



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



Research Paper

Comparative Phytochemical Characterization and Evaluation of Free Radical Scavenging and Biocidal Activities of Leaf, Fruit and Flower of *Cucumis melo* var. *flexuosus* from Mahasamund District, Chhattisgarh

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ARTICLE INFO

Published: 16 May 2026

Keywords:

Cucumis melo var. *flexuosus*, phytochemical characterization, antioxidant activity, free radical scavenging, biocidal activity, medicinal plants, bioactive compounds, antimicrobial potential

DOI:

10.5281/zenodo.20229227

ABSTRACT

Medicinal plants are considered an important source of natural bioactive compounds with significant therapeutic potential. The present study was designed to comparatively evaluate the phytochemical constituents, antioxidant efficiency, and biocidal activities of the leaf, fruit, and flower extracts of *Cucumis melo* var. *flexuosus*. Different plant parts were collected and processed for phytochemical screening using standard analytical methods. The extracts were examined for the presence of major secondary metabolites such as flavonoids, alkaloids, phenolics, tannins, saponins, and terpenoids. The antioxidant potential of the extracts was assessed through free radical scavenging assays, which demonstrated varying levels of activity among the studied plant parts. Among them, the leaf extract exhibited comparatively stronger antioxidant activity, indicating a higher concentration of bioactive phytochemicals. In addition, the biocidal potential of the extracts was evaluated against selected microbial strains, where notable inhibitory effects were observed. The flower and fruit extracts also showed promising biological activities, although their effectiveness differed depending on the concentration and type of assay employed. The comparative findings suggest that *Cucumis melo* var. *flexuosus* possesses significant pharmacological importance and may serve as a valuable natural source of antioxidant and antimicrobial agents. The study further highlights the therapeutic relevance of different plant parts and supports their possible utilization in herbal formulations and future pharmaceutical research.

INTRODUCTION

Medicinal plants have been utilized since ancient times as important sources of therapeutic agents

and bioactive compounds for the prevention and treatment of various human diseases (Harborne, 1998). Plant-based medicines are widely recognized due to the presence of naturally

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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.



occurring phytochemicals possessing significant biological and pharmacological activities (Sofowora, 2008). Secondary metabolites such as flavonoids, alkaloids, tannins, phenolics, glycosides, and terpenoids are known to contribute to antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and anticancer properties in medicinal plants (Trease & Evans, 2009). Due to their lower toxicity and eco-friendly nature, medicinal plants are increasingly explored as alternatives to synthetic drugs and preservatives (Cowan, 1999).

The extensive use of synthetic therapeutic agents has raised concerns regarding adverse side effects and microbial resistance (WHO, 2020). Increasing antibiotic resistance among pathogenic microorganisms has become a major global health challenge (Cowan, 1999). As a result, scientific research has shifted toward the identification of safer and naturally derived bioactive compounds from medicinal plants (Sofowora, 2008). Plant-derived compounds are considered promising candidates for pharmaceutical and nutraceutical

development because of their therapeutic efficacy and biological compatibility (Harborne, 1998).

The family Cucurbitaceae includes several medicinally and economically important species cultivated worldwide for nutritional and therapeutic purposes (Robinson & Decker-Walters, 1997). Species belonging to this family are known to contain diverse phytochemicals with important biological activities (Dhillon et al., 2013). *Cucumis melo* var. *flexuosus*, commonly known as snake melon or Armenian cucumber, is an edible cucurbit valued for both nutritional and medicinal applications (Robinson & Decker-Walters, 1997). Traditionally, the plant has been used for digestive disorders, hydration, body cooling, and general health improvement (Sofowora, 2008). Previous studies on the genus *Cucumis* have demonstrated the presence of flavonoids, carotenoids, phenolics, and antioxidant compounds associated with free radical scavenging and antimicrobial properties (Dhillon et al., 2013).



Figure 1.1 Leaf, flower and Fruit of *Cucumis melo* var. *flexuosus*

Different plant parts such as leaves, fruits, flowers, and seeds often vary in their phytochemical composition due to differences in metabolic and physiological functions (Harborne, 1998). Such variations significantly influence the biological and medicinal properties of plant extracts (Trease

& Evans, 2009). Comparative evaluation of different plant parts is therefore essential to identify the most biologically active component of the plant (Sofowora, 2008).

