammatory arthritis (Choudhary et al., 2015).

Assessment of paw volume provides a direct measure of inflammatory edema, whereas estimation of PGE_2, IL-1β, and TNF-α provides information regarding the inflammatory response. Measurement of GSH and SOD further helps in evaluating the antioxidant status associated with the inflammatory condition. Changes in inflammatory and oxidative stress

biomarkers have been used to investigate the pharmacological effects of potential anti-inflammatory and anti-arthritic agents in experimental models (Hijazy et al., 2023).

In view of the reported medicinal importance of *Mimusops elengi* and the potential biological significance of its phytoconstituents, systematic investigation of its leaves may provide useful information regarding its anti-arthritic potential. Therefore, the present study was designed to prepare and characterize the ethanolic extract of *Mimusops elengi* leaves, investigate its phytochemical composition, and evaluate its anti-arthritic activity using the FCA-induced arthritic rat model. The study further assessed the effects of the extract on paw volume, PGE_2, IL-1β, TNF-α, GSH, and SOD levels to obtain a broader understanding of its possible anti-inflammatory and antioxidant effects.

Materials

The materials used in the study consisted of various analytical-grade chemicals procured from reputed suppliers. Potassium mercuric iodide and picric acid were obtained from Thomas Baker, Mumbai. Iodine, potassium iodide, sodium nitropruside, sodium hydroxide, lead acetate, and Folin–ciocalteu reagent were procured from Loba Chemie Pvt. Ltd., Mumbai. Potassium bismuth iodide, pyridine, gelatin, nitric acid, copper acetate, and sodium chloride were obtained from S. D. Fine Chem. Ltd., Mumbai. Organic solvents such as methanol, ethanol, and chloroform were supplied by Qualigens Fine Chemicals, Mumbai. Fehling's solution was procured from Central Drug House Ltd., Delhi. All chemicals and reagents used in the study were of analytical grade and utilized without further purification.

Methods

Physicochemical parameters

Organoleptic characters

It included evaluation of plant powder by colour and odour.

Fluorescence analysis

Fluorescence analysis of the drug was observed under day and UV light using various solvent extracts as well as acids and alkaline treated with solutions of the drug. The powder was treated with neutral, acids and alkaline solvents solutions like acetic acid, picric acid, $FeCl_3$, 1 N hydrochloric acid, 1% sulphuric acid 1 N NaoH nitric acid, aqueous and KoH.

Extraction by soxhlet extraction process

Extraction from plant materials is an important step in phytochemical processing for discovering bioactive secondary metabolite. Selection of a suitable extraction technique is also important for the standardization of herbal products.

Extraction is used to extract suitable soluble constituents, with the aid of the chosen solvents except those not necessary. The products obtained from the plant were thoroughly washed in tap water and rinsed in purified water. The cool, stable samples obtained from the plants were cut into small pieces and dried under shade for 3 to 4 weeks. 50 gram of powdered of *Mimusops elengi* has been extracted with ethanol solvent using soxhlet extraction process for 48 hrs, filtered and dried using vacuum evaporator at 40°C (Mukherjee, 2007).

Determination of percentage yield

The extraction yield is evaluate of the solvent's efficiency to extracts bioactive components from the selected natural plant samples and it was defined as quantity of plant extracts recovered in mass after solvent extraction compared with the initial quantity of plant samples. After extraction, yield of the plant extracts obtained were calculated in grams and then converted it into percentage. The percentage yield of each extract was calculated by using following formula:

$$\textbf{Percentage Yield} = \frac{Weight\ of\ Extract}{Weight\ of\ Powder\ drug\ taken} x\ 100$$

Phytochemical screening

Medicinal plants are resources of traditional medicines and many of the modern medicines are produced indirectly from plants. Phytochemical constituents are of two type primary bioactive constituents (chlorophyll, proteins, amino acids, sugar etc.) and secondary bioactive constituents include (alkaloids, terpenoids, phenols, flavonoids etc.). Phytochemical examinations were carried out for all the extracts as per the standard methods (Kokate, 1994).

