



CODEN [USA]: IAJPBB

ISSN : 2349-7750

**INDO AMERICAN JOURNAL OF  
PHARMACEUTICAL SCIENCES**

SJIF Impact Factor: 7.187

<https://doi.org/10.5281/zenodo.20071803>Available online at: <http://www.iajps.com>

Research Article

**INVESTIGATING THE ANTIOXIDANT AND  
ANTIMICROBIAL POTENTIAL OF SELECTED MEDICINAL  
PLANT****Bhoora Singh\*<sup>1</sup>, Dr Vivek Gupta<sup>2</sup>, Yogesh Bhardwaj<sup>3</sup>**<sup>1</sup>Scholar, Faculty of Pharmacy, P.K. University Shivpuri (M.P.)<sup>2</sup>Professor, Faculty of Pharmacy, P.K. University Shivpuri (M.P.)<sup>3</sup>Associate Professor, Faculty of Pharmacy, P.K. University Shivpuri (M.P.)**Abstract:**

*The present study investigates the antioxidant and antimicrobial potential of three medicinal plants Aegle marmelos Linn (AE), Gmelina arborea Roxb (GE), and Lantana camara (LE) through systematic pharmacognostic, phytochemical, and biological evaluations. Leaves were collected, shade-dried, and processed for morphological, microscopic, and physicochemical characterization. Distinct diagnostic features such as trichomes, stomatal types, calcium oxalate crystals, and vascular bundle organization were identified, supporting authentication and quality control. Extractive yield analysis revealed A. marmelos with the highest recovery (51.32%), followed by G. arborea (43.53%) and L. camara (25.32%), correlating with phytochemical abundance. Phytochemical screening confirmed the presence of alkaloids, flavonoids, tannins, glycosides, and essential oils, highlighting diverse therapeutic potential. Antioxidant activity, evaluated using DPPH and ABTS assays, demonstrated concentration-dependent inhibition across all extracts. G. arborea consistently exhibited superior free radical scavenging activity (up to 92.09%), aligning with its rich phenolic and flavonoid content, while A. marmelos and L. camara also showed significant activity, supporting their traditional use against oxidative stress. Antimicrobial assays revealed A. marmelos as the most potent antibacterial agent, with inhibition zones comparable to ciprofloxacin, while L. camara demonstrated notable antifungal activity against Aspergillus niger. Collectively, these findings validate the ethnomedicinal relevance of the selected plants, establish pharmacognostic markers for authentication, and highlight their potential as natural sources of antioxidants and antimicrobials. The study underscores the importance of integrating traditional knowledge with scientific evaluation to guide future formulation development and therapeutic applications.*

**KEYWORDS:** Aegle marmelos Linn, Gmelina arborea Roxb, Lantana camara, Antioxidant, Medicinal plants and Antimicrobial

**Corresponding author:****Bhoora Singh,**

TIT - College of Pharmacy, Bhopal (M.P.)

dimpalsakre12@gmail.com

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Please cite this article in press Bhoora Singh et al Investigating The Antioxidant And Antimicrobial Potential Of Selected Medicinal Plant., Indo Am. J. P. Sci, 2026; 13(05).

## INTRODUCTION:

Antioxidants act by delaying or preventing the oxidation of other chemicals. The first studies on the role of antioxidants in biology focused on their use in preventing unsaturated fats from going rancid. However, the milestone that led to the understanding of the role of antioxidants for living organisms was the identification of vitamins A, C, and E and the understanding of the mechanism of lipid peroxidation prevention by vitamin E<sup>1</sup>.

Antioxidants significantly delay or prevent oxidation of oxidizable substrates when present at lower concentrations than the substrate. Antioxidants can be synthesized in vivo (e.g., reduced glutathione (GSH), superoxide dismutase (SOD), etc.) or taken as dietary antioxidants<sup>2</sup>. Plants have long been a source of exogenous (i.e., dietary) antioxidants. The interest in the exogenous plant antioxidants was first evoked by the discovery and subsequent isolation of ascorbic acid from plants<sup>3</sup>. Since then, the antioxidant potential of plants has received a great deal of attention because increased oxidative stress has been identified as a major causative factor in the development and progression of several life threatening diseases, including neurodegenerative and cardiovascular disease. In addition, supplementation with exogenous antioxidants or boosting of endogenous antioxidant defenses of the body has been found to be a promising method of countering the undesirable effects of oxidative stress<sup>4</sup>. There are currently approximately 19 in-vitro and 10 in-vivo methods of assessing antioxidant activity that are commonly applied for evaluation of the antioxidant activity of plant samples<sup>5</sup>.

