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LANTANA CAMARA L.: A NATURAL TREASURE TROVE OF ANTIOXIDANTS AND ANTI-INFLAMMATORY AGENTS

LANTANA CAMARA L.: ANTİOKSİDANLAR VE ANTİ-İNFLAMATUAR AJANLARIN DOĞAL HAZİNESİ

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ABSTRACT

Lantana camara L. leaves were extracted using solvents of differing polarity—petroleum ether, acetone, and chloroform—to investigate their phytochemical composition, functional groups, and antioxidant potential. Preliminary phytochemical screening revealed a rich presence of bioactive metabolites such as flavonoids, phenolics, alkaloids, tannins, terpenoids, glycosides, and steroids predominantly in acetone and chloroform extracts, while petroleum ether showed limited polarity-associated compounds. Quantitative analysis demonstrated significantly higher total phenolic (54.86 mg GAE/g) and flavonoid content (39.44 mg QE/g) in acetone extracts compared to petroleum ether (8.72 mg GAE/g and 5.31 mg QE/g) and chloroform (28.17 mg GAE/g and 19.25 mg QE/g). Antioxidant assays corroborated these findings: acetone extract exhibited the strongest DPPH radical scavenging activity (IC_{50} = 41.25 µg/mL), highest ferric reducing antioxidant power (429.55 µmol Trolox equivalents/g), and ABTS inhibition (88.36%). Fourier Transform Infrared (FTIR) spectroscopy confirmed the presence of key functional groups, including hydroxyl, carbonyl, and aromatic moieties, varying with solvent polarity. These results highlight acetone as the most effective solvent for extracting antioxidant-rich phytochemicals from L. camara leaves, emphasizing the plant's potential as a natural source of therapeutic antioxidants for pharmaceutical and nutraceutical applications.

Keywords: *Lantana camara*, Bioactive compounds, Antioxidant activity, FTIR

ÖZ

Lantana camara L. yaprakları, fitokimyasal bileşimlerini, fonksiyonel gruplarını ve antioksidan potansiyellerini araştırmak için farklı polariteye sahip çözücüler (petrol eteri, aseton ve kloroform) kullanılarak ekstrakt edildi. Ön fitokimyasal tarama, aseton ve kloroform özütlerinde baskın olarak flavonoidler, fenolikler, alkaloidler, tanenler, terpenoidler, glikozitler ve steroidler gibi biyoaktif metabolitlerin zengin bir varlığını ortaya koyarken, petrol eteri sınırlı polariteyle ilişkili bileşikler gösterdi. Kantitatif analiz, aseton özütlerinde petrol eteri (8,72 mg GAE/g ve 5,31 mg QE/g) ve kloroform (28,17 mg GAE/g ve 19,25 mg QE/g) ile karşılaştırıldığında önemli ölçüde daha yüksek toplam fenolik (54,86 mg GAE/g) ve flavonoid içeriği (39,44 mg QE/g) gösterdi. Antioksidan analizleri bu bulguları doğruladı: aseton özütü en güçlü DPPH radikal temizleme aktivitesini (IC_{50} = 41,25 µg/mL), en yüksek ferrik indirgeyici antioksidan gücünü (429,55 µmol Trolox eşdeğeri/g) ve ABTS inhibisyonunu (%88,36) gösterdi. Fourier Dönüşümlü Kızılötesi (FTIR) spektroskopisi, çözücü polaritesine göre değişen hidroksil, karbonil ve aromatik gruplar dahil olmak üzere temel fonksiyonel grupların varlığını doğruladı. Bu sonuçlar, asetonu L. camara yapraklarından antioksidan açısından zengin fitokimyasalları çıkarmak için en etkili çözücü olarak vurgulayarak, bitkinin farmasötik ve nutrasötik uygulamalar için doğal bir terapötik antioksidan kaynağı olarak potansiyelini vurguladı.