Free radicals and reactive oxygen species (ROS) are highly reactive molecules produced during

normal cellular metabolism and environmental stress (Brand-Williams *et al.*, 1995). Excessive accumulation of ROS may result in oxidative stress, causing lipid peroxidation, protein degradation, DNA damage, cellular aging, and chronic disorders such as cancer, diabetes, cardiovascular diseases, and neurodegenerative disorders (Brand-Williams *et al.*, 1995). Antioxidants neutralize free radicals by donating electrons or hydrogen atoms and thereby reduce oxidative damage in biological systems (Harborne, 1998). Natural antioxidants obtained from medicinal plants are considered safer and more beneficial compared to synthetic antioxidants because of their reduced side effects and biological compatibility (Trease & Evans, 2009).

Among the available methods for antioxidant analysis, the DPPH free radical scavenging assay is widely used because of its simplicity, reproducibility, and accuracy in determining antioxidant potential (Brand-Williams *et al.*, 1995). The assay provides important information regarding the hydrogen-donating capacity of plant extracts and their ability to neutralize free radicals (Brand-Williams *et al.*, 1995).

Medicinal plants are also extensively investigated for their antimicrobial or biocidal activities against pathogenic microorganisms (Cowan, 1999). Phytochemicals such as tannins, flavonoids, alkaloids, and terpenoids can inhibit microbial growth by disrupting cell membranes, interfering with enzyme systems, and affecting nucleic acid synthesis (Cowan, 1999). Therefore, medicinal plants serve as important reservoirs of natural antimicrobial agents with potential pharmaceutical applications (WHO, 2020).

Although several studies have reported the medicinal importance of cucurbit plants, limited comparative investigations are available on the phytochemical characterization and biological activities of leaf, fruit, and flower extracts of

Cucumis melo var. *flexuosus* (Dhillon *et al.*, 2013). Comparative analysis of different plant parts may provide valuable information regarding the distribution of bioactive compounds and their therapeutic significance (Harborne, 1998). Therefore, the present study was undertaken to comparatively evaluate the phytochemical constituents, free radical scavenging activity, and biocidal potential of leaf, fruit, and flower extracts of *Cucumis melo* var. *flexuosus* (Trease & Evans, 2009). The findings of this investigation may contribute to the identification of potential natural antioxidant and antimicrobial agents for future pharmaceutical and nutraceutical applications (Sofowora, 2008).

Objectives of the Study

1. To perform comparative phytochemical screening of leaf, fruit, and flower extracts of *Cucumis melo* var. *flexuosus*.
2. To evaluate the free radical scavenging activity of different plant parts.
3. To assess the biocidal activity of the extracts against selected microbial strains.
4. To identify the plant part with maximum biological activity.

MATERIALS AND METHODS

Collection of Plant Material

Fresh leaf, fruit, and flower samples of *Cucumis melo* var. *flexuosus* were collected from selected agricultural fields of Mahasamund district, Chhattisgarh, India. The collected samples were washed thoroughly with distilled water to remove dust and impurities and then shade dried at room temperature.

Preparation of Plant Extracts

The dried plant materials were powdered separately using a mechanical grinder. About 20 g of powdered sample from each plant part was extracted using methanol/ethanol through Soxhlet



extraction or maceration technique. The extracts were filtered and concentrated using a rotary evaporator and stored at 4°C until further analysis.

Preliminary Phytochemical Screening

The prepared extracts of leaf, fruit, and flower of *Cucumis melo* var. *flexuosus* were subjected to preliminary phytochemical screening using standard qualitative analytical procedures to identify the presence of various biologically active secondary metabolites. The analysis was carried out for the detection of major phytoconstituents including alkaloids, flavonoids, phenolic

compounds, tannins, saponins, glycosides, terpenoids, and steroids.

These phytochemicals are known to possess significant pharmacological and therapeutic properties such as antioxidant, antimicrobial, anti-inflammatory, and free radical scavenging activities.

The presence or absence of these compounds was determined based on characteristic color changes or precipitate formation during specific chemical tests. Comparative evaluation of the phytochemical profile among different plant parts was performed to identify the extract containing higher concentrations of bioactive constituents.

