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PHYSICO-CHEMICAL ANALYSIS OF TOXIC COMPOUNDS IN AZALEAS AND PRUNUS LAUROCERASUS

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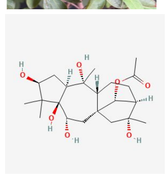
Abstract: This paper addresses the topic of decorative plants frequently used in landscaping, with a focus on their toxic properties. Ornamental plants may have various hidden characteristics that are not well known to those who usually own them. Therefore, understanding the compounds found in these plants is essential for living in a safe environment. This dual nature of Azaleas and Prunus laurocerasus (English laurel) makes them a subject of current scientific interest. This study aims to identify the potentially toxic components present in two plant species, Azaleas and Prunus laurocerasus (English laurel), and to establish an experimental protocol that can be used to detect these compounds in samples, with applications in forensic investigations. The methodology is based on the identification and characterization of the chemical compounds present in the aforementioned plants through the use of Fourier Transform Infrared Spectroscopy (FTIR) and Ultraviolet–visible (UV–Vis) spectroscopy.

Introduction

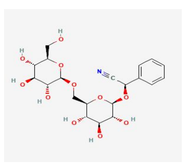
Ornamental plants have been used to beautify the environment since prehistoric times. Some of them have also been valued for their medicinal properties; however, when used improperly, they can negatively affect the health of both humans and animals (the severity varies depending on the organism and the amount ingested). Azaleas, belonging to the Rhododendron genus, are flowering shrubs known for their vibrant and attractive blooms. They are part of the Ericaceae family. Ingestion of azalea leaves, flowers, or nectar can lead to "mad honey poisoning," characterized by the following symptoms: gastrointestinal (nausea, vomiting, salivation, abdominal pain), cardiovascular (bradycardia—slow heart rate, hypotension—low blood pressure, arrhythmias), and neurological (confusion, dizziness, weakness, and in severe cases, seizures and loss of consciousness). In the case of Prunus laurocerasus, poisoning symptoms are classified into two types: acute and chronic. Acute symptoms include headaches, dizziness, confusion, anxiety, vomiting, abdominal pain, and diarrhea. In severe cases, poisoning can lead to respiratory failure, cardiovascular collapse, coma, and death. Long-term exposure to sublethal doses of cyanide may cause weakness, paralysis, nerve damage, hypothyroidism, and neurodegenerative effects.

Material and methods

Studied plants:



Azaleas contain toxic compounds known as grayanotoxins. Grayanotoxins are present in all parts of the plant, including flowers and nectar, and just two leaves can cause severe poisoning. The most prominent and toxic of these compounds is Grayanotoxin I ($C_{22}H_{36}O_6$).



The main toxic compound in Prunus laurocerasus is amygdalin ($C_{20}H_{27}NO_{11}$), a cyanogenic glycoside. Upon hydrolysis, amygdalin releases hydrocyanic acid (HCN), a potent toxin. Amygdalin is predominantly found in the seeds, leaves, and bark of the plant.

Sample Preparation:

The collected plants were placed in an oven for drying for 24 hours at a constant temperature suitable for complete dehydration of the plant material without burning it. After complete drying, the plants were ground using a mortar and pestle until a fine powder consistency was obtained. The resulting powders were stored in sterile 120 ml Urocultor containers.

PREPARATION OF EXTRACTS:

To obtain liquid extracts from the biological samples, two different solvents were used—90% ethanol and acetone—depending on the nature of the samples.

1. Laurel leaves (Prunus laurocerasus): 90% ethanol was used as the extraction solvent, with an extraction ratio of 1:60.
2. Azalea leaves (Rhododendron spp.): Acetone was used as the extraction solvent, with an extraction ratio of 1:50.

METHODS:

UV–Vis Spectroscopy

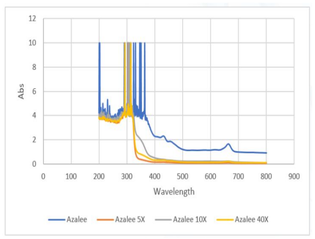
FTIR Spectroscopy

Comparison of Techniques:

Both UV–Vis and FTIR spectroscopy provide valuable information about the structure and composition of chemical substances, but they are complementary in nature. UV–Vis is more suitable for studying electronic transitions and the quantitative analysis of compounds with chromophores, whereas FTIR is ideal for detailed analysis of molecular structure and identification of functional groups.

