INTERNATIONAL CONFERENCE
ON LIFESTYLE DISEASES AND NATURAL MEDICINE (ICOLIFEMED)
Nomor ISSN: 3124-1115

Phytochemical screening and in vitro anti-inflammatory evaluation of *Garcinia mangostana* peel extract

Mangatas Halomoan Parluhutan Hutagalung *[1], Gusbakti Rusip[2], Florenly[3]

[1]Doctoral Program, Faculty of Medicine, Universitas Prima Indonesia, Medan, Indonesia

[2]Department of Family Medicine, Faculty of Medicine, Universitas Prima Indonesia, Medan, Indonesia

[3]Faculty of Medicine, Universitas Prima Indonesia, Medan, Indonesia

*E-mail : mangatashutagalung@unprimdn.ac.id

ABSTRACT

Inflammation is a natural defense mechanism that can become harmful when chronic, contributing to several degenerative diseases. This study evaluated the phytochemical composition and in vitro anti-inflammatory activity of *Garcinia mangostana* peel extract. The peels were macerated in 70 percent ethanol, and qualitative screening revealed the presence of xanthones, flavonoids, tannins, saponins, triterpenoids, and glycosides, while alkaloids were absent. Anti-inflammatory activity was assessed through inhibition of Bovine Serum Albumin and egg albumin denaturation, with aspirin serving as the reference drug. The extract demonstrated concentration-dependent inhibition of Bovine Serum Albumin denaturation ranging from 58.45 to 73.50 percent, closely comparable to aspirin 66.90 to 76.20 percent. In the egg albumin assay, inhibition increased from 12.80 to 33.40 percent, while aspirin showed 30.40 to 52.60 percent. The strong presence of xanthones and flavonoids likely contributes to the observed effects by stabilizing protein structures and preventing heat-induced denaturation. These findings confirm that Garcinia mangostana peel extract possesses promising anti-inflammatory potential, supporting its traditional medicinal use and highlighting its value as a natural source for developing safer anti-inflammatory agents.

Keywords: *Garcinia mangostana, xanthones, phytochemical screening, anti-inflammatory activity, protein denaturation*

INTRODUCTION

Inflammation Inflammation is a protective physiological process that enables the body to eliminate harmful stimuli and promote tissue repair. While acute inflammation is beneficial, chronic inflammation can lead to the progression of many degenerative diseases, including

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rheumatoid arthritis, atherosclerosis, diabetes, and even certain cancers. The persistence of inflammatory mediators such as cytokines, prostaglandins, and reactive oxygen species (ROS) contributes to oxidative stress and tissue destruction (Ahmed, 2011). Therefore, developing safer and more effective anti-inflammatory agents is a major pharmacological goal. Conventional anti-inflammatory drugs, including corticosteroids and nonsteroidal anti-inflammatory drugs (NSAIDs), provide rapid relief but are often associated with adverse effects such as gastric irritation, renal toxicity, and cardiovascular risk upon prolonged use (Sohail, et al., 2023). Consequently, there is increasing interest in plant-derived compounds as alternative therapeutic options. Phytochemicals such as flavonoids, and phenolic acids are known to modulate inflammatory pathways by scavenging free radicals, inhibiting cyclooxygenase (COX) and lipoxygenase (LOX) enzymes, and suppressing nuclear factor kappa B (NF-κB) activation (Al-Khayri et al., 2022).

One of the promising natural sources of anti-inflammatory compounds is *Garcinia mangostana* L., commonly known as mangosteen, belonging to the Clusiaceae family. The pericarp or peel of *G. mangostana* traditionally regarded as waste contains an abundance of xanthones, including α-mangostin, γ-mangostin, and garcinone E, which exhibit strong antioxidant, antimicrobial, and anti-inflammatory activities (Yuvanatemiya, et al., 2022). Traditionally, the peel has been used to treat skin infections, wounds, and diarrhea in Southeast Asian medicine.

Scientific evidence has demonstrated that flavonoid from mangosteen inhibit the production of pro-inflammatory mediators such as TNF-α, IL-1β, and COX-2, as well as reduce nitric oxide (NO) synthesis (Setiawan et al., 2022). These bioactivities suggest that the peel extract could act as a natural anti-inflammatory agent. However, few studies have explored its mechanism through simple in vitro models such as protein denaturation inhibition, which serves as a reliable indicator of anti-inflammatory activity. Protein denaturation leads to loss of structural integrity and formation of autoantigens, which can trigger inflammatory responses. Thus, preventing protein denaturation is a key target in anti-inflammatory drug development. In vitro assays such as bovine serum albumin (BSA) and egg albumin denaturation tests are widely used to screen anti-inflammatory potential due to their simplicity and reproducibility.

