# VALORIZING MANGO LEAF WASTE: GREEN CHEMISTRY EXTRACTION OF MANGIFERIN AND ITS EFFICACY IN MITIGATING OXIDATIVE STRESS

**SRI NAVEENKUMAR M [1], A ROHINI[2*]**

[1] II M.Sc Biochemistry Student, Department of Biochemistry, RVS College of Arts and Science, Coimbatore, Tamil Nadu, 641402, India

[2]Assistant Professor, Department of Biochemistry, RVS College of Arts and Science, Coimbatore, Tamil Nadu, 641402, India

## Abstract

Natural products serve as a fundamental reservoir for bioactive compounds, essential for advancing global health and achieving Sustainable Development Goal (SDG) 3. Among these, *Mangifera indica* (mango) leaves are a prolific source of mangiferin, a C-glucosyl xanthone traditionally valued in Ayurveda for its structural stability and diverse pharmacological potential, including anti-inflammatory, antidiabetic, and cardioprotective effects. This study focused on the sustainable extraction and antioxidant validation of mangiferin from agro-waste foliage, supporting SDG 12 (Responsible Consumption and Production). Mangiferin was extracted from leaf powder using Soxhlet extraction with 70% ethanol, followed by purification via dichloromethane partitioning and acid hydrolysis to yield pale-yellow needle-like crystals. The antioxidant efficacy was evaluated through Superoxide Dismutase (SOD) and Catalase (CAT) activity assays. Results demonstrated a robust dose-dependent increase in enzymatic activity. The linear progression confirms the potent radical-scavenging ability of the extract, reinforcing its role in neutralizing reactive oxygen species (ROS) and preventing oxidative stress. By bridging indigenous knowledge with green chemistry extraction techniques—such as ultrasound-assisted methods—this research highlights the valorization of agricultural byproducts into high-value therapeutics. Such findings validate the use of mango leaf-derived mangiferin as a sustainable candidate for pharmaceutical and dermatological applications, promoting economic growth and biodiversity conservation.

**Keywords:** Mangiferin, Mangifera indica, Superoxide Dismutase (SOD), Catalase (CAT), Antioxidant Activity, Sustainable Development Goals (SDGs)

## Introduction

Nature has traditionally served as a primary reservoir for bioactive agents essential to pharmaceutical advancement and public health. Plant-based compounds are especially significant due to their intricate chemical structures, diverse therapeutic effects, and generally favourable safety profiles. These organisms produce secondary metabolites—including alkaloids, flavonoids, terpenoids, and xanthones—which function as natural defence mechanisms against biological and environmental pressures. Transitioning toward plant-derived medicine aligns with Sustainable Development Goal (SDG) 3 (Good Health and Well-Being) by offering safer, preventive, and curative health options Newman, D. J *et al.*, (2012)

**Mangifera indica: A Sustainable Source of Mangiferin**

A primary example of these potent phytochemicals is mangiferin, a C-glucosyl xanthone concentrated in the foliage of the mango tree (*Mangifera indica L.*). While the mango fruit is a global economic staple, the leaves have been utilized for millennia in traditional medical systems like Ayurveda, Siddha, and Unani. Bridging ancient indigenous wisdom with modern scientific verification supports both SDG 3 and SDG 12 (Responsible Consumption and Production) (Imran *et al.*, 2017).

**Chemical Composition and Stability**

Mango leaves are a dense source of polyphenols, including:

- Flavonoids: Quercetin, catechin, and rutin.
- Phenolic Acids: Gallic and protocatechuic acids.
- Others: Tannins and triterpenes.

Mangiferin stands out as the most biologically active component. Its unique xanthone skeleton, characterized by a C-glycosidic bond and multiple hydroxyl groups, provides superior antioxidant capacity and greater chemical stability than O-glycosides. This resilience makes it highly suitable for pharmaceutical manufacturing and long-term storage, contributing to SDG 9 (Industry, Innovation, and Infrastructure) Kulkarni *et al.*, (2020)

**Therapeutic Potential and Pharmacological Scope**

Research indicates that mangiferin possesses a broad spectrum of medicinal properties, including:

- Protective Effects: Cardioprotective, hepatoprotective, and neuroprotective.
- Disease Management: Anti-inflammatory, antidiabetic, and anticancer activities.
- Pathogen Defense: Antiviral and antimicrobial properties.