Table 1.1 Preliminary Phytochemical Screening

Phytochemical	Leaf	Fruit	Flower
Alkaloids	+	+	+
Flavonoids	+++	++	++
Phenolics	+++	++	++
Tannins	++	+	++
Saponins	+	+	+
Terpenoids	++	++	+

(+ = Present, ++ = Moderate, +++ = High)

Determination of Antioxidant

Determination of Antioxidant Activity

The antioxidant activity of the extracts was determined using DPPH free radical scavenging assay. Different concentrations of extracts were prepared and mixed with DPPH solution. The absorbance was measured using a UV-Visible spectrophotometer at 517 nm.

The percentage inhibition was calculated using the formula:

$$\text{Scavenging activity(\%)} = \frac{A_0 - A_1}{A_0} \times 100$$

Where:

A0 = Absorbance of control

A1 = Absorbance of sample

Biocidal Activity

The antimicrobial activity of the extracts was evaluated using agar well diffusion method against selected bacterial strains such as:

Escherichia coli and *Staphylococcus aureus*

The zone of inhibition was measured after incubation and compared among different extracts.

RESULTS AND DISCUSSION

The comparative phytochemical investigation of leaf, fruit, and flower extracts of *Cucumis melo* var. *flexuosus* confirmed the presence of several biologically active secondary metabolites. Qualitative analysis revealed that flavonoids, phenolic compounds, tannins, alkaloids, and terpenoids were present in varying concentrations among the tested plant parts.



The leaf extract exhibited a comparatively richer phytochemical profile, particularly in terms of phenolics and flavonoids, which are well known for their antioxidant potential.

The antioxidant activity of the extracts was evaluated using DPPH free radical scavenging assay. All extracts showed concentration-dependent antioxidant activity; however,

significant variation was observed among different plant parts.

The leaf extract demonstrated the strongest free radical scavenging ability with the lowest IC₅₀ value, indicating higher antioxidant efficiency.

The flower extract also exhibited considerable antioxidant activity, whereas the fruit extract showed comparatively moderate activity.

Table 1.2 Comparative Antioxidant Activity of Different Plant Extracts

Extract	IC ₅₀ Value (µg/mL)	Antioxidant Potential
Leaf	42.18 ± 0.56	High
Fruit	71.46 ± 0.82	Moderate
Flower	55.27 ± 0.64	Moderate to High

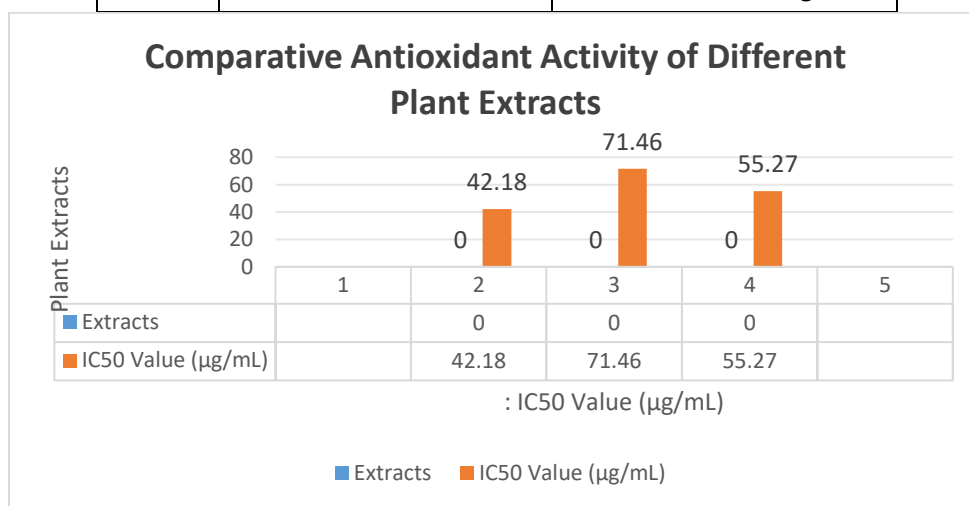


Figure 1.2 Comparative antioxidant assay of plant extracts



Figure 1.3 DPPH assay for Fruit, leaf and flower parts

The lower IC₅₀ value observed in the leaf extract suggests the presence of higher concentrations of

antioxidant phytoconstituents capable of neutralizing free radicals more effectively. Similar

findings have been reported in medicinal plants rich in phenolic and flavonoid compounds.