The *Aegle marmelos* (Linn) tree, which is worshipped by Hindus and offered in the prayers of Lord Shiva and Parvati, is also known as Shivaduma (The Tree of Shiva). In India, *Aegle marmelos* L. is a plant that is readily accessible in many locations. Also called the "Bale fruit tree," Bael (*Aegle Marmelos* (Linn)) is a moderately sized, slender, aromatic tree<sup>6</sup>. The leaves are most effective in treating fever, nausea, vomiting, swellings, dysentery, dyspepsia, seminal weakness, and intermittent fever. Bael fruits are edible. The pulp used to make delicious items like murabba, puddings, and juice. Apart from their laxative use and curing respiratory ailments, also used in several traditional medications to treat chronic diarrhea, peptic ulcers, inhibit lipid peroxidation, free radicals scavenging, antioxidants, anti-ulcerative colitis, gastroprotective, hepatoprotective, antidiabetic, cardioprotective, radioprotective, antibacterial, antidiarrheal and antiviral properties<sup>7</sup>.

*Gmelina arborea* is known as Kashmari (as it grows in Kashmir), this tree is native to Asia and found in India, It is mostly found in deciduous and moist deciduous forests. Gambhari has many uses. It is a fast growing tree from teak family. Gambhari is also a medicinal tree and its roots, stem, stem bark, fruits, leaves, flowers all are used for medicinal purpose in India since ancient times. Its mention is found in all classical texts of Ayurveda<sup>8</sup>. The root and bark of *Gmelina arborea* are stomachic, galactagogue laxative and anthelmintic; improve appetite, useful in hallucination, piles, abdominal pains, burning sensations, fevers, 'tridosha' and urinary discharge. Leaf paste is applied to relieve headache and juice is used as wash for ulcers. Flowers are sweet, cooling, bitter, acrid and astringent. They are useful in leprosy and blood diseases. In Ayurveda it has been observed that Gamhar fruit is acrid, sour, bitter, sweet, cooling, diuretic tonic, aphrodisiac, alternative astringent to the bowels, promote growth of hairs, useful in 'vata', thirst, anaemia, leprosy, ulcers and vaginal discharge. The plant is recommended in combination with other drugs for the treatment of snake – bite and scorpion- sting. In snake – bite a decoction of the root and bark is given internally<sup>9</sup>.

*Lantana camara* Linn is flowering ornamental plant belonging to family *Verbenaceae*. *L. Camara* is distributed throughout India where there is a moderate to high summer rainfall and Well-drained sloping Sites. The plants can grow individually in clumps or as dense thickets, crowding out more desirable species. *Lantana camara* (*Verbenaceae*) is a solid, evergreen, sweet-smelling blooming bush with an unmistakable fragrance<sup>10</sup>. The plant fills in tropical and subtropical locales of the world. Fresh leaves crushed in water treat skin inflammation, fungal infections, ulcers, cholera and wounds. Leaf powder and oil separate have been displayed to show antimicrobial, Anti-inflammatory, cancer prevention agent, antihypertensive, and anti-tussive effects. Plant roots and a few pieces of the plant have been utilized to treat jungle fever, Rheumatism, and certain skin afflictions, among others<sup>11</sup>.

## MATERIALS AND METHOD:

### Preliminary Work

**Collection of plant:** The leaves of *Aegle marmelos*, *Gmelina arborea* and *Lantana camara* were collected locally from Bhopal M. P. in the month of February. They were separated, washed thoroughly with tap water and shade dried.

**Authentication of plant:** The plants were authenticated by Department of Botany Saifia Science College, Bhopal via Ref. No. 12-

B/838/2025 date: 27-02-2025, by comparing morphological features of crude drug sample.

**Drying and size reduction of plant material:**

The leaves of *Aegle marmelos*, *Gmelina arborea* and *Lantana camara* were dried under shade then dried leaves were pulverized to coarse powder. The coarse powder of leaves was passed through sieve No.40 to maintain uniformity and stored in cool and dry place.

**Morphological study:** This study was performed by the observation of leaf shape, size, color, texture, and venation.

**Microscopic analysis:** Microscopic analysis was performed to identifying internal structures like stomata, trichomes, oil globules and calcium oxalate crystals using microscopes.

**Physiochemical screening of powders:** The powders of the plants leaves of *Aegle marmelos*, *Gmelina arborea* and *Lantana camara* were subjected for Loss on drying, Total ash value, Acid insoluble ash value, Water soluble ash value and Foaming index using standard method.

**Extraction Procedure**

Extraction of leaves powder of *Aegle marmelos*, *Gmelina arborea* and *Lantana camara* were done by Soxhlet extraction method. Prepared extracts were (a) Ethanolic extract of *Aegle marmelos* leaves (AE) (b) Ethanolic extract of *Gmelina arborea* leaves (GE) (c) Ethanolic extract of *Lantana camara* leaves (LE). Macroscopic characters of extracts e.g. color, odor, test, appearance etc. was observed.

