Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
Impact Factor (RJIF): 6.35
www.phytojournal.com
JPP 2025; 14(5): 290-298
Received: 24-06-2025
Accepted: 27-07-2025

Snehal T Bhandakkar
[1] Department of Botany, Arts, Commerce and Science College, Maregaon, Yavatmal, Maharashtra, India
[2] Post Graduate Teaching Department of Botany, RTM Nagpur University, Nagpur, Maharashtra, India

Dayanand P Gogle
Post Graduate Teaching Department of Botany, RTM Nagpur University, Nagpur, Maharashtra, India

Corresponding Author:
Snehal T Bhandakkar
[1] Department of Botany, Arts, Commerce and Science College, Maregaon, Yavatmal, Maharashtra, India
[2] Post Graduate Teaching Department of Botany, RTM Nagpur University, Nagpur, Maharashtra, India

Extractive values, quantitative phytochemical analysis, and FTIR spectroscopic profiling of *Careya arborea* Roxb. root

Snehal T Bhandakkar and Dayanand P Gogle

DOI: https://www.doi.org/10.22271/phyto.2025.v14.i5d.15587

Abstract
This study aimed to explore the phytochemical profile, extractive values, quantitative assessment of bioactive compounds, anti-inflammatory activity and FTIR characterization of *Careya arborea* Roxb. root. The evaluation of extractive values revealed the highest yields when using polar solvents such as methanol ethanol and water underscoring their efficiency in extracting polar phytochemicals. Initial phytochemical screenings verified the presence of alkaloids, phenols, flavonoids, tannins, saponins, terpenoids, phytosterols, and cardiac glycosides, with variations observed based on the polarity of the solvents. Quantitative analyses further confirmed that significant levels of phenolic compounds, flavonoids tannins and terpenoids were present. In- vitro anti-inflammatory activity showed maximum amount of inhibition of protein denaturation increasing from 57.6% at 100 µg/mL to 92.3% at 500 µg/mL reaching near that of Prednisone, Aceclofenac. *The* FTIR analysis revealed characteristic absorption peaks associated with O-H C-H C=O C=C, and C-O bonds supporting the presence of phenols, flavonoids glycosides and terpenoids. A review of earlier studies has shown that while the bark and fibre of *Careya arborea* Roxb. have been investigated, these findings collectively provided a scientific basis for the traditional uses of *C. arborea* Root underscoring its potential as a source of pharmacologically effective substances.

Keywords: Careya, extractive values, terpenoids, FTIR, ethanol, prednisone

1. Introduction
Since ancient times, Plants have been a major source of bioactive components, with a vast diversity of phytochemicals providing as a valuable resource for drug development and therapeutic applications (Nida S & Rahimullah., 2022). Nearabout, 40% of pharmaceutical drugs are derived from plant origins and 80% of people around the world utilize herbal treatment (Mwangi *et al*., 2024) [21]. For thousands of years, traditional medicine has relied on botanical sources due to their diverse secondary metabolites that have demonstrated therapeutic properties (Mahapatra *et al*. 2021) [20]. An example of such a plant is *Careya arborea* belonging to the Lecythidaceae family and commonly known as slow match tree or wild guava. This species is prevalent throughout India and in other tropical Asian countries particularly in areas with both moist and dry deciduous forests. *C. arborea* root, has a reddish-brown colour and possesses a spicy flavour. Rich in mineral content and secondary metabolites *Careya arborea* roots could help mitigate malnutrition and be a source for herbal medicines. They include essential nutrients such as potassium, calcium and iron making them beneficial as food supplements to address hypocalcaemia and anaemia. (Kashyap K *et al*., 2022) [16]. The crude methanol extract of *Careya arborea* roots showed strong cytotoxic and Antioxidant activity (Ramdurga, B *et al*., 2021) [28]. Its pharmacological activities include, astringent, anti-fertility, antibacterial, hyperglycaemic, antidiarrheal, and antifungal actions. In Ayurvedic scripture it used for treating TB, broken bones, and addressing 'Vata-Kapha imbalances' (Kashyap K *et al*., 2023: Ambardar, *et al*., 2013) [17, 4]. The leaves, bark, fruits and other parts have applications in ethnomedicine for treating various disorders, including coughs, colds, skin infections inflammation, ulcers and tumours (Kaur *et al*., 2017) [18]. Previous research has identified secondary metabolites in bark, leaves, and seeds, including flavonoids, cardiac glycosides, coumarins, essential oils, and lignans, using methods like HPTLC (Gupta PC *et al*., 2019) [12].
The extractive values, which indicate the solubility of a plant material in various solvents, are essential for standardising plant-based raw materials for pharmacological studies. The pharmacognostic study of *C. arborea* showed that the water-soluble extractives in the leaf and

stem bark typically surpass the alcohol-soluble ones (Gupta, PC *et al*., 2012) [11]. Additionally, while extractive values (water-soluble alcohol-soluble) and physicochemical standardization have been done for leaves and stem bark (including in leaves/stems pharmacognostic s studies) of *C. arborea*, there is an absence of published data combining extractive values, quantitative phytochemical assays for roots, anti-inflammatory activity and FTIR analysis altogether. Therefore, in this study we aim to fill these gaps by (i) determining extractive values of *C. arborea* roots (with solvents such as water and alcohol), (ii) qualitative and quantitative estimating major phytochemical classes (alkaloids, phenols, flavonoids, tannins, saponins) in root extracts, and (iii) *in vitro* anti-inflammatory activity (iv)conducting FTIR spectroscopy to profile functional groups present in the extracts. This integrative chemical profiling of roots will provide baseline data for standardization, potential bioactivity correlation, and for guiding future isolation of bioactive compounds.

2. Material and Methodology

2.1. Plant Material Collection

Fresh roots of *Careya arborea* Roxb. were collected from Atal-Anandwan Dense Forest plantation, Near Anandwan, Warora forest region, Maharashtra, India in the month of July. The collected roots were washed under running tap water to remove soil and debris. The material was shade-dried at room temperature. The dried roots were then pulverized using a mechanical grinder, sieved through mesh, and stored in airtight containers at room temperature until further use (Odey *et al*., 2010) [24].