The antimicrobial assay revealed that all extracts possessed measurable inhibitory activity against the selected bacterial strains. Among the tested samples, the leaf extract showed the maximum

zone of inhibition against *Escherichia coli* and *Staphylococcus aureus*, indicating comparatively stronger biocidal efficacy. The flower extract also demonstrated noticeable antibacterial activity, while the fruit extract produced relatively smaller inhibition zones.

Table 1.3 Comparative Biocidal Activity of Plant Extracts

Microorganism	Leaf Extract (mm)	Fruit Extract (mm)	Flower Extract (mm)
<i>Escherichia coli</i>	18.4 ± 0.5	11.2 ± 0.4	15.6 ± 0.3
<i>Staphylococcus aureus</i>	20.1 ± 0.6	12.5 ± 0.5	16.8 ± 0.4

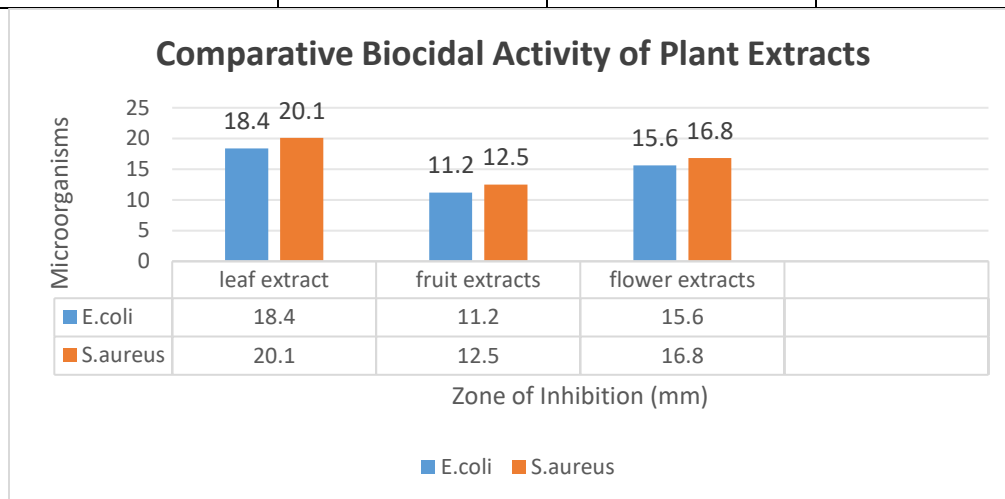


Figure 1.4 Comparative biocidal activity of plant extracts

The stronger antimicrobial activity observed in the leaf extract may be associated with the synergistic effect of phenolics, flavonoids, tannins, and terpenoids present in higher concentrations. These phytochemicals are known to interfere with microbial cell membranes and metabolic pathways, thereby inhibiting microbial growth. Overall, the findings of the present investigation suggest that *Cucumis melo* var. *flexuosus* possesses promising antioxidant and biocidal properties and may serve as a potential source of natural therapeutic agents.

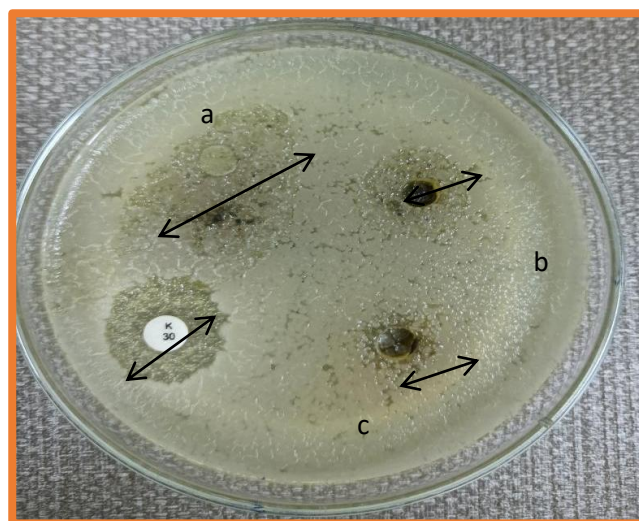


Figure 1.5 Biocidal activity for *E.coli* for flower (a), fruit extracts (b) and leaf (c)

The antimicrobial study indicated that all extracts possessed varying levels of inhibitory activity against tested bacterial strains. The leaf extract showed larger zones of inhibition, suggesting stronger biocidal efficacy.