This study aimed to evaluate the phytochemical profile and in vitro anti-inflammatory potential of Garcinia mangostana peel extract using protein denaturation models. By comparing its inhibitory activity with the standard drug aspirin, this work provides

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experimental evidence supporting the traditional medicinal use of mangosteen peel and its potential as a natural anti-inflammatory agent.

METHODS

Ethical Clearance

The study received ethical clearance from the Ethics Committee of the Faculty of Medicine, Universitas Prima Indonesia, Medan, Indonesia (Approval Number:062/KEPK/UNPRI/X/2025).

Materials

Fresh Garcinia mangostana fruits were collected from local markets in Medan, North Sumatra, Indonesia. The fruit peels were separated, washed, and air-dried. Analytical-grade ethanol (70%), bovine serum albumin (BSA, Fraction V), phosphate buffer saline (PBS, pH 6.4), hydrochloric acid (HCl), and aspirin were purchased from Merck (Germany). All other chemicals used were of analytical grade.

Preparation of Extract

The dried mangosteen peels were ground into coarse powder and macerated in 70% ethanol at a 1:10 ratio (w/v) for 72 hours with occasional shaking. The filtrate was concentrated using a rotary evaporator at 45°C under reduced pressure to obtain a thick, dark-purple crude extract, which was stored at 4°C until analysis. (Kemenkes RI, 2017).

Phytochemical Screening

Qualitative phytochemical analyses were carried out using standard procedures to identify the major classes of secondary metabolites. Tests performed included Mayer's and Dragendorff's reagents for alkaloids, the Shinoda reaction (Mg–HCl) for flavonoids, the ferric chloride (1% $FeCl_3$) test for tannins, the foam test for saponins, the Liebermann–Burchard reaction for triterpenoids, and the Keller–Kiliani test for glycosides. The appearance or intensity of characteristic color changes or precipitates was used as an indicator of the presence of each respective phytochemical group (Nortjie et al., 2022).

Inhibition of Albumin Denaturation Assay

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The method was adapted from Rastogi et al. (2018) with modifications. The reaction mixture consisted of equal volumes of test extract (100, 200, and 400 µg/mL) and 1% BSA solution. The pH was adjusted with a few drops of 1N HCl, and the mixture was incubated at 37°C for 20 minutes, followed by heating at 70°C for 5 minutes. After cooling, absorbance was measured at 660 nm using a UV–Vis spectrophotometer. Aspirin was used as the reference standard.

The percentage inhibition of protein denaturation was calculated as:

$$\%\text{Inhibition} = 100 \times (1 - \frac{A_2}{A_1})$$

where $A_1$is the absorbance of the control and $A_2$is the absorbance of the test sample.

Protein Denaturation (Egg Albumin) Method

The egg albumin method followed Kiranmayi et al. (2018) with minor modifications. The reaction mixture contained 0.2 mL egg albumin, 2 mL extract at various concentrations (100, 200, 400 µg/mL), and 2.8 mL PBS (pH 6.4). The mixture was incubated at 37°C for 15 minutes, heated at 70°C for 5 minutes, cooled, and measured at 660 nm. Aspirin served as a reference.

$$\%\text{Inhibition} = \frac{A_{\text{control}} - A_{\text{treated}}}{A_{\text{control}}} \times 100$$

All experiments were performed in triplicate, and results were expressed as mean ± standard deviation (SD).

RESULTS

Phytochemical Constituents

Phytochemical The qualitative analysis of *Garcinia mangostana* peel extract revealed the presence of xanthones, flavonoids, tannins, saponins, triterpenoids, and glycosides, while alkaloids were absent (Table 1).

Table 1. Phytochemical profile of *Garcinia mangostana* peel extract

No	Phytochemical Parameter	Test Method	Observation	Result

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1	Alkaloids	Mayer's and Dragendorff's tests	No precipitate formed	(–): Absent
2	Flavonoids	Shinoda test (Mg–HCl)	Orange-red coloration	(+): Present
3	Tannins	Ferric chloride test	Dark green coloration	(+): Present
4	Saponins	Foam test	Persistent froth (>10 min)	(+): Present
5	Triterpenoids	Liebermann–Burchard test	Greenish-blue coloration	(+): Present
6	Glycosides	Keller–Kiliani test	Reddish-brown ring formed	(+): Present

Inhibition of Albumin Denaturation

The extract exhibited marked inhibition of BSA denaturation in a dose-dependent manner (Table 2). At concentrations of 100, 200, and 400 µg/mL, inhibition values were 58.45%, 67.12%, and 73.50%, respectively, compared to aspirin (66.90%–76.20%).