Anahtar Kelimeler: *Lantana camara*, Biyoaktif bileşikler, Antioksidan aktivite, FTIR

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Introduction

Lantana camara, commonly known as lantana, is a perennial shrub native to tropical regions and recognized for its vibrant flowers and potential medicinal properties (Bhowmik et al., 2013). Historically, various parts of the plant have been employed in traditional medicine to treat ailments ranging from fevers and skin diseases to respiratory conditions (Chandra et al., 2016). Recent studies have highlighted the importance of phytochemicals, such as flavonoids and phenolic compounds, which contribute to the plant's therapeutic effects (Kumar et al., 2021). The rising interest in natural antioxidants and anti-inflammatory agents stems from their potential to combat oxidative stress and chronic inflammation, both of which are linked to numerous health issues, including cardiovascular diseases, diabetes, and cancer (Nita et al., 2020). This underscores the necessity to scientifically validate the traditional uses of Lantana camara by exploring its phytochemical profile and assessing its biological activities. Understanding these properties may provide insights into developing natural health products and pharmaceuticals derived from this plant.

Methods

Plant Collection and Authentication

Fresh leaves of Lantana camara L. were collected from areas in and around the vicinity of Hindusthan College of Arts & Science, Coimbatore, Tamil Nadu, India. The plant material was authenticated by a qualified Botanist at Tamil Nadu Agricultural University. After authentication, leaves were washed with distilled water to remove dust and debris, air-dried at ambient room temperature (25±2°C) for 7–10 days, and ground into a fine powder using a mechanical grinder. The powdered material was stored in airtight containers at room temperature until further analysis (Bhuvaneshwari et al., 2017).

Solvent Extraction Procedure

Bioactive compounds were extracted from the dried leaf powder using Soxhlet extraction with petroleum ether, acetone, and chloroform. Each solvent was used in triplicate extractions to ensure reproducibility. For each run, 20 g of powdered leaf material was placed in a thimble and extracted with 250 mL of the respective solvent for 6 hours. The extraction was conducted under the boiling point range specific to each solvent (petroleum ether: 40–60°C; acetone: ~56°C; chloroform: ~61°C). Post-extraction, the solvents were removed using a rotary evaporator under reduced pressure at 45°C. Residual moisture was eliminated by drying the concentrates in a hot air oven at 40°C to a constant weight. Dried extracts were stored in airtight containers at 4°C for further use (Hossain et al., 2016).

FTIR Spectroscopy

Fourier Transform Infrared (FTIR) spectroscopy was performed to identify the functional groups present in the extracts. Solid extracts (1–2 mg) were mixed with 100 mg of spectroscopic-grade potassium bromide (KBr) and compressed into pellets. Liquid extracts were applied to an ATR (Attenuated Total Reflectance) crystal for direct measurement. Spectra were recorded in the range of 4000–400 cm^{-1} using an FTIR spectrometer calibrated with a background scan to correct for atmospheric interferences. The spectra were analyzed for characteristic absorption bands to infer the presence of functional groups such as O–H, C=O, C–H, and C–O (Mason et al., 2019).

Quantification of Phytochemicals

Total Phenolic Content (TPC)

TPC was determined using the Folin-Ciocalteu method (Singleton et al., 1999). A calibration curve was established using gallic acid (10–100 µg/mL). To 1 mL of each standard or sample, 1 mL of Folin-Ciocalteu reagent and 7 mL of distilled water were added. After a 5-minute reaction period, 1 mL of 7.5% sodium carbonate was added. The mixture was incubated at room temperature for 30 minutes, and absorbance was recorded at 765 nm using a UV-Vis spectrophotometer. Results were expressed as mg of gallic acid equivalents per gram of extract (mg GAE/g).

Total Flavonoid Content (TFC)

TFC was estimated using the aluminum chloride colorimetric method (Jiang et al., 2011). A standard curve was generated using quercetin (10–100 µg/mL). One mL of standard or sample was mixed with 0.5 mL of 5% sodium nitrite and incubated for 5 minutes. Subsequently, 0.5 mL of 2% aluminum chloride was added, followed by 1 mL of 1 M sodium hydroxide and 2.5 mL of distilled water. The absorbance was measured at 415 nm. Results were expressed as mg quercetin equivalents per gram of extract (mg QE/g).

Antioxidant Activity Assays

DPPH Radical Scavenging Activity

The DPPH assay was performed as described by Brand-Williams et al. (1995). A 0.1 mM DPPH solution in methanol was prepared and protected from light. Extract samples at various concentrations were mixed with DPPH solution and incubated in the dark for 30 minutes. The absorbance was recorded at 517 nm. Antioxidant activity was expressed as the percentage of DPPH radical inhibition.