Quantitative estimation of bioactive compounds

Estimation of total phenol content

The total phenol content of the extract was determined by the modified folin-ciocalteu method (Gaur Mishra *et al.,* 2017). 10 mg Gallic acid was dissolved in 10 ml methanol, various aliquots of 5-25µg/ml was prepared in methanol. 10 mg of dried extract was dissolved in 10 ml methanol and filter. Two ml (1mg/ml) of this extract was for the estimation of phenol. 2 ml of extract and each standard was mixed with 1 ml of folin-ciocalteu reagent (previously diluted with distilled water 1:10 v/v) and 1 ml (7.5g/L) of sodium carbonate. The mixture was vortexed for 15s and

allowed to stand for 10min for color development. The absorbance was measured at 765 nm using a spectrophotometer.

Estimation of total flavonoids content

Determination of total flavonoids content was based on aluminum chloride method (Gaur Mishra *et al.,* 2017). 10 mg quercetin was dissolved in 10 ml methanol, and various aliquots of 5-25µg/ml were prepared in methanol. 10 mg of dried extract was dissolved in 10 ml methanol and filter. Three ml (1mg/ml) of this extract was for the estimation of flavonoids. 1 ml of 2% $AlCl_3$ solution was added to 3 ml of extract or each standard and allowed to stand for 15min at room temperature; absorbance was measured at 420 nm.

In vivo* antiarthritic activity of *Mimusops elengi

Freund's complete adjuvant (FCA)-induced arthritis in rats

Animals

Albino Wistar rats of both sexes, weighing 150-200 g, were kept in groups of six under a conventional 12-hour light/dark cycle, with controlled relative humidity (55–65%) and ambient temperature (25 ± 2 °C). Standard rat feed and unlimited water were given to the animals. The rats were acclimated to laboratory conditions for seven days prior to research. Every trial was carried out between 8:00 and 15:00 in a quiet setting. For every experimental set, a different set of six rats was employed. The Institutional Animal Ethics Committee (IAEC), which was established in accordance with the regulations of the Ministry of Environment and Forests, Government of India, New Delhi, for the control and monitoring of animal studies, approved the study protocol.

Acute oral toxicity study

Acute oral toxicity was conducted according to the method of the Organization for Economic Co-operation and Development (OECD) (Saleem *et al.,* 2020). An extract of *Mimusops elengi* (up to 2000 mg/kg) was administered orally for 4 days to six groups of rats (n=6), and the animals were observed for mortality and behavioral changes to evaluate a possible anti-arthritic effect.

Anti-arthritis activity

Freund's adjuvant induced arthritis in rats: Animals were divided into five groups containing six animals each. Arthritic syndrome was induced by subcutaneous injection of 0.1ml of complete

Freund's adjuvant (10 mg of heat killed mycobacterium tuberculosis per ml of paraffin oil) into the planter surface of the left hind paw (Rathore *et al.,* 2023).

Group I served as the normal and received 2% gum acacia

Group II served as the arthritis control-untreated received 2% gum acacia,

Group III received Indomethacin (0.25 mg/kg, i.p.), served as the reference standard

Group IV received the extract of *Mimusops elengi* at doses of 100mg/kg p.o.

Group V received the extract of *Mimusops elengi* at doses of 200mg/kg p.o.

The drug treatment was started on the 14th day of adjuvant induction and terminated on the 28th day. The changes in paw volume were measured weekly by using a plethysmometer.

Estimation of PGE2

An ELISA kit was used to estimate PGE2 levels by competitive binding. 0.15 ml of samples, control, and standard were added to precoated wells in a 96-well microtiterplate. The PGE2 antibody (50µl) was then added, and the microplate was shaken horizontally at 500 ± 50 rpm at 37°C. The PGE2 conjugate (50 µL) was added to each well and incubated for the next 2 hours after the first 60 minutes. The substrate solution (200µl) was then added to each well, and the mixture was allowed to sit at room temperature for 30 minutes. The reaction was then stopped by adding the stop solution (100µl), and the optical density was measured at 450 nm (Alzarea *et al.,* 2022).