Fig 1: Fresh Material of *Careya arborea* Roxb. Root on Left and Dried on Right

Fig 2: Powdered Form of *Careya arborea* Roxb. Root

2.2. Determination of Extractive Values

The extractive values of *Careya arborea* Roxb. root powder was determined by simple Cold maceration method described by (Pawar S., 2016) [26] using solvents of varying polarity including water, methanol, ethanol, acetone, petroleum ether, chloroform, ethyl acetate, and h-hexane. Approximately, 2 g of Root powder was soaked in 20 mL of each solvent for 24 hours with occasional shaking. Post-maceration, the mixtures were filtered, and the filtrates were concentrated to dryness. The dried residues were weighed to calculate the percentage extractive values based on dry weight using given formula:

$$\text{Extractive Value (\% w/w)} = \frac{\text{(Weight of dried extract)}}{\text{(Weight of powdered root sample)}} \times 100$$

2.3. Qualitative Phytochemical Analysis

Qualitative phytochemical analysis of *Careya arborea* Roxb. Root extract was performed by standard methods (Harborne., 1998; Balamurugan *et al*., 2019; Velavan., 2015) [14, 37] as described in Table 1.

Table 1: Qualitative phytochemical screening of *Careya arborea* Roxb. root extract.

Phytoconstituent/ Test Name	Procedure / Reagent Used	Observation
Alkaloid		
Mayer's Test	1ml extract + 2-3 drops Mayer's reagent ($HgCl_2$ + KI solution)	Cream/white precipitate
Wagner's Test	1ml extract + few drops Wagner's reagent (I_2 in KI solution)	Reddish-brown precipitate
Dragendroff Test	1ml extract+ Dragendroff's Reagent	Orange or Red ppt
Phenol		
Ferric Chloride Test	1ml extract + 2-3 drops $FeCl_3$ (5%)	Blue-green/black coloration
Flavonoid		
Alkaline Reagent Test	1 ml extract + few drops NaOH solution; acidify with dilute HCl	Intense yellow → colour disappears
Lead Acetate Test	1 ml extract + 1 ml 10% Lead acetate	White precipitate
Tannin		
Braymer's Test	2 ml extract + 2 ml distilled water + 2-3 drops $FeCl_3$ (5%)	Green precipitate
Gelatine Test	1 ml extract + 1% gelatine solution containing NaCl	White precipitate
Saponin		
Foam Test	Extract + distilled water, shaken vigorously	Persistent froth formation
Phytosterols		
Terpenoids Salkowski's Test	2 ml extract + 2 ml acetic anhydride + 2-3 drops conc. H_2SO_4	Deep red coloration
Triterpenoids Libermann-Burchard Test	2 ml extract + 2 ml acetic anhydride + conc. H_2SO_4 (few drops)	Formation of Ring
Diterpenes Copper Acetate Test	Extract + copper acetate solution	Emerald green coloration
Cardiac Glycoside		
Keller-Killani Test	2 ml extract + glacial acetic acid + 1 drop $FeCl_3$ + conc. H_2SO_4 (under layered)	Brown ring at interface
Legal's Test	1 ml extract + sodium nitroprusside + pyridine + NaOH	Pink/red coloration

2.4. Preparation of Extract using Soxhlet Extraction
Amongst all the extracts, the solvent with maximum number of Phytochemicals detected was proceeded further for Soxhlet Extraction preparation method described by (Alara *et al*., 2018) [3].

2.5. Quantitative Phytochemical Analysis
The major phytochemical groups were estimated using Soxhlet prepared extract in root using standard protocols:

2.5.1. Total Alkaloid Content
Total alkaloid content was determined by using the Bromocresol Blue method (Ajanal *et al*., 2012) [2]. 1 ml of extract (1mg/mL) was mixed with 2N HCl, and filtered using Whatman Fiter paper No. 1. The Filtrate was collected in separating funnel and washed thrice with 10 ml of chloroform every time. The washed filtrate mixed with 5 mL of 0.1% bromocresol blue solution and 5 mL of phosphate buffer (pH 4.7). The mixture was shaken and allowed to settled for some time followed by extraction with 1,2,3 and 4 mL chloroform. The absorbance of the chloroform layer was measured at 430 nm. Atropine was used to prepare the standard calibration curve, and results were expressed as mg alkaloid per gram of extract. The calibration curve was prepared using Atropine (20-100 µg/mL), and the results were reported in mg AE/g of extract.

2.5. 2. Total Flavonoid Content
An aluminium chloride colorimetric method was used to estimate the Total flavonoid content described by Belguidoum, *et al*., 2015 [8] with some minor modifications. Around 100 µL of extract (1 mg/mL) was added to with 0.3 mL of a 5% $NaNO_2$ solution and 4 mL of distilled water. 0.3 mL of 10% $AlCl_3$ solution was added after 5 minutes, and then 2 mL of 1 M NaOH after 6 minutes. Distilled water was then added to bring the volume up to 10 mL. After 15 minutes of incubation, the mixture's absorbance at 510 nm was measured. The calibration curve was prepared using quercetin (100-1000 µg/mL), and the results were reported in mg QE/g of extract.

2.5.3. Total Phenol Content
The total Phenolic content was evaluated by he Folin-Ciocalteu method, as described by Wabaidur, *et al*., 2020.The methanolic Root extract, roughly 100 µL (1 mg/mL) of extract,2 mL of 7.5% sodium carbonate solution, 2.5 mL of Folin-Ciocalteu reagent (Diluted in 1:10 with distilled water) were mixed. The mixture was incubated at room temperature for 90 minutes, and the absorbance was measured at 765 nm. A standard curve was constructed using gallic acid (25-500 µg/mL), and results were expressed as mg GAE/ g of extract.