FRAP (Ferric Reducing Antioxidant Power)

The FRAP assay was conducted as per Benzie & Strain (1996). FRAP reagent was freshly prepared from acetate buffer, TPTZ, and ferric chloride. Plant extract (100 µL) was mixed with 3 mL of FRAP reagent and incubated at 37°C for 30 minutes. Absorbance was measured at 593 nm. Results were expressed in µmol Trolox equivalents.

ABTS Radical Cation Decolorization Assay

The ABTS assay was performed according to Re et al. (1999). ABTS radical cations were generated by reacting 7 mM ABTS with 2.45 mM potassium persulfate and incubating in the dark for 12–16 hours. The solution was diluted to an absorbance of 0.7 at 734 nm. Extracts were mixed with the ABTS solution and incubated for 6 minutes, followed by absorbance measurement at 734 nm. Antioxidant activity was calculated as the percentage inhibition.

Statistical Analysis

All experiments were performed in triplicate. Results were reported as mean ± standard deviation (SD). One-way Analysis of Variance (ANOVA) was used to determine statistical significance among extract groups, with p-values < .05 considered significant (Duncan, 1955; McHugh & Krieger, 2005).

Results and Discussion

This study systematically investigated the extraction efficiency, phytochemical composition, and antioxidant properties of Lantana camara leaf extracts using solvents of varying polarity: petroleum ether, acetone, and chloroform. The comparative evaluation provides critical insights into solvent-specific performance in isolating pharmacologically relevant secondary metabolites and establishes a basis for optimized extraction strategies in phytotherapeutic research.

Solvent extraction efficiency

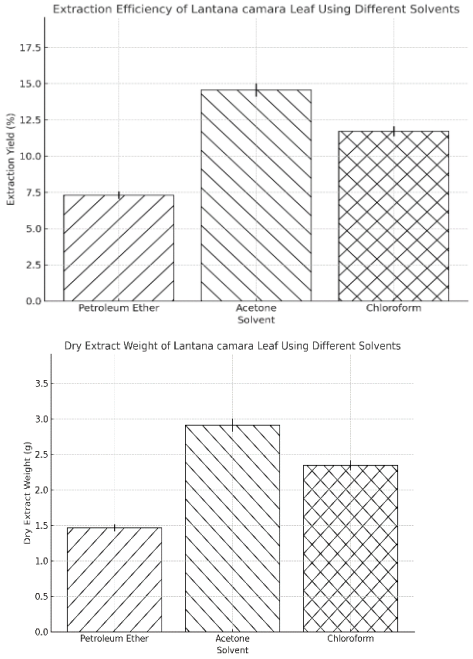

Figure 1. Extraction efficiency and dry extract weight of Lantana camara leaf using petroleum ether, acetone, and chloroform as solvents. Significant differences among groups were determined using one-way ANOVA ($p < 0.05$). Results are expressed as mean ± standard deviation ($n = 3$).

The solvent extraction efficiency (Figure 1) for Lantana camara leaves was evaluated by comparing the dry extract weight obtained from a fixed input of 20 g powdered leaf material for each solvent. The acetone extract provided the highest dry extract weight at 2.91 g, resulting in a proportional extraction yield of 14.55%. This was followed by chloroform with 2.34 g (yield 11.70%) and petroleum ether with 1.46 g (yield 7.30%). The proportional yield reflects the efficiency of each solvent in recovering extractable phytochemicals relative to the initial plant material. Acetone's superior extraction yield can be attributed to its intermediate polarity, allowing it to dissolve a broader spectrum of phytochemicals, including both polar and non-polar compounds (Do et al., 2014). Chloroform also demonstrated considerable efficacy, especially for moderately polar bioactives. Petroleum ether, a non-polar solvent, showed the lowest extraction yield, consistent with its selectivity for lipophilic constituents such as fats and waxes. This gradient in solvent extraction efficiency aligns well with the chemical nature of the bioactive compounds targeted and underscores the

importance of solvent choice in maximizing extraction output for phytochemical studies.