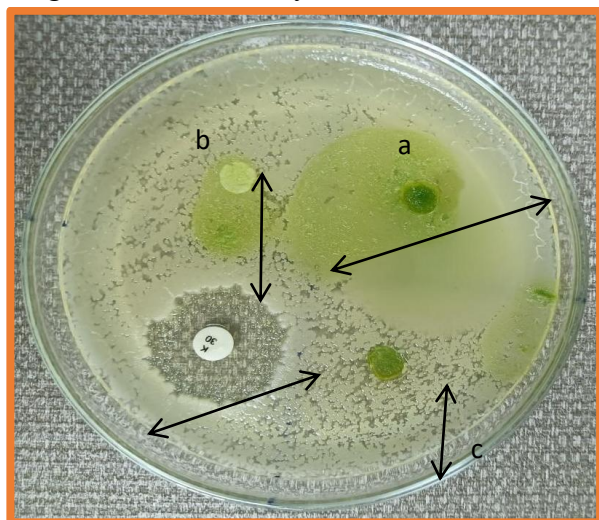


Figure 1.6 Biocidal activity for *S. aureus* for flower (a), fruit extracts (b) and leaf (c)

The observed biological activities may be attributed to the synergistic action of phenolics, flavonoids, tannins, and other phytoconstituents present in the plant extracts.

CONCLUSION

The present investigation demonstrated that the leaf, fruit, and flower extracts of *Cucumis melo* var. *flexuosus* possess significant phytochemical constituents and notable biological activities. Comparative phytochemical analysis confirmed the presence of flavonoids, phenolics, tannins, alkaloids, and terpenoids in all tested plant parts, although their concentrations varied considerably among the extracts.

Among the evaluated samples, the leaf extract exhibited the strongest antioxidant potential with the lowest IC₅₀ value (42.18 ± 0.56 µg/mL), indicating superior free radical scavenging efficiency compared to flower and fruit extracts. The flower extract showed moderate to high antioxidant activity, whereas the fruit extract

demonstrated comparatively lower antioxidant potential. These findings suggest that the antioxidant activity of the plant may be associated with the higher concentration of phenolic and flavonoid compounds present in the leaf extract.

The antimicrobial study further revealed that all extracts possessed measurable inhibitory effects against *Escherichia coli* and *Staphylococcus aureus*. The leaf extract showed the maximum zone of inhibition against both bacterial strains, indicating comparatively stronger biocidal efficacy. The flower extract also demonstrated considerable antibacterial activity, while the fruit extract exhibited relatively lower inhibitory effects.

Overall, the findings of the study indicate that *Cucumis melo* var. *flexuosus* can serve as a promising natural source of antioxidant and antimicrobial agents.

The results also suggest that the leaf extract possesses greater therapeutic potential among the studied plant parts. Further research involving isolation, purification, and characterization of active phytoconstituents may help in the development of novel plant-based pharmaceutical and nutraceutical products.

ACKNOWLEDGMENTS

The author expresses sincere gratitude to the Central Instrumentation Facility (CIF) of Kalinga University for providing the necessary laboratory infrastructure and instrumental facilities required for the present study. Special appreciation is extended to the technical staff of the facility for their continuous support and cooperation during the experimental work. Their valuable assistance greatly contributed to the successful completion of this research investigation.

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HOW TO CITE: Dr. Divya Acharya, Comparative Phytochemical Characterization and Evaluation of Free Radical Scavenging and Biocidal Activities of Leaf, Fruit and Flower of *Cucumis melo* var. *flexuosus* from Mahasamund District, Chhattisgarh, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 5, 3947-3954, <https://doi.org/10.5281/zenodo.20229227>