Table 2. Inhibition of albumin denaturation by *Garcinia mangostana* peel extract

No	Sample	Concentration (µg/mL)	Abs (A_2)	% Inhibition
1	Control (BSA 1%)	—	0.545	—
2	Aspirin	100	0.180	66.90%
		200	0.165	69.72%
		400	0.130	76.20%
3	*G. mangostana* Extract	100	0.226	58.45%
		200	0.179	67.12%
		400	0.145	73.50%

The results indicate that *G. mangostana* peel extract possesses strong anti-inflammatory potential comparable to aspirin, likely due to xanthones and flavonoids that prevent protein denaturation by forming hydrogen bonds with peptide chains, stabilizing their tertiary structure.

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Protein Denaturation (Egg Albumin) Assay

The extract also inhibited egg protein denaturation in a concentration-dependent pattern (Table 3). The inhibition ranged from 12.8% at 100 µg/mL to 33.4% at 400 µg/mL, while aspirin showed higher inhibition (30.4%–52.6%).

Table 3. Inhibition of egg protein denaturation by *G. mangostana* peel extract

No	Sample	Concentration (µg/mL)	Abs	% Inhibition
1	Control (Egg Albumin 4%)	—	0.680	—
2	Aspirin	100	0.474	30.40%
		200	0.410	39.70%
		400	0.322	52.60%
3	*G. mangostana* Extract	100	0.593	12.80%
		200	0.521	23.40%
		400	0.453	33.40%

DISCUSSION

The present study revealed that the ethanol extract of *Garcinia mangostana* peel contains several bioactive secondary metabolites, including flavonoids, tannins, saponins, triterpenoids, and glycosides, while alkaloids were absent. These compounds are known to contribute significantly to various pharmacological activities, particularly antioxidant and anti-inflammatory effects. The strong presence of flavonoids observed in the extract is consistent with previous studies that identified α-mangostin and γ-mangostin as the dominant xanthones in mangosteen peel, both possessing potent free radical–scavenging and enzyme-inhibitory activities (Jung et al., 2006). Flavonoids and tannins are also well-documented for their ability to modulate inflammatory mediators and stabilize cell membranes, suggesting a synergistic contribution to the extract's biological effect (Baqer et al., 2024).

The results of the in vitro anti-inflammatory assays demonstrated that the *G. mangostana* peel extract effectively inhibited protein denaturation in a concentration-dependent manner. In the BSA assay, the extract achieved up to 73.50% inhibition at 400 µg/mL, closely comparable to the standard drug aspirin, which reached 76.20%. This strong inhibition indicates that the extract can stabilize protein structures against heat-induced denaturation a mechanism associated with the prevention of inflammation-related tissue

Nomor ISSN: 3124-1115

damage. The comparable efficacy to aspirin suggests that polyphenolic compounds, especially xanthones, may form hydrogen bonds with protein residues, preventing unfolding and aggregation of the protein chains (Stefani & Rigacci, 2013).

In the egg albumin assay, the extract exhibited a lower but still concentration-dependent inhibition (12.80–33.40%) compared with aspirin (30.40–52.60%). The reduced activity may be related to structural differences between egg albumin and serum albumin or to variations in protein-binding affinity. Nevertheless, the positive trend indicates that *G. mangostana* peel extract possesses meaningful protein-stabilizing and anti-inflammatory potential. These findings align with earlier reports that phenol suppress inflammatory pathways by inhibiting nitric oxide synthesis and downregulating COX-2 and NF-κB activity (Rudrapal et al., 2025). Overall, the results confirm that *G. mangostana* peel extract is a promising natural source of anti-inflammatory agents, supporting its traditional medicinal applications and encouraging further in vivo and molecular studies.

CONCLUSION

The ethanol extract of *Garcinia mangostana* peel demonstrated notable anti-inflammatory activity by inhibiting protein denaturation in both BSA and egg albumin assays. Phytochemical screening confirmed the presence of flavonoids, tannins, saponins, triterpenoids, and glycosides, which likely act synergistically to stabilize proteins and mitigate inflammation. The extract showed concentration-dependent effects comparable to aspirin, supporting its traditional use as a natural anti-inflammatory agent. Further in vivo and mechanistic studies are warranted to identify active compounds and elucidate their pharmacological pathways.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the Faculty of Medicine, Universitas Prima Indonesia, for providing laboratory facilities and technical support throughout this research.

Nomor ISSN: 3124-1115

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