Estimation of Cytokines

ELISA kits were used to measure pro-inflammatory cytokines TNF-α and IL-1β. The quantity of markers was expressed as pg/ml of serum and determined using standard curves.

Endogenous Antioxidants

The Ellman method was used to quantify the reduced glutathione (GSH). Superoxide dismutase (SOD) was measured using the Misra and Fridovich technique. 100µl of the sample was combined with 1.9ml of phosphate buffer (50mM, pH 7.0) in a cuvette, and 1.0ml of freshly made H_2O_2 (30mM) was added as a reaction initiator to determine the catalase activity (Alavala *et al.,* 2020).

Statistical analysis

The values were expressed as mean ± SEM (n=6). Statistical significance was assessed using one-way analysis of variance (ANOVA), followed by Tukey's test; $P<0.05$, $P<0.01$, and $P<0.001$ were considered statistically significant.

Results and Discussion

The fluorescence analysis of the powdered leaves of *Mimusops elengi* was performed using different chemical reagents under visible light, short UV light (254 nm), and long UV light (366 nm). The untreated powdered drug exhibited a green colour under visible and short UV light, while black fluorescence was observed under long UV light. Similar fluorescence responses were observed after treatment with most of the chemical reagents. Acetic acid, picric acid, 1 N HCl, 1 N NaOH, nitric acid, distilled water, and KOH produced green fluorescence under visible and short UV light and black fluorescence under long UV light. Ferric chloride produced a black colour under visible light and green fluorescence under short UV light, whereas 1% sulphuric acid produced brick-red fluorescence under short UV light. These characteristic changes in fluorescence may be attributed to the presence of different phytoconstituents and their reactions with the applied chemical reagents. The observed fluorescence characteristics can therefore serve as useful preliminary parameters for identification and standardization of *Mimusops elengi* leaves, as presented in Table 1.

The ethanolic extraction of *Mimusops elengi* leaves produced a black-coloured extract with a characteristic odour. The percentage yield of the ethanolic extract was found to be 6.20% w/w. The obtained yield indicates successful extraction of the soluble constituents from the powdered plant material using ethanol. The colour and characteristic odour of the extract may be associated with the presence of various secondary metabolites and other extractable constituents. The observed extract characteristics and percentage yield are summarized in Table 2. The percentage yield may also provide a useful parameter for evaluating the efficiency and reproducibility of the extraction procedure.

Preliminary phytochemical screening of the ethanolic extract of *Mimusops elengi* leaves revealed the presence of several important classes of phytoconstituents. Alkaloids showed a positive response with Wagner's test but a negative response with Hager's test. Glycosides were detected by the concentrated sulphuric acid test. Flavonoids showed a positive reaction with the lead acetate test, although the alkaline reagent test was negative. Phenolic compounds were detected by the ferric chloride test, while tannins showed a positive response to the gelatin test. Carbohydrates were also detected by both Fehling's and Benedict's tests. In contrast, saponins, proteins, diterpenes, and sterols showed negative reactions with their respective tests. The presence of flavonoids, phenols, tannins, alkaloids, glycosides, and carbohydrates suggests that

the ethanolic extract contains a diverse range of biologically active constituents. These phytoconstituents may contribute to the pharmacological properties of *Mimusops elengi*. The results of the preliminary phytochemical screening are presented in Table 3.

Quantitative phytochemical analysis demonstrated that the ethanolic extract of *Mimusops elengi* contained measurable amounts of phenolic and flavonoid compounds. The total phenolic content was found to be 0.523 mg/100 mg, whereas the total flavonoid content was 0.641 mg/100 mg of extract. The comparatively higher flavonoid content suggests the appreciable presence of flavonoid constituents in the ethanolic extract. Phenolic and flavonoid compounds are recognized for their antioxidant and potential anti-inflammatory properties and may contribute to the biological activity observed with the plant extract. The quantitative results of total phenolic and flavonoid contents are shown in Table 4.