**Qualitative Phytochemical Analysis of Crude Extracts:**

The crude extract obtained by solvent extraction was subjected to various qualitative tests to detect presence of common chemical constituents as: Alkaloids, Glycosides, Carbohydrates, Phytosterols, Saponins, Tannins, Flavonoids Proteins etc.

**Antioxidant Activity**

**Free radical scavenging by DPPH scavenging method:**

Free radical scavenging activity of samples was measured using the 2,2-diphenyl-1-picrylhydrazyl (DPPH). Briefly, 1.0 ml of sample solution with different concentrations (0.1, 0.2, 0.3, 0.4, 0.5 and 0.6 mg/ml) was added to a 4 ml of 0.004% methanolic solution of DPPH. The absorbance was read at 517 nm after 30 min incubation at room temperature in the dark. Ascorbic acid was used as a standard. The DPPH radical-scavenging activity was calculated according to the following equation:

$$\text{DPPH scavenging activity (\%)} = 1 - \frac{A_i - A_j}{A_c} \times 100$$

Where,  $A_c$  was the absorbance of DPPH solution without sample (2 ml DPPH + 2 ml of 95% methanol);  $A_i$  was the absorbance of the test sample

mixed with DPPH solution (2 ml sample + 2ml DPPH) and  $A_j$  was the absorbance of the sample without DPPH solution (2 ml sample + 2 ml of 95% ethanol).

**Reducing power by ABTS radical scavenging method:**

The ABTS radical (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) scavenging activity was carried out based on the method of Gan and Latiff with some modifications. Briefly,  $ABTS^+$  was produced directly by reacting 7 mM ABTS solution with 2.45 mM potassium persulfate and allowing the mixture to stand for 16 h at room temperature in the dark. Prior to beginning the assay, the ABTS solution was diluted with methanol. One milliliter of sample solution with different concentrations (0.1, 0.2, 0.3, 0.4, 0.5 and 0.6 mg/ml) was added to 2 ml of the ABTS solution mixed solution was observed at 734 nm. The sample absorbance was read at 734 nm after 30 min incubation at room temperature. Ascorbic acid was used as a standard. The ABTS radical-scavenging activity was calculated according to the following equation:

$$\text{ABTS + scavenging activity (\%)} = 1 - \frac{A_2 - A_1}{A_0} \times 100$$

Where,  $A_0$  was defined as the absorbance of control at 734 nm, and  $A_1$  and  $A_2$  were defined as the absorbance of the sample without the  $ABTS^+$  solution and with added  $ABTS^+$  solution, respectively.

**Antimicrobial Screening of Extracts**

**Cultivation of microorganisms:**

The bacterial cultures were aseptically inoculated into nutrient broth and incubated under aerobic conditions at 37 °C for 24h. Fungal cultures were inoculated into Sabouraud's broth and incubated under aerobic conditions at 25 °C for 48 h. The bacterial and fungal strains used for the study were *Bacillus Subtilis*, *Escherichia Coli*, *Candida Albicans* and *Aspergillus Niger*. The bacterial cultures were aseptically inoculated into nutrient broth and incubated under aerobic conditions at 37 °C for 24 h. fungal cultures were inoculated in to Sabouraud's broth and incubated under aerobic conditions at 25 °C for 48 h.

Each Petri plate containing nutrient/ sabouraud's agar medium was inoculated with one bacterial/ fungal culture by spreading the suspension of the organism with a sterile cotton swap. Each plate was divided into six equal portions along the diameter. Each portion was used to place one disk. Four disks of each sample were placed on four portions, one disk with standard drug and a disk impregnated with the solvent (DMF). All the plates were kept in the refrigerator for 30 minutes to allow the diffusion of the sample in to the refrigerator for 30 minutes to allow the diffusion of the sample into the surrounding agar medium. Then the plates

inoculated with bacterial cultures were incubated at 37 °C for 18 h and those with incubated at 25 °C for 48 h. Diameter of the zones of inhibition wherever produced were measured and the average diameter for each sample was calculated. The diameters obtained for the test samples were compared with that produced by the standard antibiotics, ciprofloxacin for antibacterial activity and clotrimazole for antifungal activity. The results of antibacterial and antifungal activity are given in Tables and figures.