Preliminary Phytochemical Screening

Preliminary qualitative phytochemical analysis revealed distinct profiles across petroleum ether, acetone, and chloroform extracts of Lantana camara leaves, reflecting the differential solubility of phytochemicals in solvents of varying polarity (Figure 2). Alkaloids, which are known for their pharmacological activities including analgesic and antimalarial effects, were absent in the petroleum ether extract but detected in both acetone and chloroform extracts. The presence of alkaloids in these polar and mid-polar solvents indicates their higher solubility in such media, consistent with previous findings (Singh et al., 2013). Flavonoids and phenolics—classes of compounds widely reported for their antioxidant and anti-inflammatory activities—were notably more abundant in the acetone extract (++), with moderate presence in the chloroform extract (+) and absence in the petroleum ether extract (–). These results suggest that acetone is more efficient in extracting polar phenolic constituents from L. camara, in agreement with earlier reports that employed similar solvents for polyphenol extraction (Kaur & Arora, 2009).

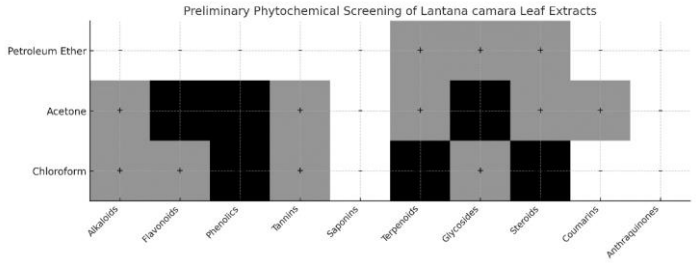

Figure 2: Preliminary phytochemical screening of Lantana camara leaf extracts using petroleum ether, acetone, and chloroform. (Symbolic representation: "–" = Absent, "+" = Present (low), "++" = Strongly Present (high). Data is encoded as a heatmap based on presence intensity)

Tannins, another group of phenolic compounds with astringent and antimicrobial properties, were moderately present in acetone and chloroform extracts, while absent in the petroleum ether extract. Their detection further supports the presence of phenolic-rich fractions in polar solvents. Saponins were not detected in any of the extracts, which might reflect either their absence in the leaf tissue or their insolubility in the selected solvents. Since saponins are typically extracted using aqueous or methanolic solvents, their absence here is not unexpected (Hostettmann & Marston, 1995). Terpenoids and steroids were observed in all three extracts, with strong presence (++ for chloroform) indicating that mid-polar solvents are particularly effective for triterpenoid extraction. These non-polar to mid-polar compounds are known to contribute to various bioactivities such as anti-inflammatory and cytotoxic effects (Jassim & Naji, 2003). Their abundance in the chloroform extract suggests it may contain significant lipophilic secondary metabolites. Glycosides, which are often associated with cardiotonic and antimicrobial functions, were most pronounced in the acetone extract (++), and also detected in petroleum ether and chloroform extracts (+). The broad solubility of glycosides across solvents highlights the diversity of glycosidic compounds within L. camara. Coumarins were detected only in the acetone extract, which may be due to their polar nature and affinity for medium-polar solvents. Coumarins possess anticoagulant and antimicrobial properties, and their presence supports the therapeutic potential of L. camara. Anthraquinones were not detected in any of the extracts. This suggests that such compounds may not be prevalent in the leaf tissues of L. camara or may require alternative solvents for extraction, such as ethanol or strong acid/base hydrolysis, commonly used for anthraquinone liberation. In summary, acetone emerged as the most efficient solvent for extracting a broad spectrum of phytochemicals from L. camara leaves, especially phenolics, flavonoids, glycosides, and coumarins. Chloroform was effective in extracting terpenoids, steroids, and alkaloids, whereas petroleum ether showed limited efficacy, extracting primarily non-polar compounds such as steroids and terpenoids. These findings are consistent with previous reports emphasizing solvent polarity as a key factor in phytochemical extraction efficiency (Harborne, 1998; Sasidharan et al., 2011).

This screening provides a foundational understanding of the phytochemical landscape of L. camara, informing solvent selection for targeted isolation of bioactive compounds in future studies. The predominance of antioxidant-associated groups such as flavonoids and phenolics in polar extracts correlates with their anticipated antioxidant potential, which is further explored through in vitro antioxidant assays in subsequent sections.

Total Phenolic and Flavonoid Content

The total phenolic content (TPC) and total flavonoid content (TFC) of the petroleum ether, acetone, and

chloroform extracts of Lantana camara leaves were quantified using the Folin–Ciocalteu and aluminum chloride colorimetric methods, respectively. The results are presented in Figure 3.