2.5.4. Total Tannin Content
Total tannin content was measured using the Folin-Denis's method described by Guglani *et al*., 2020 [10], with some minor modifications. Nearabout, 100 µL of plant extract was mixed with 2.5. mL of Folin-Denis's reagent and 5 mL of 35% sodium carbonate solution. The final volume was made up to 10mL with distilled water, followed by incubation at room temperature for 30 min. The absorbance was recorded at 700 nm. The standard calibration curve was prepared using tannic acid, and the results were reported as mg of tannic acid equivalents (TAE) per gram of extract. The calibration curve was prepared using Tannic acid (20-1000 µg/mL), and the results were reported in mg TAE/g of extract.

2.5.5 Total Saponin Content
For the estimation of total saponin content, Vanillin-sulfuric acid method described by V. Le, *et al*., 2018 [36] was used. Notably, 0.25 mL of plant extract (1 mg/mL) was mixed with of 8% vanillin solution and 2.5 mL of 72% sulfuric acid. After 15 minutes of incubation at 60 °C in a water bath, the mixture was immediately cooled to room temperature using an ice water bath. At 560 nm, the absorbance was measured. The calibration curve was prepared using Diosgenin (20-1000 µg/mL), and the results were reported in mg DE/g of extract.
All the data are presented as the mean ± standard deviation, and analysis was performed in triplicate.

2.6. *In vitro* anti-inflammatory activity
In vitro Anti-inflammatory activity of *Careya arborea* root extract was performed by protein denaturation assay by BSA Method. NSAID (Acelofenac) and one steroid (prednisolone) were used as reference drugs. To the total of 5ml of Reaction mixtures, 0.2 ml of egg albumin (from fresh hen's egg) 2.8 ml of phosphate-buffered saline (pH 6.4) 2ml of varying concentration of *C. arborea* root extract or reference drug was added. All the test tubes were incubated in a water bath at 37°C ± 2°C for 15-20 min, followed by heating at 70°C for 5 min. The test tubes containing reaction mixtures were cooled down and the absorbance was taken at 660 nm. The percentage inhibition of Protein was evaluated by following formula (Dharmadeva, *et al*., 2018) [9].

% Inhibition = {(Absorbance of control- Absorbance of Test Extract)/ Absorbance of control) *100}

2.7. FTIR Analysis
FTIR spectra of *Careya arborea* Roxb. Root powder was recorded using a FTIR spectrophotometer (Bruker/PerkinElmer) in the range 4000-400 cm^{-1}. Samples were dried and prepared as KBr pellets (1:100 w/w). Spectra were obtained at a resolution of 4 cm^{-1} with 32 scans, and major absorption bands were identified for functional group characterization based on standard references (Oliveira *et al*., 2016).

3. Results and Discussion
3.1. Extractive value
The Extractive yield % of different solvent extracts from *Careya arborea* Roxb roots showed increasing values with solvent polarity as depicted in Table 2. Among all extracts, Water displayed the highest extract at 8.33 ± 0.76%, followed by Acetone (7.8± 0.15), Methanol (6.70 ± 0.52%,) and Ethanol (5.5 ± 0.42%). Ethyl acetate showed a moderate 0.63± 0.46%, while non-polar solvents like petroleum ether, chloroform, and hexane displayed low amounts. The results presented here support the solubility of bioactive substances like flavonoids and phenolics by showing that *C. arborea* roots are abundant in polar and mid-polar phytoconstituents. Fat-soluble compounds may be present in smaller amounts, as indicated by the lower yields from non-polar solvents (Tiwari *et al*., 2011) [35]. Previous investigation by Wadje *et al*. (2019) found that methanol and aqueous extracts from *C. arborea* leaves and bark had higher extractive values, while petroleum ether extracts were negligible. Ramesh *et al*. (2015) [29] observed a similar trend in fruits and bark. A similar polarity-dependent trend was also reported by Kashyap *et al*. (2023) [17], where water extract showed maximum yield (18.97%), and petroleum ether the least. The current findings on roots support and expand earlier observations. These findings collectively confirm that *C. arborea* roots are enriched with polar phytoconstituents, validating the uses of polar solvents in phytochemical investigations.

Table 2: Extractive Value Percentage of *Careya arborea* Roxb. Root

Sr. No	Solvent	% Yield Mean±SD
1	Petroleum ether	0.13±0.06
2	Chloroform	0.30 ± 0.00
3	Hexane	0.33 ±0.58
4	Ethyl acetate	0.63± 0.46
5	Acetone	7.8± 0.15
6	Ethanol	5.69. ±0.42
7	Methanol	6.70± 0.52
8	Water	8.33± 0.76

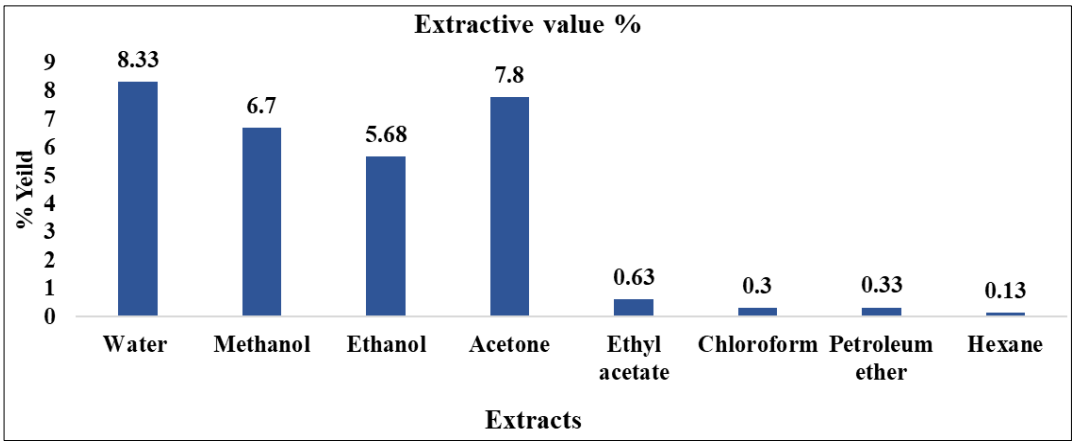

Fig 3: Extractive Value Percentage of *Careya arborea* Roxb. Root

3.2. Qualitative Phytochemical Analysis

Distribution of secondary metabolites across various solvents of *Careya arborea* Roxb. Root extracts, as indicated in the Table 3.