## RESULT & DISCUSSION:

### Morphologically of *Aegle marmelos*, *Gmelina arborea* and *Lantana camara* leaves:

*Aegle marmelos*, the trifoliolate leaf structure with ovate to lanceolate leaflets and a mildly citrusy odor was consistent with its traditional recognition as a medicinal plant. The terminal leaflet dimensions (5–6 cm long, 2.3–2.8 cm wide) and lateral leaflet sizes provide measurable parameters that can aid in authentication and quality control. The slightly pungent taste further reflects the presence of bioactive phytoconstituents such as alkaloids and flavonoids. *Gmelina arborea* leaves, in contrast, are simple, large, and broadly ovate, ranging from 10–25 cm in length and 7–20 cm in width. Their opposite decussate arrangement and bitter, astringent taste are characteristic features that distinguish them from the trifoliolate leaves of *Aegle marmelos*. The mild herbal scent suggests the presence of volatile compounds, while the large lamina size indicates potential for higher photosynthetic activity, which may correlate with phytochemical abundance. *Lantana camara* leaves are comparatively smaller (5–8 cm long, 3–4 cm wide), dark green, and rough-textured with regularly dentate margins and an acute apex. The opposite leaf arrangement, acrid taste, and characteristic odor are diagnostic markers that align with its known phytochemical profile, including terpenoids and essential oils. The rough lamina and strong odor also serve as ecological adaptations, deterring herbivory and contributing to its invasive nature. Overall, the morphological differences

among these species trifoliolate vs. simple leaves, variation in lamina size, odor, and taste provide reliable parameters for botanical identification. These features not only aid in distinguishing the plants but also correlate with their phytochemical diversity and therapeutic potential. Such morphological characterization is essential for ensuring authenticity in herbal drug formulations and preventing adulteration.

### Microscopic analysis:

Microscopic study of *Aegle marmelos* leaves revealed diagnostic features supporting its pharmacognostic identity. A single-layered epidermis with polygonal cells and cuticle aids protection, while unicellular and multicellular trichomes enhance defense. Oil globules indicate volatile phytoconstituents with antimicrobial activity. Calcium oxalate crystals and collateral vascular bundles confirm authenticity and therapeutic potential.

Microscopic analysis of *Gmelina arborea* leaves revealed key pharmacognostic markers. A single-layered epidermis with cuticle ensures protection, while paracytic stomata and leaf constants aid authentication. Differentiated mesophyll with chloroplast-rich palisade and spongy parenchyma supports photosynthesis. Collateral vascular bundles with xylem and phloem highlight efficient transport, ensuring bioactive compound distribution.

Microscopic analysis of *Lantana camara* leaves revealed dorsiventral anatomy with thick cuticle, amphistomatic surfaces bearing anisocytic stomata, and differentiated mesophyll for efficient photosynthesis. Non-glandular and glandular trichomes secrete essential oils, while calcium oxalate crystals act as pharmacognostic markers. Collateral vascular bundles and powder microscopy confirm diagnostic identity and therapeutic relevance.



Figure : T. S. of *Lantana camara* leaves, *Gmelina arborea* and *Lantana camara* Leaves

## Physiochemical screening of powders

Table No. 8: Physiochemical screening of Leaves powders of selected plants

S. No.	Parameters	<i>Aegle marmelos</i>	<i>Gmelina arborea</i>	<i>Lantana camara</i>
1	Loss on drying (%)	1.57	2.42	0.83
2	Total ash value (%)	7.05	7.63	4.17
3	Acid insoluble ash value (%)	2.82	3.42	1.84
4	Water soluble ash value (%)	2.43	3.25	1.23
5	Foaming index	13 (ml)	15 (ml)	11 (ml)

Extraction of *Aegle marmelos*, *Gmelina arborea* and *Lantana camara* Leaves

The macroscopic characterization of extracts from *Aegle marmelos* (AE), *Gmelina arborea* (GE), and *Lantana camara* (LE) revealed consistent features across all three species, with subtle differences that aid in pharmacognostic identification.

Table No. 9: Macroscopic character of extracts

S. No.	Parameters	AE	GE	LE
1	Color	Dark Green	Dark Green	Dark Green
2	Odor	Aromatic	Herbal	Characterstics
3	Test	Pungent	Bitter	Characterstics
4	Physical Appearance	Semisolid	Semisolid	Semisolid
5	State	Greasy	Greasy	Greasy
6	Yield (%)	51.32 %	43.53 %	25.32 %

Phytochemical Screening of Extracts of *A. marmelos*, *G. arborea* and *L. camara*:

The phytochemical screening demonstrates that while all three plants share common classes of bioactive compounds such as alkaloids, steroids, and flavonoids, *Lantana camara* exhibits greater diversity with glycosides and saponins, *Gmelina arborea* shows strong tannin presence, and *Aegle marmelos* is rich in flavonoids and aromatic oils. These differences highlight the complementary therapeutic potential of the selected plants and reinforce the importance of phytochemical profiling in validating traditional medicinal uses and guiding future formulation development.