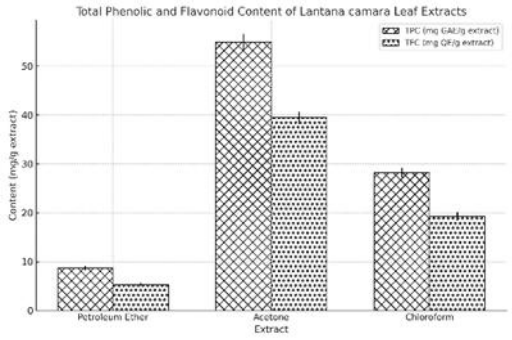

Figure 3: Grouped bar chart showing Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) in Lantana camara leaf extracts using petroleum ether, acetone, and chloroform. (Values are represented as mean ± standard deviation (n=3). Significant differences among extract types were assessed using one-way ANOVA ($p < .05$) and Duncan's multiple range test)

The highest TPC and TFC values were recorded in the acetone extract, followed by chloroform, with petroleum ether showing the lowest levels. This trend reflects the influence of solvent polarity on the extraction efficiency of phenolic and flavonoid compounds. Acetone, being a polar aprotic solvent, is highly effective at dissolving phenolic hydroxyl groups and conjugated systems typically found in flavonoid structures (Do et al., 2014). Phenolic compounds are major contributors to the antioxidant potential of plant extracts due to their ability to donate hydrogen atoms or electrons to free radicals. The high phenolic content in the acetone extract (54.86 ± 1.72 mg GAE/g) suggests a significant antioxidant reservoir, correlating with the strong radical scavenging observed in subsequent DPPH and FRAP assays. The moderate TPC in chloroform extract (28.17 ± 1.03 mg GAE/g) indicates the presence of less polar phenolic constituents, while the low TPC in petroleum ether extract (8.72 ± 0.45 mg GAE/g) is attributed to its limited solubilizing ability for polar compounds. Similarly, flavonoids—recognized for their free radical scavenging and metal-chelating properties—were found in highest concentration in the acetone extract (39.44 ± 1.26 mg QE/g), moderate in the chloroform extract (19.25 ± 0.88 mg QE/g), and lowest in the petroleum ether extract (5.31 ± 0.39 mg QE/g). These findings align with studies suggesting that mid-to-high polarity solvents such as methanol, ethanol, and acetone are optimal for flavonoid extraction (Panche et al., 2016).

The elevated levels of phenolics and flavonoids in the acetone extract strongly support its use in further pharmacological investigations, particularly those exploring antioxidant, anti-inflammatory, and antimicrobial potentials. These secondary metabolites are known to interact synergistically, enhancing biological activity beyond the effects of individual compounds (Rice-Evans et al., 1997).

Antioxidant Activity

The antioxidant potential of Lantana camara leaf extracts were evaluated using three complementary in vitro assays: DPPH radical scavenging activity, FRAP (Ferric Reducing Antioxidant Power), and ABTS radical cation Decolorization as illustrate in Figure 4. These assays assess the extracts' capacity to neutralize free radicals or reduce oxidants, which collectively reflects their potential for mitigating oxidative stress.

DPPH Radical Scavenging Activity

The DPPH assay evaluates the ability of antioxidants to donate hydrogen atoms or electrons to the stable DPPH radical, resulting in a color change measurable at 517 nm. The acetone extract exhibited the highest DPPH radical scavenging activity with an IC_{50} value of 41.25 ± 1.03 µg/mL, followed by chloroform (76.43 ± 1.51 µg/mL) and petroleum ether (122.64 ± 2.06 µg/mL) extracts. These results align with the total phenolic and flavonoid content, reinforcing the role of phenolic compounds as primary radical scavengers. The lower IC_{50} value of the acetone extract suggests stronger antioxidant capacity, likely due to higher concentrations of hydroxylated phenolics capable of stabilizing free radicals through hydrogen donation (Brand-Williams et al., 1995).

Ferric Reducing Antioxidant Power (FRAP)

The FRAP assay measures the ability of an extract to reduce ferric (Fe^{3+}) to ferrous (Fe^{2+}) ions in the presence of TPTZ, forming a blue-colored complex that absorbs at 593 nm. Among the tested extracts, the acetone extract displayed the strongest ferric reducing activity with a value of 429.55 ± 12.73 µmol Trolox equivalents/g, followed by chloroform (238.61 ± 9.64 µmol TE/g) and petroleum ether (105.47 ± 5.84 µmol TE/g). The trend observed in the FRAP assay is consistent with DPPH results, affirming the redox potential of phenolic-rich acetone extracts. These compounds can act as reducing agents, hydrogen donors,

and metal chelators (Benzie & Strain, 1996), which are critical mechanisms in combating oxidative stress.