The anti-inflammatory effect of the ethanolic extract of *Mimusops elengi* was evaluated in FCA-induced arthritic rats by monitoring paw volume on days 7, 14, 21, and 28. The normal control group showed relatively constant paw volume throughout the experimental period, with values decreasing slightly from 0.23 ± 0.03 ml on day 7 to 0.20 ± 0.02 ml on day 28. In contrast, the arthritic control group exhibited a progressive increase in paw volume from 0.78 ± 0.04 ml on day 7 to 1.19 ± 0.05 ml on day 28, confirming the successful induction and progression of arthritis.

Treatment with the standard drug markedly reduced paw swelling compared with the arthritic control group. The *Mimusops elengi* extract also produced a dose- and time-dependent reduction in paw volume. The low-dose extract reduced paw volume to 0.42 ± 0.03 ml by day 28, while the high-dose extract produced a greater reduction to 0.29 ± 0.03 ml. The reductions were statistically significant, particularly during the later observation periods. The greater effect observed with the high dose indicates a possible dose-dependent anti-inflammatory activity of the extract. These findings suggest that *Mimusops elengi* extract can attenuate FCA-induced inflammatory swelling and may possess significant anti-arthritic activity. The changes in paw volume are presented in Table 5.

The arthritic control group showed a pronounced elevation in PGE_2 concentration (126.4 ± 5.2 pg/ml) compared with the normal control group (36.8 ± 2.1pg/ml), indicating enhanced inflammatory activity following FCA administration. Treatment with the standard drug significantly reduced PGE_2 levels to 46.7 ± 2.8pg/ml. Administration of *Mimusops elengi* extract

also produced a significant reduction, with PGE_2 levels decreasing to 72.9 ± 3.5 pg/ml in the low-dose group and 55.8 ± 3.0pg/ml in the high-dose group. The greater reduction produced by the high dose suggests that the extract may suppress inflammatory mediator production. The observed reduction in PGE_2 may contribute to the decreased paw edema observed in the treated animals. The effect of the extract on PGE_2 levels is summarized in Table 6.

IL-1β levels were markedly elevated in the arthritic control group (102.7 ± 4.8 pg/ml) compared with the normal control group (22.8 ± 1.6pg/ml), demonstrating enhanced inflammatory cytokine activity in FCA-induced arthritis. Treatment with the standard drug reduced IL-1β levels to 34.9 ± 2.4pg/ml. The low-dose *Mimusops elengi* extract reduced IL-1β concentration to 61.5 ± 3.3pg/ml, whereas the high-dose treatment produced a greater reduction to 46.2 ± 2.7 pg/ml. The significant reduction in IL-1β levels suggests that the extract may exert its anti-inflammatory effect partly through modulation of pro-inflammatory cytokine production. The findings are presented in Table 7.

The TNF-α concentration was substantially increased in the arthritic control group (108.6 ± 5.1 pg/ml) compared with the normal control group (23.4 ± 1.7pg/ml). Administration of the standard drug significantly reduced TNF-α levels to 36.8 ± 2.5 pg/ml. Treatment with *Mimusops elengi* extract produced a significant reduction in TNF-α levels, with values of 64.7 ± 3.4 pg/ml and 48.9 ± 2.8 pg/ml observed for the low- and high-dose groups, respectively. The greater reduction in the high-dose group indicates a dose-dependent effect and suggests that *Mimusops elengi* may inhibit inflammatory responses associated with TNF-α production. The results are shown in Table 8.

FCA-induced arthritis produced a marked reduction in antioxidant status, as indicated by decreased GSH and SOD levels in the arthritic control group. GSH decreased from 8.94 ± 0.36 µmol/mg in the normal control group to 2.96 ± 0.18 µmol/mg, while SOD decreased from 16.4 ± 0.65 U/mg to 5.92 ± 0.34 U/mg. Treatment with the standard drug substantially restored GSH and SOD levels to 7.82 ± 0.31 µmol/mg and 14.6 ± 0.57 U/mg, respectively.