Table No. 11: Phytochemical screening of extracts

Chemical Tests	AE	GE	LE
<b>Alkaloids</b>			
Dragendorff's Test	(+)	(+)	(+)
Mayer's Test	(+)	(+)	(+)
Hager's Test	(-)	(-)	(+)
<b>Glycosides</b>			
Legal Test	(-)	(-)	(+)
Baljet Test	(-)	(-)	(-)
Borntrager's Test	(-)	(-)	(-)
<b>Carbohydrates</b>			
Molisch's Test	(-)	(-)	(-)
Benedict's test	(-)	(-)	(-)
Fehling's Test	(-)	(-)	(-)
<b>Steroids and Sterols</b>			
Salkowski Test	(+)	(+)	(+)
Libermann-Burchard	(+)	(+)	(+)
<b>Proteins and Amino Acids</b>			
Biuret Test	(-)	(-)	(-)
Ninhydrin Test	(-)	(-)	(-)
Millon's Test	(-)	(-)	(-)

<b>Tannins</b>			
5% ferric chloride solution	(-)	(-)	(+)
10% aqueous K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> solution	(+)	(+)	(+)
10% lead acetate solution	(+)	(+)	(-)
<b>Flavonoids and Phenols</b>			
Shinoda's Test	(+)	(+)	(+)
Alkaline reagent test	(+)	(+)	(+)
Lead acetate test	(+)	(+)	(-)
<b>Saponins</b>			
Foam taste	(-)	(-)	(-)

(+) = Present, (-) = Absent

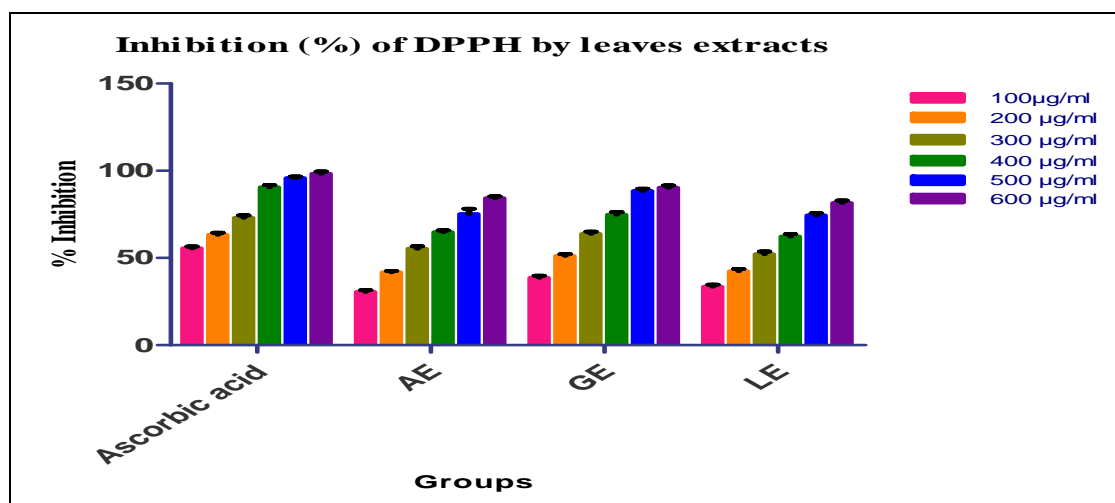
#### Antioxidant Activity of *A. marmelos* (AE), *G. arborea* and *L. camara* (LE) Extracts:

**Free radical scavenging by DPPH scavenging method:** DPPH assay revealed concentration-dependent antioxidant activity in *Aegle marmelos* (AE), *Gmelina arborea* (GE), and *Lantana camara* (LE) extracts. GE showed superior inhibition, reaching 88.39% at 500 µg/ml and 90.31% at 600 µg/ml, close to ascorbic acid. AE and LE also demonstrated significant activity, supporting traditional use against oxidative stress.

**Table No. 12: Inhibition (%) of DPPH by leaves extracts**

Conc. (µg/ml)	% Inhibition of DPPH by			
	Ascorbic acid	AE	GE	LE
100	55.53 ± 1.04	30.52 ± 1.02	38.65 ± 1.13	33.52 ± 1.16
200	63.27 ± 1.12	41.76 ± 0.78	51.13 ± 1.09	42.42 ± 1.22
300	73.11 ± 1.32	55.37 ± 1.32	63.87 ± 1.17	52.17 ± 1.51
400	90.53 ± 1.28	64.81 ± 1.04	74.84 ± 1.52	62.36 ± 1.32
500	95.76 ± 0.89	75.16 ± 1.15	88.39 ± 1.33	74.42 ± 1.27
600	98.27 ± 1.32	84.25 ± 1.12	90.31 ± 1.26	81.61 ± 1.31

The values are mean of three repeated readings (n=3) (mean ± SD)



**Figure 10: Antioxidant Activity of extracts by Inhibition (%) of DPPH**

#### Free radical scavenging by ABTS scavenging method:

ABTS assay confirmed concentration-dependent antioxidant activity in *Aegle marmelos* (AE), *Gmelina arborea* (GE), and *Lantana camara* (LE) extracts. GE consistently showed superior inhibition, reaching 86.22% at 500 µg/ml and 92.09% at 600 µg/ml, close to ascorbic acid. AE and LE also demonstrated significant activity, supporting traditional use against oxidative stress.