Table 3: Phytochemical Screening using Various Extracts on *Careya arborea* Roxb. Root.

Phytochemical Screening								
Test Name / Solvents	Methanol	Ethanol	Water	Acetone	Ethyl acetate	Chloroform	Petroleum ether	n- Hexane
Alkaloid test								
Mayers test	+	+	-	+	-	-	-	-
Wagnar Test	+	+	+	+	+	+	-	-
Dragendroff Test	+	+	+	-	-	-	-	-
Phenol								
Ferric chloride test	+++	+++	+++	+++	+	+	-	-
Flavonoid								
Alkaline reagent	+++	++	+++	+++	+	-		-
Lead acetate	+++	++	++	+++	++	+	-	-
Tannins								
Gelatine test	+++	+++	+	++	-	+	-	-
Bramer's Test	+++	+++	+++	+++	+	+	-	-
Saponins								
Foam Test	+++	-	+++	+	-	-	-	-
Phytosterols								
Terpenoid -Salkowski's Test	++	++	++	+	+++	++	++	++
Triterpenoid Libermann Burchard's	+++	+++	+++	+	+	++	+++	++
Diterpenes -Copper acetate test	+++	+++	+++	+++	-	-	-	-
Cardiac Glycoside								
Legal Test	++	++	++	+++	-	++	+++	-
Kellar -Killani Test	++	+	-	+	-	++	++	+

The phytochemical analysis of *Careya arborea* Roxb. Root extracts indicated a rich presence of phenolics, flavonoids, tannins, saponins, terpenoids and glycosides especially in the extracts obtained with methanol, ethanol, water and acetone. Strong positive reactions were observed in phenols, while weak to moderate reactions were found in ethyl acetate and chloroform. Flavonoids were observed in methanol, water, and acetone extracts, with moderate reactions in ethanol and ethyl acetate. Tannins were found in methanol, ethanol, water, and acetone extracts, with moderate reactions in chloroform. The study also found a broad presence of terpenoids, with ethyl acetate showing the highest. Diterpenes were found in methanol, ethanol, water, and acetone, while acetone showed weaker responses. Ramdurga *et al*., 2019 [28] detected Several major classes of phytoconstituents in the root extracts, including alkaloids, tannins, saponins, sterols glycosides, phenolics, flavonoids. This solvent-dependent variability aligns with the solubility profiles of these metabolites as polar solvents generally enhance the extraction of polyphenols tannins and glycosides whereas non-polar solvents more selectively extract sterols and triterpenoids (Harborne 1998; Tiwari *et al*. 2011) [14, 35].

3.3. Extractive value of Soxhlet Extracted solvent

Qualitative Phytochemical Test was performed on Cold macerated extract using various solvents. Amongst all the extract maximum phytochemicals were present in Methanolic extract hence for Qualitative analysis, the methanolic extract was prepared using Soxhlet Extraction method. Post extraction the solvent was evaporated until complete dryness and the residual powder was stored at -4 C for further analysis. The methanolic extract yield obtained through Soxhlet extraction was 19.05%. For quantitative analysis mg/ml extract was prepared.

3.4. Quantitative Phytochemical Test Using Methanolic Extract

The content of the phytochemicals in the Methanolic extract were determined from regression equation obtained through the calibration curve.

Table 4: Quantitative phytochemical content of *Careya arborea* Roxb. Root extract

Phytochemical	Content (mg/g extract)	Equivalent Standard
Total Alkaloid Content	1.79 ± 0.15	AE (Atropine Equivalent)
Total Flavonoid Content	440.41±0.35	QE (Quercetin Equivalent)
Total Phenol Content	76.78 ± 0.04	GAE (Gallic Acid Equivalent)
Total Tannin Content	55.31 ± 2.47	TAE (Tannic Acid Equivalent)
Total Saponin Content	206.22 ± 2.74	DG (Diosgenin Equivalent)