By modulating metabolic pathways and reducing oxidative stress, mangiferin offers a viable strategy for managing chronic non-communicable diseases. Utilizing this compound helps lower the global disease burden and reduces long-term medical expenses (Saha & Ghosh, 2012).

**Green Chemistry and Waste Valorization**

The extraction of mangiferin is evolving from traditional maceration to green technologies such as ultrasound-assisted and microwave-assisted extraction. These methods are more efficient, use fewer solvents, and require less energy, adhering to SDG 13 (Climate Action).

Furthermore, mango leaves—often treated as agricultural byproduct—can be "valorized." Converting this waste into high-value bioactive products promotes:

1. Economic Growth: Creating rural jobs (SDG 8).

2. Resource Efficiency: Reducing environmental impact (SDG 12).
3. Biodiversity: Protecting plant resources (SDG 15). Kulkarni, V. M. *et al.,* (2020)

**Sample Collection and Preparation**

*Mangifera indica L.* leaves were sourced from the Sulur market in Coimbatore, India. To ensure purity, the specimens were cleaned sequentially with tap and distilled water. Dehydration was achieved through a 10–15 day shade-drying process at room temperature. The resulting dry material was reduced to a coarse powder using a mechanical mill and preserved in sealed, airtight containers to prevent degradation prior to use.

**Extraction Process**

A total of 250 g of pulverized, dehydrated mango leaves was processed via Soxhlet extraction using 1.5 L of 70% ethanol as the solvent. This procedure was maintained for a duration of 18 to 20 hours. Once the extraction was complete, the resulting liquid was passed through a filter. To recover the crude extract, the solution was condensed into a semi-solid state using a rotary evaporator under vacuum at a constant temperature of 40°C. The final residue was kept in cold storage at 4°C for subsequent analysis.

**Isolation and Crystallization**

The obtained concentrate was initially reconstituted in 50 mL of 50% ethanol. To eliminate non-polar contaminants, the mixture underwent a partitioning process with dichloromethane (100 mL), repeated four times. Following purification, the aqueous ethanol fraction was subjected to acid hydrolysis by refluxing with 2N sulfuric acid at a pH of 3. This reaction was carried out for 60 minutes under constant agitation. Once the mixture reached ambient temperature, it was washed three times with ethyl acetate to isolate the target fraction. These ethyl acetate phases were pooled and evaporated to dryness. The remaining solid was dissolved in ethanol and placed in a refrigerator overnight. This cooling process facilitated the formation of pale-yellow, needle-like crystals. These mangiferin crystals were then collected through filtration, dried thoroughly. (Kulkarni, V. M *et al.,* 2020)

**Methodology**

**Superoxide Dismutase Activity**

Superoxide dismutase (SOD) is a metallo enzyme that catalyse the dismutation superoxide radical into hydrogen peroxide ($H_2O_2$) and molecular oxygen ($O_2$ ) and consequently provide an important defense mechanism against superoxide radical toxicity (Nishikimi *et al.,* 1972).

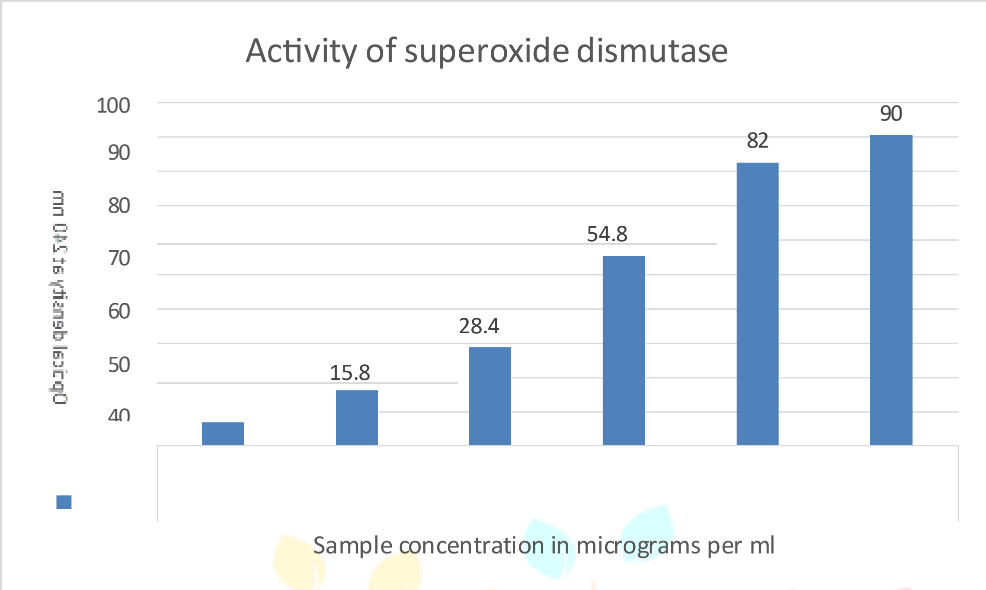
Superoxide radicals were generated in a PMS-NADH system by oxidation of NADH and assayed through reduction of NBT.