**Table No. 13: Inhibition (%) of ABTS by leaves extracts**

Conc. (µg/ml)	% Inhibition of ABTS by			
	Ascorbic acid	AE	GE	LE
100	51.16 ± 1.52	32.15 ± 1.02	36.69 ± 0.96	31.15 ± 0.87
200	62.45 ± 1.05	43.28 ± 1.15	52.42 ± 0.89	47.82 ± 0.91
300	72.63 ± 1.12	52.31 ± 1.11	66.41 ± 0.91	53.23 ± 1.25
400	80.28 ± 1.43	64.31 ± 1.02	77.79 ± 1.12	64.71 ± 0.98
500	89.83 ± 0.92	72.84 ± 1.32	86.22 ± 0.84	78.63 ± 1.12

600	96.51 ± 0.97	81.78 ± 1.06	92.09 ± 1.07	83.78 ± 1.25
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The values are mean of three repeated readings (n=3) (mean ± SD)

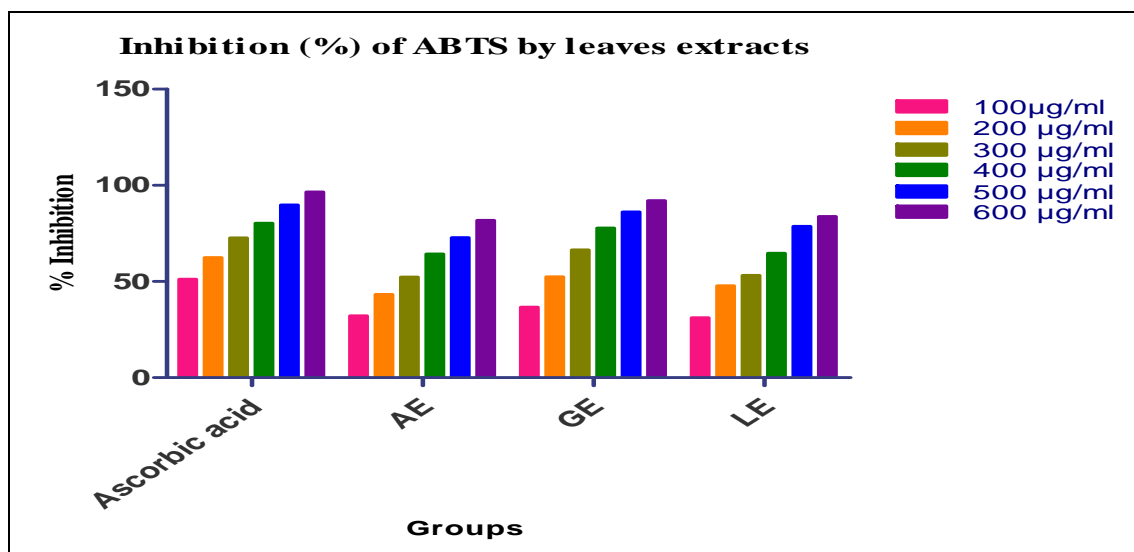


Figure 11: Antioxidant Activity of extracts by Inhibition (%) of ABTS

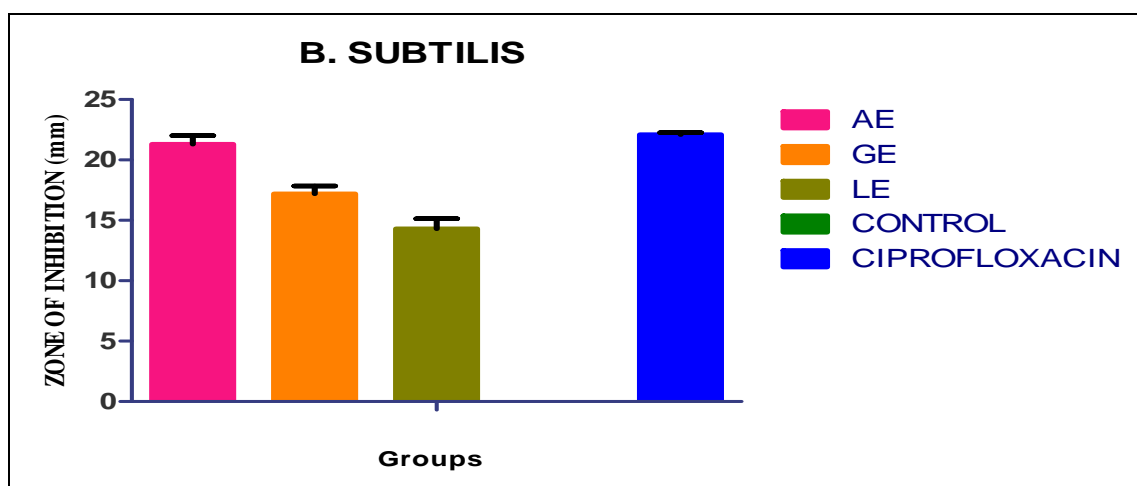
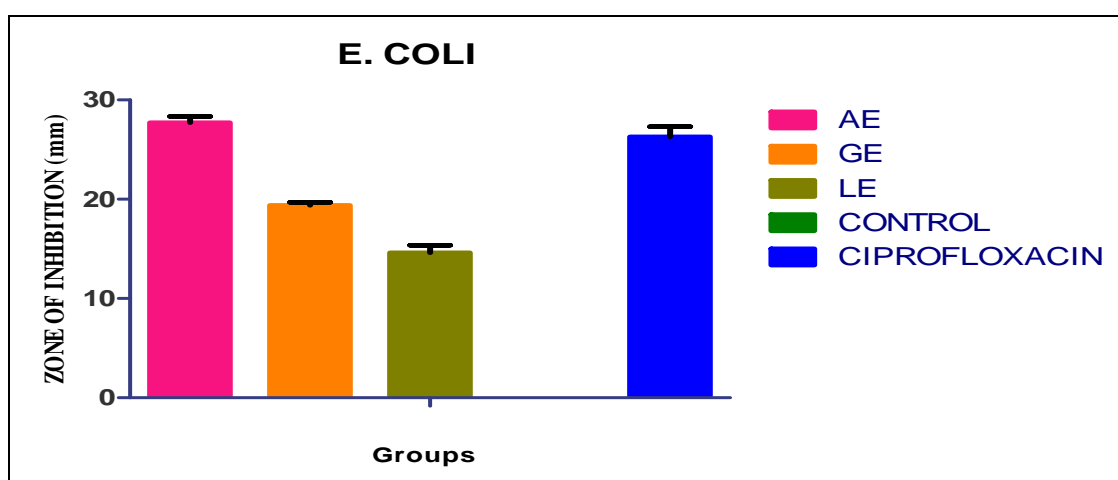
#### Evaluation of antimicrobial activity of *A. marmelos*, *G. arborea* and *L. camara*

**Antibacterial activity of *A. marmelos*, *G. arborea* and *L. camara*:** Among the three medicinal plants tested, *Aegle marmelos* exhibited the highest antibacterial activity, comparable to ciprofloxacin, while *Gmelina arborea* and *Lantana camara* showed moderate and mild effects, respectively. This underscores AE's potential as a natural antimicrobial agent. The results indicate that *Aegle marmelos* possesses the most promising antibacterial activity, nearly equivalent to the standard drug ciprofloxacin, while *Gmelina arborea* and *Lantana