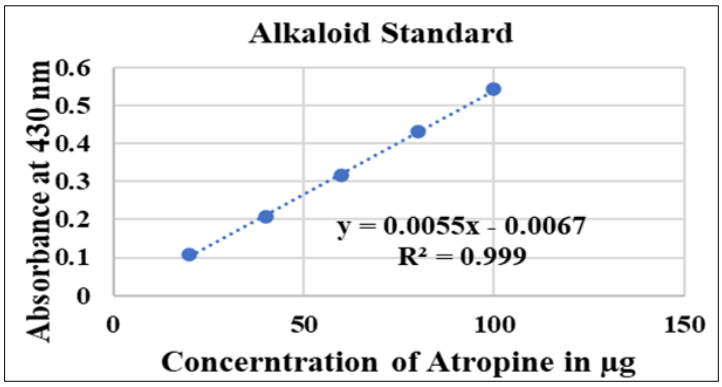

Fig 4: Standard calibration curve for standard Atropine

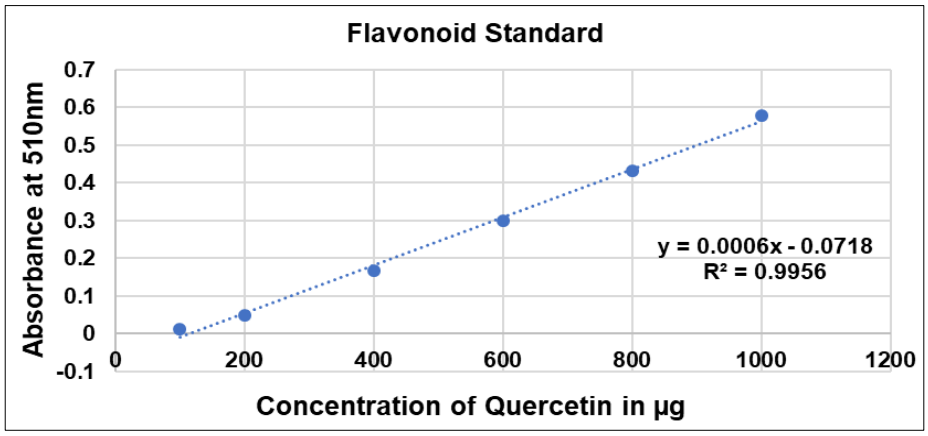

Fig 5: Standard calibration curve for standard Saponin

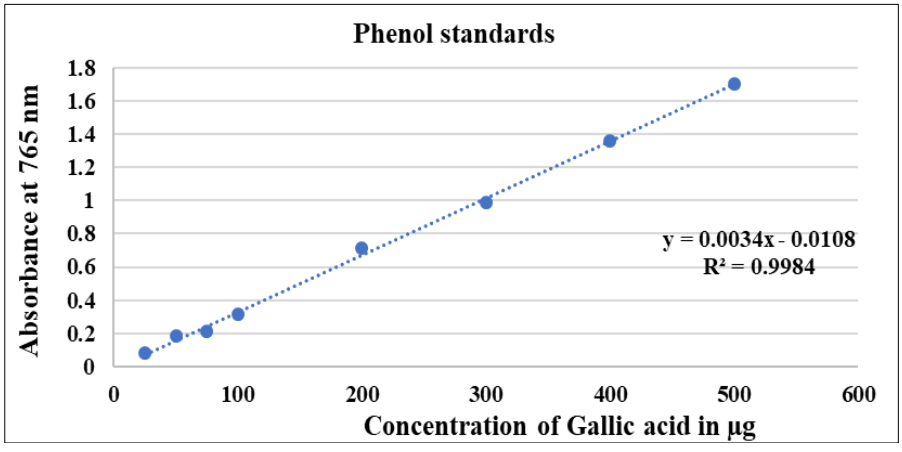

Fig 6: Standard calibration curve for standard Gallic acid

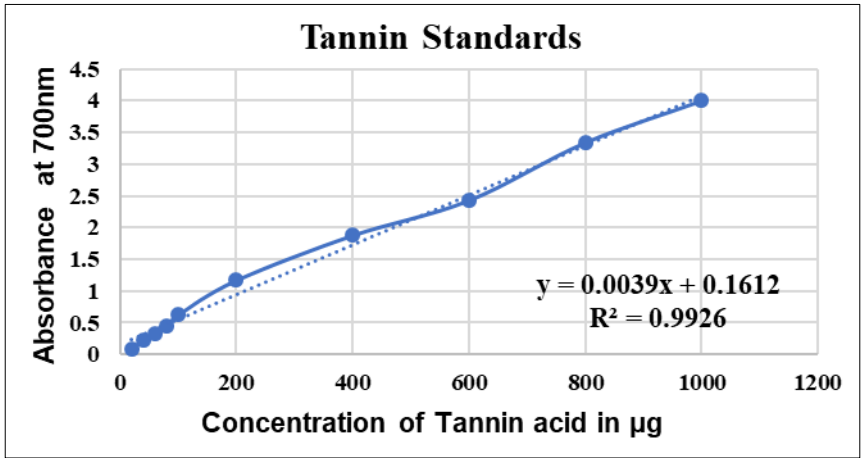

Fig 7: Standard calibration curve for standard Tannic acid

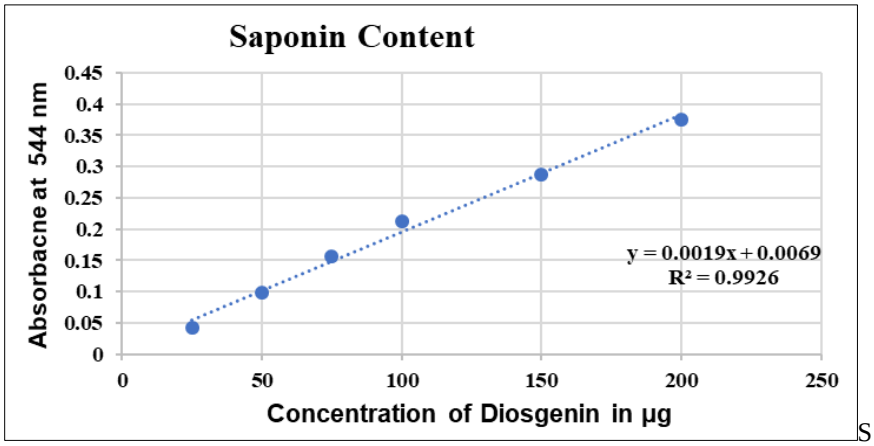

Fig 8: Standard calibration curve for standard Saponin

The present findings reveal that the major phytochemicals in the roots of *Careya arborea* Roxb. are flavonoids (440.41± 0.35 mg/g) and saponins (206.22 mg/g). The study found the flavonoids concentration to be higher than that of Saponin, suggesting that, unlike the aerial parts, the roots may serve as a very rich source of these compounds. Phenols and tannins were detected in moderate concentrations, alkaloids were present at very low levels, which suggests that pharmacologically active even in small quantities and could still play a role in the overall bioactivity profile (Sabir M N, *et al*., 2024) [33]. Previous studies on bark and leaves have found flavonoids and phenolics as the main constituents of *C. arborea* Roxb. The high number of Flavonoids significantly contribute to the antioxidant properties, as reported by (Gupta *et al*. 2019, 2020) [12] who used HPTLC profiling to identify flavonoids abundant in bark extracts. The elevated level of saponins also suggests strong antimicrobial and immunomodulatory properties, which have been reported in the stem bark of *C. arborea* and related medicinal plants (Kumar *et al*., 2013) [19].