ABTS Radical Cation Decolorization Assay

The ABTS assay evaluates both hydrophilic and lipophilic antioxidant capacities. $ABTS^{+}$ radicals are reduced upon interaction with antioxidants, with a decrease in absorbance at 734 nm. The acetone extract again demonstrated superior activity with 88.36 ± 1.92% inhibition, compared to 65.22 ± 1.68% for chloroform and 39.47 ± 1.41% for petroleum ether extracts at 100 µg/mL. The broad-spectrum sensitivity of ABTS to various antioxidant classes confirms the robust activity of the acetone extract and complements the observations from DPPH and FRAP assays. It also highlights the presence of both polar and non-polar antioxidant constituents (Re et al., 1999).

Comparative analysis and biological relevance: The consistent superiority of the acetone extract across all antioxidant assays underscores its efficiency in extracting a diverse range of antioxidant phytochemicals, notably flavonoids and phenolic acids. These molecules neutralize reactive oxygen species through multiple pathways, making them highly desirable for therapeutic development (Rice-Evans et al., 1997). In contrast, the petroleum ether extract, despite containing lipophilic constituents like terpenoids and steroids, exhibited comparatively lower antioxidant potential. This suggests that the bulk of antioxidative efficacy in L. camara leaves is attributable to polar compounds rather than non-polar ones. These findings align with earlier phytochemical and antioxidant studies on L. camara, reinforcing its potential as a source of natural antioxidants for pharmaceutical and nutraceutical applications (Mendoza-Castillo et al., 2017).

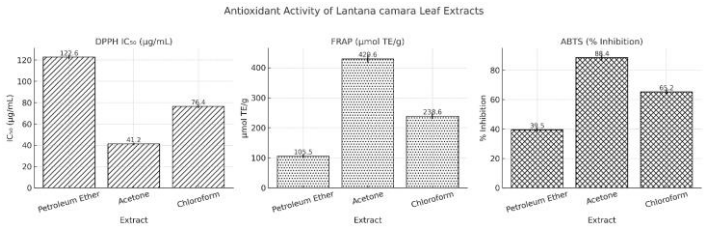

Figure 4: Comparative Antioxidant Activity of Lantana camara Leaf Extracts as Assessed by DPPH, FRAP, and ABTS Assays (Bar charts illustrate the antioxidant performance of petroleum ether, acetone, and chloroform extracts of Lantana camara leaves. (A) DPPH IC_{50} values reflect radical scavenging efficiency, where lower values denote stronger activity. (B) FRAP assay indicates reducing power, with higher values representing greater antioxidant potential. (C) ABTS assay shows percentage inhibition at 100 µg/mL, with higher values indicating stronger radical scavenging. Error bars represent standard deviation (n = 3). Statistical significance determined by one-way ANOVA ($p < .05$).

FTIR Spectroscopic characterization of Lantana camara leaf extracts

Fourier Transform Infrared (FTIR) spectroscopy was employed to identify major functional groups present in the petroleum ether, acetone, and chloroform extracts of Lantana camara leaves. The spectral profiles revealed the chemical diversity of the bioactive constituents extracted by solvents of differing polarities, thus offering insights into solvent–compound interactions and extract composition (Figures 5). All three extracts displayed a broad absorption band around 3400 cm^{-1}, indicating O–H stretching vibrations associated with hydroxyl groups found in alcohols and phenolics, or due to retained moisture. Prominent peaks at ~2920 cm^{-1} and ~2850 cm^{-1} were consistently observed across all samples, corresponding to asymmetric and symmetric C–H stretching vibrations, characteristic of long-chain aliphatic hydrocarbons and saturated compounds (Kumar et al., 2017). A strong peak near 1740–1745 cm^{-1} across the extracts was attributed to C=O stretching of carbonyl groups, indicating the presence of esters, aldehydes, or ketones—functional groups commonly found in lipids and flavonoid glycosides (Singh et al., 2018). The 1650–1400 cm^{-1} region showed signals corresponding to C=C stretching and CH_2/CH_3 bending, signifying both saturated and unsaturated hydrocarbons and suggesting the presence of aromatic systems or conjugated double bonds. In the 1250–1100 cm^{-1} region, C–O stretching vibrations indicated the presence of oxygenated compounds, such as esters, ethers, or phenolic glycosides. Notably, aromatic C–H out-of-plane bending vibrations were evident in the 950–750 cm^{-1} range, especially in the acetone and chloroform extracts, supporting the presence of polyphenolic or aromatic constituents (Ghosh et al., 2015). The petroleum ether extract, being non-polar, showed relatively intense bands related to lipids and long-chain hydrocarbons, with limited polar functional group signals. The acetone extract demonstrated strong O–H and C=O absorption, underscoring its efficiency in extracting phenolics and polar compounds. The chloroform extract, with intermediate