camara* provide moderate to mild effects. These findings validate the traditional use of these plants in treating microbial infections and highlight AE as a strong candidate for further development into natural antimicrobial formulations.

Table No. 14: Antibacterial activity of *A. marmelos*, *G. arborea* and *L. camara*

Sample applied	Diameter of zone of inhibition (mm)	
	<i>B. subtilis</i>	<i>E. coli</i>
<i>A. marmelos</i> Extract (AE)	21.3 ± 0.72 (6.25)	27.7 ± 0.63 (6.25)
<i>G. arborea</i> Extract (GE)	17.2 ± 0.64 (12.5)	19.4 ± 0.28 (12.5)
<i>L. camara</i> (LE)	14.3 ± 0.38 (6.25)	14.6 ± 0.75 (6.25)
Control	-	-
Ciproflaxacin	22.1 ± 0.16 (6.25)	26.3 ± 1.02 (12.5)

The values are mean of three repeated readings (n=3) (mean ± SD), Values in brackets are MIC values ( $\mu\text{g mL}^{-1}$ ).

Figure 12: Antibacterial activity of extracts against *B. subtilis*Figure 13: Antibacterial activity of extracts against *E. coli*

**Antifungal activity of *A. marmelos*, *G. arborea* and *L. camara*:** The antifungal study demonstrates that *Aegle marmelos* is highly effective against *C. albicans*, *Lantana camara* shows notable activity against *A. niger*, and *Gmelina arborea* provides moderate inhibition against both fungi. These findings validate their traditional use and highlight species-specific antifungal potential, with AE and LE emerging as promising candidates for natural antifungal formulations.