3.6. *In vitro* Anti-inflammatory activity By Protein Denaturation Method using Methanolic extract

The present *in vitro* protein-denaturation assay demonstrated a clear, dose-dependent anti-inflammatory effect of *Careya arborea* root extract, with percentage inhibition increasing from 57.6% at 100 µg/mL to 92.3% at 500 µg/mL reaching near that of Prednisone, Aceclofenac.

Table 5: *In vitro* Anti-inflammatory activity of *Careya arborea* root extract compared with standard drugs (Prednisone and Aceclofenac).

Concentration µg/ml	Prednisone (% Inhibition)	Aceclofenac (% Inhibition)	*Careya Root (% Inhibition)*
100	59.29±4.22	68.49±0.70	57.60±0.65
200	81.54±0.35	86.95±0.48	64.01±0.84
300	83.10±0.41	92.81±0.93	71.97±0.14
400	89.83±0.14	94.91±0.00	80.35±7.25
500	93.72±0.91	97.29±0.05	92.26±0.08

Our research is in agreement with Earlier investigation indicates that *Careya arborea* extracts have significant anti-inflammatory properties. Previous studies by Begum *et al.* (2015) illustrated a decrease in carrageenan-induced paw swelling and a reduction in inflammatory markers, including TNF-α IL-1β and COX-2. Bindu and Aleykutty (2022) [7] Protein denaturation and proteinase inhibition activity of the *C. arborea* extract bark. Rayhana *et al.* (2014) [31] found that the extract reduced joint inflammation and improved mobility in chronic inflammatory models, showing effects similar to standard anti-inflammatory drugs. Additionally, Perunnal *et al.* also reported the anti-inflammatory and analgesic effects of the extract in animal studies. Altogether, these outcomes support the ethnomedicinal application of *C. Arborea* suggesting its root extract may be a promising source for new anti-inflammatory medications.

3.7. FTIR analysis

The presence of several bioactive phytoconstituents in *Careya arborea* Roxb Roots is revealed by the FTIR analysis. In Total 15 peaks were obtained for the FTIR analysis of Careya arborea.

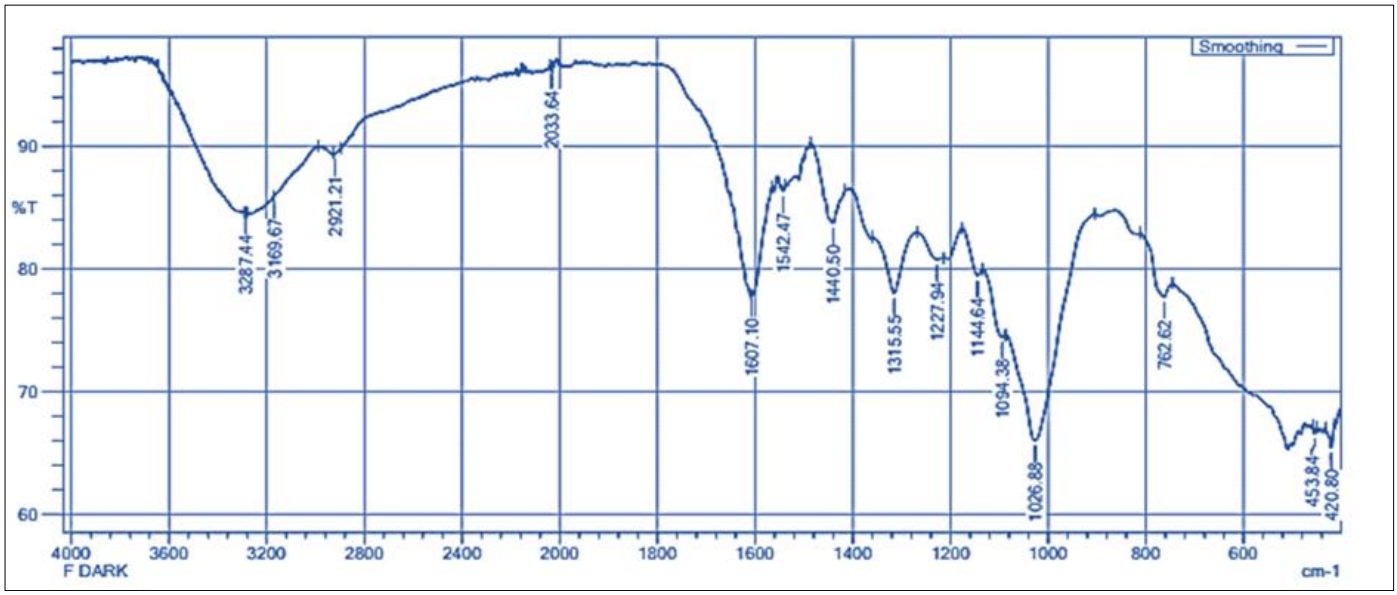

Fig 9: FT-IR analysis of *Careya arborea* Root.

Table 6: FTIR absorption frequencies and corresponding functional groups of bioactive compounds in *Careya arborea* Roxb.