**Catalase Activity**

Catalase (CAT) is a key antioxidant hemoprotein that facilitates the decomposition of hydrogen peroxide ($H_2O_2$)into water ($H_2O$) and molecular oxygen ($O_2$). This enzymatic process serves as a primary line of defense, neutralizing the toxic effects of hydrogen peroxide and preventing the formation of highly reactive hydroxyl radicals within the cellular environment (Sinha, 1972)

**Results And Discussion**

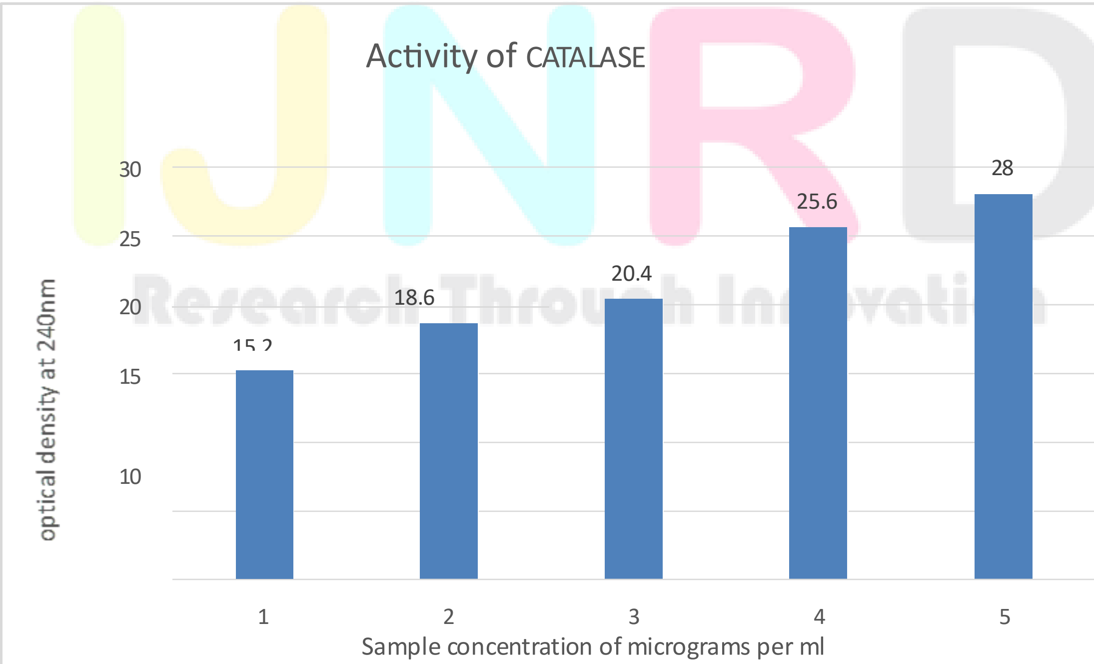
**Superoxide Dismutase Activity**




The graph illustrates a dose-dependent increase in the activity of Superoxide Dismutase relative to the concentration of the sample. As the concentration of the sample (measured in micrograms per ml) increases, there is a corresponding and significant rise in the measured optical density.

The results show a steady upward trend across the six measured intervals. The lowest measured activity starts at an optical density of 6.5. The activity more than doubles to 15.8, then consistently climbs to 28.4 and 54.8. The highest concentration tested yielded the maximum activity, reaching an optical density of 90. The linear-like progression suggests that the sample contains potent bioactive compounds—likely the mangiferin. At lower doses, the enzyme defense mechanism is present but limited. At the highest concentrations, the system demonstrates robust antioxidant capacity, effectively providing protection against superoxide radical toxicity.