The *Mimusops elengi* extract also significantly improved the antioxidant status of arthritic animals. The low-dose group showed GSH and SOD levels of 5.74 ± 0.24 µmol/mg and 10.5 ± 0.43 U/mg, respectively, whereas the high-dose group showed higher values of 6.96 ± 0.28 µmol/mg and 12.9 ± 0.51 U/mg, respectively. The greater restoration observed with the high dose indicates improved antioxidant protection and suggests that the extract may counteract

oxidative stress associated with FCA-induced inflammation. The findings for GSH and SOD are presented in Table 9.

Table 1: Fluorescence analysis of leaves of *Mimusops elengi*

S. No.	Treatment with Chemical Reagent	Visible Light	Short UV (254 nm)	Long UV (366 nm)
1	Acetic acid	Green	Green	Black
2	Picric acid	Green	Green	Black
3	Ferric chloride ($FeCl_3$)	Black	Green	Black
4	1 N Hydrochloric acid (HCl)	Green	Green	Black
5	1% Sulphuric acid (H_2SO_4)	Green	Brick red	Black
6	1 N Sodium hydroxide (NaOH)	Green	Green	Black
7	Nitric acid (HNO_3)	Green	Green	Black
8	Distilled water (Aqueous)	Green	Green	Black
9	Potassium hydroxide (KOH)	Green	Green	Black
10	Powder as such	Green	Green	Black

Table 2: % Yield of *Mimusops elengi*

S. No.	Extract	Colour	Odor	% Yield (w/w)
1.	Ethnaolic	Black	Characteristic	6.20

Table 3: Result of phytochemical screening of ethnaolic extract of *Mimusops elengi*

S. No.	Constituents	Ethnaolic extract
1.	**Alkaloids**	
	Wagner's test:	+Ve
	Hager's test:	-Ve
2.	**Glycosides**	
	Conc. H_2SO_4 test	+Ve
3.	**Flavonoids**	
	Alkaline reagent test:	-Ve
	Lead acetate test:	+Ve
4.	**Saponins**	
	Froth test:	-Ve
5.	**Phenol**	
	Ferric chloride test:	+Ve
6.	**Proteins**	
	Xanthoproteic test:	-Ve
7.	**Carbohydrate**	
	Fehling's test:	+Ve
	Benedict's test:	+Ve
8.	**Diterpenes**	
	Copper acetate test:	-Ve
9.	**Tanins**	
	Gelatin test	+Ve
10.	**Sterols**	
	Salkowski test	-Ve

[+Ve= Present; -Ve= Absent]

Table 4: Total phenol and flavonoid content of *Mimusops elengi*

S. No.	Extract	Total phenol content	Total flavonoid content
		mg/ 100mg	
1.	Ethnaolic extract	0.523	0.641

Table 5: Effect of *Mimusops elengi* extract on paw volume in FCA-induced arthritic rats

Group	Day 7 (ml)	Day 14 (ml)	Day 21 (ml)	Day 28 (ml)
Group I (Normal Control)	0.23 ± 0.03	0.22 ± 0.02	0.21 ± 0.03	0.20 ± 0.02
Group II (Arthritic Control)	0.78 ± 0.04	0.97 ± 0.05	1.12 ± 0.04	1.19 ± 0.05
Group III (Standard Drug)	0.59 ± 0.03	0.43 ± 0.02**	0.31 ± 0.03***	0.24 ± 0.02***
Group IV (*Mimusops elengi* Extract Low Dose)	0.70 ± 0.04	0.62 ± 0.03*	0.53 ± 0.03**	0.42 ± 0.03**
Group V (*Mimusops elengi* Extract High Dose)	0.65 ± 0.03*	0.52 ± 0.03**	0.40 ± 0.02***	0.29 ± 0.03***

Values expressed as mean ± SEM (n=6) *P<0.05, **P<0.01, *** P<0.001 as compared to arthritis Control