Wavenumber (cm^{-1})	Functional Group	Type of Vibration	Possible Phytochemical Classes
3287, 3169	O-H / N-H	Stretching	Alcohols, Phenols, Flavonoids, Tannins, Amines
2921	C-H (-CH_3, -CH_2)	Stretching	Alkanes, Fatty acids, Terpenoids
2033	C≡C / C≡N (weak overtone)	Stretching	Alkynes, Nitriles
1607, 1542	C=C (aromatic) / N-H	Stretching / Bending	Aromatic rings, Phenolic compounds, Alkaloids
1440, 1315	N-O / N-H / C-H	Bending	Alkaloids, Nitro compounds, Proteins
1227, 1144	C-O / C-N / C-O-C	Stretching	Alcohols, Ethers, Glycosides, Carbohydrates
1094, 1026	C-O-C	Stretching	Polysaccharides, Flavonoid glycosides
762	C=C / C-H (aromatic ring)	Out-of-plane bending	Aromatic hydrocarbons, Phenolics
453, 420	C-Br / C-I	Stretching (fingerprint region)	Haloalkanes, Organ halogens, Minerals

The phytochemical screening results are supported by the strong broad and suggests a high content of phenols, flavonoids, tannins, and amines band at 3287-3169 cm^{-1}, which shows O-H and N-H stretching. Terpenoids and fatty acid derivatives are indicated by the absorption at 2921 cm^{-1}, which is consistent with C-H stretching of alkanes. The presence of phenolic compounds and alkaloids is confirmed by the peaks at 1607-1542 cm^{-1}, which are indicative of C=C aromatic ring stretching and N-H bending. The presence of proteins, nitro compounds, and alkaloids is further supported by the 1440-1315 cm^{-1} region. Glycosides, alcohols, ethers, and polysaccharides are suggested by strong absorptions at 1227-1026 cm^{-1}, which correlate to C-O and C-O-C vibrations. While the fingerprint region below 600 cm^{-1} indicates complex biomolecules like terpenoids and minerals, the 762 cm^{-1} band indicates aromatic substitutions (https://instanano.com). Previous studies on *C. arborea* bark, roots, and fibres have reported similar FTIR features, validating the presence of hydrophilic phytoconstituents and lignocellulosic components (Kashyap *et al*., 2024; Thombare, *et al*., 2023: Nayak, S *et al*., 2024, Rao at al., 2023) [15, 34, 22, 30].

4. Conclusion

The analysis of extractive values from *Careya arborea* Roxb. root indicates that polar solvents such as methanol ethanol and water efficiently extract polar bioactive compounds. A preliminary phytochemical assessment identified key secondary metabolites including alkaloids phenols flavonoids tannins saponins terpenoids phytosterols and cardiac glycosides with their presence varying according to the polarity of the used solvents. Quantitative tests demonstrated significant amounts of phenols flavonoids tannins and terpenoids within the root pointing towards considerable medicinal possibilities.

The FTIR study backed these results by revealing typical absorption peaks for specific functional groups. The root of *Careya arborea* Roxb.is recognized as a valuable source of phytochemicals supporting its traditional medicinal significance and indicating the need for further pharmacological exploration.

5. Conflict of Interest

Authors declare that they do not have any Conflict of Interest

References

1. Instanano. Available from: https://instanano.com
2. Ajanal M, Gundkalle MB, Nayak SU. Estimation of total alkaloid in *Chitrakadivati* by UV-spectrophotometer. Ancient Science of Life. 2012;31(4):198-201. doi:10.4103/0257-7941.107361
3. Alara OR, Abdurahman NH, Ukaegbu CI. Soxhlet extraction of phenolic compounds from *Vernonia cinerea* leaves and its antioxidant activity. Journal of Applied Research on Medicinal and Aromatic Plants. 2018;11:12-17.