**Catalase activity**




The results indicate that the extract possesses significant hydrogen peroxide scavenging ability. In biological systems, Catalase is responsible for the rapid decomposition of $H_2O_2$ into water and oxygen. The linear increase in optical density suggests that the bioactive components in the sample (such as mangiferin) act in a predictable, concentration-dependent manner to enhance antioxidant defense. The ability of the sample to maintain rising activity levels even at the highest test point indicates that it is an effective agent for neutralizing oxidative stress. This supports its potential use in treating conditions where reactive oxygen species (ROS) are elevated.

Antioxidants can be classified as those that act on the levels of prevention, interception, and repair. Antioxidant enzymes (SOD and CAT ) are preventive antioxidants, preventing the formation of Reactive OS. Interception of free radicals takes place mainly by radical scavenging. Here the most important role is played by low- molecular-weight antioxidants, such as vit C, carotenoids, and flavonoids. (Adwas *et al.*, 2019). The antioxidant defence mechanism plays an important role in protecting the skin against oxidative damage (Pai *et al.*, 2014)The skin is equipped with mechanisms aimed at combating free radicals and interrupting radical reaction(Wolfle *et al.*, 2014). The concentration of antioxidants is higher in the epidermis than in the dermis (Poljsak *et al.*, 2012). Fruits and leaves are the rich source of biologically active substances that have a significant effect on human skin Plants can exhibit a variety of properties, both medicinal in the case of certain skin diseases and promoting skin health, including through antioxidant effects.(Menaa *et al.*, 2014)

## Summary and Conclusion

The study establishes that mango leaves—frequently discarded as agricultural byproducts—are a high-value, renewable source of mangiferin with substantial therapeutic and economic promise. The successful isolation of this xanthone and the validation of its antioxidant properties position it as a viable candidate for pharmaceutical, nutraceutical, and cosmetic formulations. By adopting green chemistry principles, such as microwave or ultrasound-assisted extraction, this research promotes a circular bioeconomy that supports rural employment (SDG 8) and environmental resource efficiency (SDG 12). Ultimately, mangiferin represents a safe and sustainable strategy for managing oxidative stress-related conditions, contributing significantly to global health innovation

## REFERENCE


- Adwas A.A., Elsayed A.S.I., Azab A.E., Quwaydir F.A. Oxidative stress and antioxidant mechanisms in human body. *J. Appl. Biotechnol. Bioeng.* 2019;6:43–47 DOI: 10.15406/jabb.2019.06.00173
- David J. Newman and Gordon M. Cragg, Natural Products as Sources of New Drugs over the 30 Years from 1981 to 2010, Journal of Natural Products 2012, 75 (3), 311–335 DOI No.: 10.1021/np200906s
- Imran, M., et al. (2017). Mangiferin: A natural miracle bioactive compound against lifestyle-related disorders. *Lipids in Health and Disease*, 16, 84.
- Kulkarni, V. M., et al. (2020). Green extraction technologies for polyphenols from plant materials. *Journal of Cleaner Production*, 268, 122299
- Menaa F. Skin anti-aging benefits of phytoterapeutics-based emulsions. *Pharm. Anal. Acta.* 2014;5:168.DOI: 10.4172/2153-2435.1000e168
- Nishikimi, M., Rao, N. A., and Yagi, K.The occurrence of superoxide anion in the reaction of reduced phenazine methosulfate and molecular oxygen, Biochemical and Biophysical Research Communication, 1972, 46 (2) 849–854 DOI Number10.1016/S0006-291X(72)80218-3
- Pai V.V., Shukla P., Kikke N.N. Antioxidants in dermatology. *Indian Dermatol. Online J.* 2014;5:210–214. DOI: 10.4103/2229-5178.131127
- Poljšak B., Dahmane R.G., Godić A. Intrinsic skin aging: The role of oxidative stress. *Acta Dermatovener.*

2012;21:33–36

- Saha, S., & Ghosh, S. (2012). Tinospora cordifolia and mangiferin: Therapeutic prospects. *Asian Pacific Journal of Tropical Biomedicine*, 2(2), S107–S114
- Sinha, A. K, Colorimetric determination of catalase, Analytical Biochemistry, 1972, 47 (2)389–394 DOI Number: 10.1016/0003-2697(72)90132-7
- Wölfle U., Bauer G., Meinke M.C., Lademann J., Schempp C.M. Reactive molecule species and antioxidative mechanisms in normal skin and skin aging. *Skin Pharmacol. Physiol.* 2014;27:316–332. DOI: 10.1159/000360092