Table No.15: Antifungal activity of *A. marmelos*, *G. arborea* and *L. camara*

Sample applied	Diameter of zone of inhibition (mm)	
	<i>C. Albicans</i>	<i>A. Niger</i>
<i>A. marmelos</i> Extract (AE)	23.6 ± 1.03 (6.25)	10.2 ± 0.64 (12.5)
<i>G. arborea</i> Extract (GE)	21.4 ± 0.67 (12.5)	13.7 ± 0.48 (12.5)
<i>L. camara</i> (LE)	21.2 ± 1.01 (6.25)	19.1 ± 1.05 (6.25)
Control	-	-
Clotrimazole	23.1 ± 1.12 (6.25)	27.6 ± 0.96 (12.5)

The values are mean of three repeated readings (n=3) (mean ± SD), Values in brackets are MIC values ( $\mu\text{g mL}^{-1}$ ).

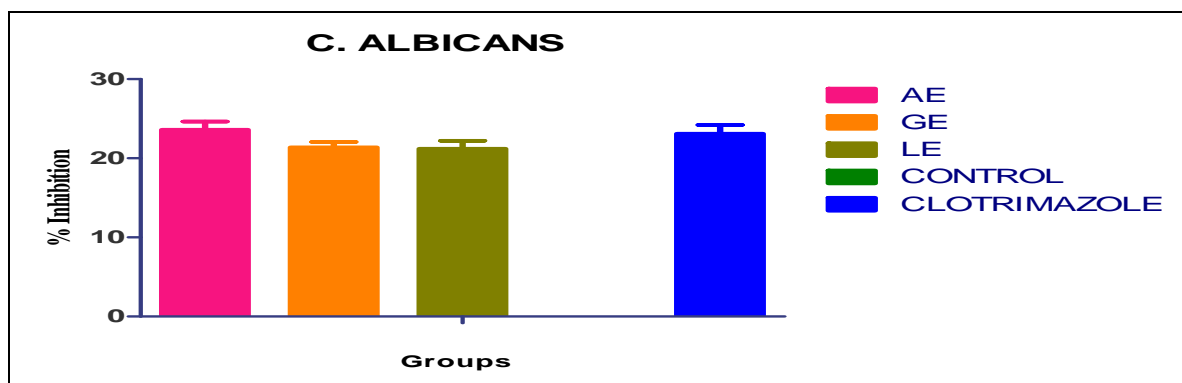


Figure 15: Antifungal activity of extracts against *C. Albicans*

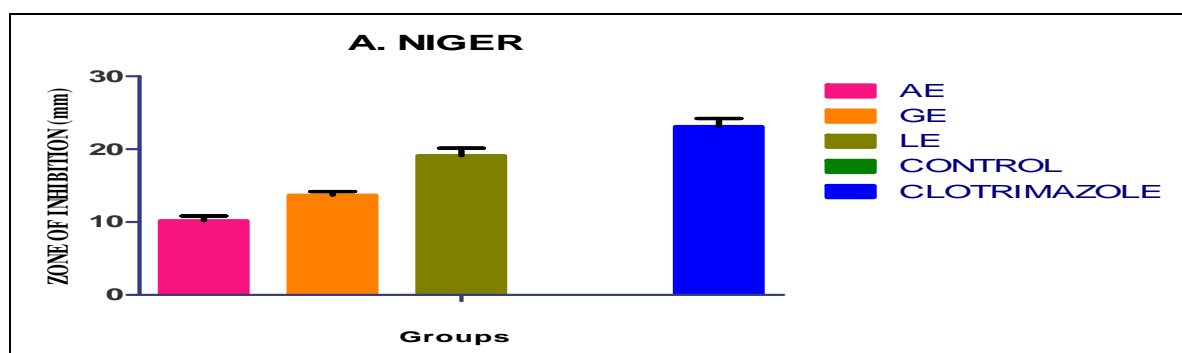


Figure 16: Antifungal activity of extracts against *A. Niger*

### CONCLUSION:

The comprehensive pharmacognostic, physiochemical, phytochemical, antioxidant, and antimicrobial evaluation of *Aegle marmelos*, *Gmelina arborea*, and *Lantana camara* leaves highlights their distinct morphological, microscopic, and biochemical profiles, validating their traditional medicinal use and potential for modern applications. Together, these findings establish that while all three plants possess valuable pharmacognostic and therapeutic properties, *Aegle marmelos* excels in antibacterial activity and flavonoid-rich antioxidant potential. *Gmelina arborea* demonstrates superior antioxidant capacity and moderate antimicrobial action. *Lantana camara* shows diverse phytochemical presence with notable antifungal efficacy. This integrated evaluation underscores the importance of combining morphological, microscopic, physiochemical, phytochemical, and bioactivity studies to authenticate medicinal plants and guide their safe, effective use in herbal formulations and potential pharmaceutical development.

### CONFLICTS OF INTERESTS

There are no any conflicts of interests.

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