4. Ambardar N, Aeri V. A better understanding of traditional uses of *Careya arborea* Roxb.: phytochemical and pharmacological review. Cellmed. 2013;3(4):21-27.
5. Balamurugan V, Fatima S, Velurajan S. A guide to phytochemical analysis. International Journal of Advance Research and Innovative Ideas in Education. 2019;5(1):236-245.
6. Begum R, Sharma M, Pillai KK, Aeri V, Sheliya MA. Inhibitory effect of *Careya arborea* on inflammatory biomarkers in carrageenan-induced inflammation. Pharmaceutical Biology. 2015;53(3):437-445.
7. Bindu AR, Aleykutty NA. *In vitro* models on inhibition of inflammatory mediators by ethanolic extract of *Careya arborea* Roxb. bark in lipopolysaccharide-induced RAW 264.7 cell lines. In: Natural Product Experiments in Drug Discovery. New York: Springer US; 2022. p. 231-248.
8. Belguidoum M, Dendougui H, Kendour Z, Belfar A, Bensaci C, Hadjadj M. Antioxidant activities, phenolic, flavonoid and tannin contents of endemic *Zygophyllum cornutum* Coss. from Algerian Sahara. Der Pharma Chemica. 2015;7(11):312-317.
9. Dharmadeva S, Galgamuwa LS, Prasadinie C, Kumarasinghe N. *In vitro* anti-inflammatory activity of *Ficus racemosa* L. bark using albumin denaturation method. AYU. 2018;39(4):239-242. doi:10.4103/ayu.AYU_27_18
10. Guglani A, Pandey HK, Arya RK, Bala M. *In vitro* antioxidant activity, total phenolic, flavonoid and tannin contents in the *Ajuga bracteosa* Wall. ex Benth grown at middle hill climatic condition of Western Himalayas. Defence Life Science Journal. 2020;5(3):198-203.
11. Gupta PC, Sharma N, Rao ChV. Pharmacognostic studies of the leaves and stem of *Careya arborea* Roxb. Asian Pacific Journal of Tropical Biomedicine. 2012;2(5):404-408. doi:10.1016/S2221-1691(12)60065-3
12. Gupta P, Patil D, Patil A. Qualitative HPTLC phytochemical profiling of *Careya arborea* Roxb. bark, leaves and seeds. 3 Biotech. 2019;9(8):311. doi:10.1007/s13205-019-1846-x
13. Gupta P, Patil D, Patil A. Evaluation of total phenol, total flavonoid content and antioxidant activity of *Careya arborea* Roxb. bark and leaves. International Journal of Botany Studies. 2020;5:125-132.
14. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd ed. London: Chapman & Hall; 1998.
15. Kashyap K, Das AK, Sur K, Kispotta A, Goswami J, Ghosh A, *et al*. Physicochemical investigation of *Careya arborea* Roxb.: a comparative study. ES General. 2024;4:1136.
16. Kashyap K, Hait M, Roymahapatra G, Vaishnav MM. Proximate and elemental analysis of *Careya arborea* Roxb. plant's root. ES Food & Agroforestry. 2022;7(8):41-47.
17. Kashyap K, Das AK, Bhardwaj AK, Roymahapatra G, Ghosh A, Hait M, Jain R. Phytochemical analysis of *Careya arborea* Roxb. root extracts: a qualitative analytical approach. ES General. 2023;1(4):959.
18. Kaur M, Yadav R. Pharmacognostic, ethnopharmacological, phytochemical and pharmacological profile of wild guava i.e. *Careya arborea* Roxb. International Journal of Current Pharmaceutical Research. 2017;9(3):1-7. doi:10.22159/ijcpr.2017.v9i3.18887
19. Kumar K, Mruthunjaya K, Kumar S, Mythreyi R. Anti-ulcer activity of ethanol extract of the stem bark of *Careya arborea* Roxb. International Current Pharmaceutical Journal. 2013;2(3):78-82. doi:10.3329/icpj.v2i3.13633
20. Mahapatra S, Das PK, Purohit GK, Pattanaik S, Palo S. Role of medicinal plant extracts in eradication of multi-drug resistant microbes.
21. Mwangi WC, Waudo W, Shigwenya ME, *et al*. Phytochemical characterization, antimicrobial and antioxidant activities of *Terminalia catappa* methanol and aqueous extracts. BMC Complementary Medicine and Therapies. 2024;24:137. doi:10.1186/s12906-024-04449-7
22. Nayak S, Mohapatra J, Muduli K, Khuntia SK, Malla C, Patra SK, *et al*. Mechanical and thermal properties of *Careya arborea* bast fiber-reinforced chitosan composites for packaging industries. Biomass Conversion and Biorefinery. 2024;14(17):20397-20404.
23. Shaikh NS, Shaikh RS. Qualitative phytochemical screening of leaf extract of *Gmelina philippensis* Cham and assessment of its antioxidant and antibacterial activity in different solvents. Journal of Pharmacognosy and Phytochemistry. 2022;11(5):133-140. doi:10.22271/phyto.2022.v11.i5b.14489
24. Odey MO, Iwara IA, Udiba UU, Johnson JT, Inekwe UV, Asenye ME, Victor O. Preparation of plant extracts from indigenous medicinal plants. International Journal of Science and Technology. 2012;1(12):688-692.
25. Oliveira RN, Mancini MC, Oliveira FCS, Passos TM, Quilty B, Thiré RMSM, McGuinness GB. FTIR analysis and quantification of phenols and flavonoids of five commercially available plant extracts used in wound healing. Matéria (Rio de Janeiro). 2016;21(3):767-779.
26. Pawar SS, Jadhav MG. Determination of extractive value and phytochemical analysis of *Bacopa monnieri* (L). Recent Advances in Life Sciences. 2016;8(7):1222-1229.
27. Ramadurga B, Jat RK, Badami S. Pharmacognostic evaluation and antimicrobial activity of root of *Careya arborea*. Pharmacognosy Journal. 2019;11(3):-.
28. Ramdurga B, Jat RK, Badami S. *In vitro* cytotoxic and antioxidant activities of *Careya arborea* root extracts. International Journal of Pharmaceutical Investigation. 2021;11(1):-.
29. Ramesh N, Viswanathan MB, Saraswathy A, Balakrishna K, Brindha P, Lakshmanaperumalsamy P. Phytochemical and pharmacological investigations of *Careya arborea* Roxb. bark. International Journal of Pharmacy and Pharmaceutical Sciences. 2015;7(2):123-128.
30. Rao HJ, Singh S, Janaki Ramulu P. Characterization of a *Careya arborea* bast fiber as potential reinforcement for lightweight polymer biodegradable composites. Journal of Natural Fibers. 2023;20(1):2128147.
31. Rayhana Begum RB, Sheliya MA, Mir SR, Singh E, Sharma MS. Inhibition of proinflammatory mediators by coumaroyl lupendioic acid, a new lupane-type triterpene from *Careya arborea*, on inflammation-induced animal model.
32. Perunnal P, Gupta M, Mazumdar UK. Anti-inflammatory and analgesic effects of *Careya arborea* stem bark in experimental animal models.
33. Sabir MN, Izzat S, Abdullah SM, Ismael BO, Saour KY, Rachid S. Examining the phytochemical analysis, *in vitro* cytotoxicity, and antimicrobial effects of rotundine glycoside isolated from *Cyperus rotundus* L. rhizomes.

Pharmaceutical and Biomedical Research. 2024;10(1):57-72. doi:10.32598/PBR.10.1.1234.1
34. Thombare N, Mahto A, Singh D, Chowdhury AR, Ansari MF. Comparative FTIR characterization of various natural gums: a criterion for their identification. Journal of Polymers and the Environment. 2023;31(8):3372-3380.
35. Tiwari P, Kumar B, Kaur M, Kaur G, Kaur H. Phytochemical screening and extraction: a review. Internationale Pharmaceutica Sciencia. 2011;1(1):98-106.
36. Le VA, Parks ES, Nguyen MH, Roach PD. Improving the vanillin-sulphuric acid method for quantifying total saponins. Technologies. 2018;6(3):84. doi:10.3390/technologies6030084
37. Velavan S. Phytochemical techniques: a review. World Journal of Science and Research. 2015;1(2):80-91.
38. Wabaidur SM, Obbed MS, Alothman ZA, Alfaris NA, Badjah-Hadj-Ahmed AY, Siddiqui MR, *et al*. Total phenolic acids and flavonoid contents determination in Yemeni honey of various floral sources: Folin-Ciocalteu and spectrophotometric approach. Food Science and Technology. 2020;40:647-652.
39. Wadje SS, Wankhede BN, Mali MP. Phytochemical and *in vitro* antibacterial activity of *Careya arborea* Roxb. International Journal of Pharmaceutical Sciences and Research. 2019;10(5):2351-2356. doi:10.13040/IJPSR.0975-8232.10(5).2351-2356