Table 6: Effect of *Mimusops elengi* extract on PGE_2 levels in FCA-induced arthritic rats

Group	PGE_2 Levels (pg/ml)
Group I (Normal Control)	36.8 ± 2.1
Group II (Arthritic Control)	126.4 ± 5.2
Group III (Standard Drug)	46.7 ± 2.8***
Group IV (*Mimusops elengi* Extract Low Dose)	72.9 ± 3.5**
Group V (*Mimusops elengi* Extract High Dose)	55.8 ± 3.0***

Values expressed as mean ± SEM (n=6) *P<0.05, **P<0.01, *** P<0.001 as compared to arthritis Control

Table 7: Effect of *Mimusops elengi* extract on IL-1β levels in FCA-induced arthritic rats

Group	IL-1β Levels (pg/ml)
Group I (Normal Control)	22.8 ± 1.6
Group II (Arthritic Control)	102.7 ± 4.8
Group III (Standard Drug)	34.9 ± 2.4***
Group IV (*Mimusops elengi* Extract Low Dose)	61.5 ± 3.3**
Group V (*Mimusops elengi* Extract High Dose)	46.2 ± 2.7***

Values expressed as mean ± SEM (n=6) *P<0.05, **P<0.01, *** P<0.001 as compared to arthritis Control

Table 8: Effect of *Mimusops elengi* extract on TNF-α levels in FCA-induced arthritic rats

Group	TNF-α Levels (pg/ml)
Group I (Normal Control)	23.4 ± 1.7
Group II (Arthritic Control)	108.6 ± 5.1
Group III (Standard Drug)	36.8 ± 2.5***
Group IV (*Mimusops elengi* Extract Low Dose)	64.7 ± 3.4**
Group V (*Mimusops elengi* Extract High Dose)	48.9 ± 2.8***

Values expressed as mean ± SEM (n=6) *P<0.05, **P<0.01, *** P<0.001 as compared to arthritis Control.

Table 9: Effect of *Mimusops elengi* extract on GSH and SOD levels in FCA-induced arthritic rats

Group	GSH Levels (µmol/mg)	SOD Levels (U/mg)
Group I (Normal Control)	8.94 ± 0.36	16.4 ± 0.65
Group II (Arthritic Control)	2.96 ± 0.18	5.92 ± 0.34
Group III (Standard Drug)	7.82 ± 0.31***	14.6 ± 0.57***
Group IV (*Mimusops elengi* Extract Low Dose)	5.74 ± 0.24**	10.5 ± 0.43**
Group V (*Mimusops elengi* Extract High Dose)	6.96 ± 0.28***	12.9 ± 0.51***

Values expressed as mean ± SEM (n=6) *P<0.05, **P<0.01, *** P<0.001 as compared to arthritis Control.

Conclusion

The present study demonstrated that the ethanolic leaf extract of *Mimusops elengi* possesses promising phytochemical, anti-inflammatory, and antioxidant properties. Phytochemical screening confirmed the presence of alkaloids, glycosides, flavonoids, phenolic compounds,

tannins, and carbohydrates, while quantitative analysis revealed appreciable amounts of total phenolic and flavonoid constituents. In the FCA-induced arthritic model, treatment with the extract produced a dose- and time-dependent reduction in paw edema. The extract also significantly decreased the elevated levels of inflammatory mediators, including PGE_2, IL-1β, and TNF-α, compared with the arthritic control group. Furthermore, treatment improved the reduced levels of GSH and SOD, indicating a beneficial effect on the antioxidant defense system. The high-dose extract showed greater activity and produced responses approaching those of the standard treatment. The findings support the potential anti-arthritic activity of *Mimusops elengi* leaves, which may be associated with the combined anti-inflammatory and antioxidant effects of its phytoconstituents. Further studies involving isolation and characterization of active constituents, detailed mechanistic investigations, toxicity evaluation, and clinical studies are warranted to establish its therapeutic potential.

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