polarity, exhibited a wide array of functional groups and distinctive peaks below 700 cm^{-1} that could be attributed to C–Cl stretching vibrations, possibly from residual solvent, in addition to aromatic signals.

These results confirm that FTIR spectroscopy effectively highlights the chemical heterogeneity of Lantana camara leaf extracts and underscores the selective extraction capabilities of solvents with varying polarities. The spectral patterns reflect a complex matrix of phytochemicals including hydrocarbons, esters, phenolics, and possibly chlorinated residues, which may contribute to the observed bioactivity of the extracts.

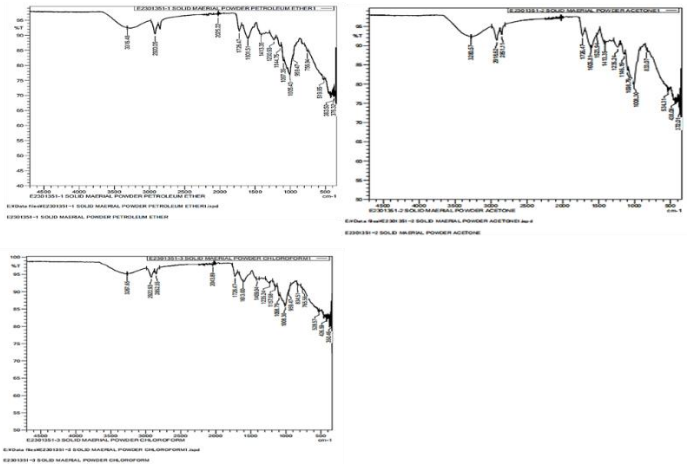

Figure 5. FTIR spectra of Lantana camara L. leaf extracts using petroleum ether, acetone, and chloroform as solvents. (The spectra exhibit characteristic absorption bands corresponding to functional groups such as O–H, C=O, C–H, and C=C, indicative of alcohols, phenolics, lipids, and hydrocarbons. Comparative analysis reveals solvent-specific variations in the chemical composition and functional group intensities of the extracts)

Conclusion

This study comprehensively evaluated the influence of solvent polarity on the extraction efficiency, phytochemical profile, and antioxidant activity of L. camara leaf extracts. Acetone, with its intermediate polarity, emerged as the superior solvent, yielding the highest total phenolic and flavonoid contents, which directly correlated with its potent antioxidant capacity demonstrated by DPPH, FRAP, and ABTS assays. Preliminary phytochemical screening and FTIR spectral analysis further supported the diverse and rich phytoconstituent profile in acetone extracts, including flavonoids, phenolics, and terpenoids, compounds known for their health-promoting bioactivities. Petroleum ether extracts, limited by its non-polar nature, extracted mainly lipophilic compounds with comparatively lower antioxidant potential. Chloroform extracts displayed moderate phytochemical richness and antioxidant capacity, consistent with its intermediate polarity. The study underscores the critical role of solvent selection in natural product extraction, providing a methodological framework for maximizing bioactive compound recovery. Given its robust antioxidant profile, L. camara leaf extract, especially when prepared with acetone, holds promising potential for development into natural antioxidant formulations. Future work should focus on isolation of individual bioactive compounds, mechanistic antioxidant studies, and in vivo validation to harness the therapeutic potential of this versatile plant.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the publication of this paper.

ETHICAL APPROVAL

This article does not contain any studies involving animals or human participants performed by any of the authors. Hence, ethical approval was not required.

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CONSENT FOR PUBLICATION

The author has read and approved the final version of the manuscript and consent to its publication

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