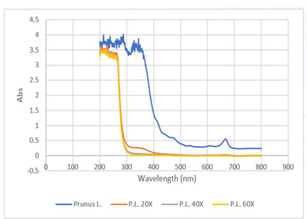
RESULTS AND DISCUSSIONS- UV Analysis

Azaleea - Liquid Extract of Azalea (Rhododendron) Leaves : Additionally, grayanotoxins in Rhododendron leaves may absorb in the UV-C (200–280 nm) and UV-B (280–315 nm) regions, contributing to the strong absorption observed in the UV-Vis spectrum of the extract.



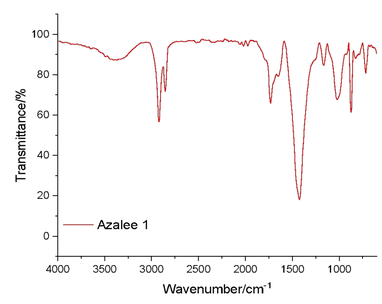
- 200–400 nm – very strong absorption in the UV region
- 200–300 nm – maximum absorption peaks (absorption begins to decrease after 300 nm)
- 200–300 nm – absorption is very high for the undiluted sample and decreases with dilution
- 300–400 nm – absorption drops sharply for all samples (consistent with the typical absorption cutoff for many organic compounds)
- 400–800 nm – relatively low absorption for all samples (the extract lacks significant chromophores absorbing in the visible range)
- 200–400 nm – compounds absorbing in this region are most likely flavonoids with conjugated systems (typically absorbing around 250–350 nm)

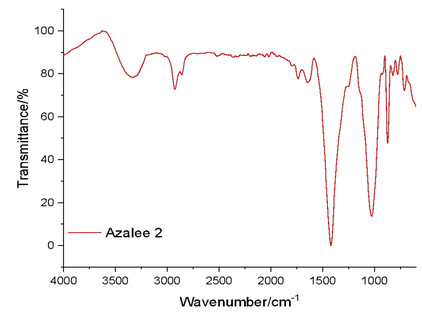
Liquid Extract of Prunus laurocerasus Leaves: The UV-Vis spectrum of the Prunus laurocerasus leaf extract shows strong absorption in the UV region, typical of compounds with conjugated systems. The dilution series (20X, 40X, 60X) shows expected decreases in absorption, confirming the concentration-dependent behavior of the extract. This analysis suggests the presence of UV-absorbing compounds, likely flavonoids and phenolic compounds, which are common in plant extracts.



- 200–400 nm – strong absorption band in the UV region
- 200–300 nm – maximum absorption (typical for organic compounds, especially those with conjugated systems such as flavonoids or phenolic compounds commonly found in plant extracts)

Results and discussions- FT-IR Spectroscopy





FTIR - Azaleeas leaves (Azalee 1): FTIR spectral analysis confirmed the presence of key functional groups that suggest the chemical composition of Azalea leaves. The identification of –OH, C–H, and C=O groups indicates the presence of phenols, alcohols, and esters, compounds commonly found in medicinal and ornamental plants.

- 3401.56 cm^{-1} – peak characteristic of –OH groups, indicating the presence of alcohols and phenols
- 2926.59 cm^{-1} – peak corresponds to C–H stretching of methyl and methylene groups, indicating the presence of aliphatic chains
- 2157.77 cm^{-1} – peak may be attributed to C≡C or C≡N functional groups (less common in plant samples)
- 1736.48 cm^{-1} – distinct peak for carbonyl (C=O) groups, indicating the presence of esters, aldehydes, or ketones
- 1626.61 cm^{-1} – peak specific for C=C stretching in aromatic compounds or alkenes
- 1419.01 cm^{-1} – peak associated with CH_2 and CH_3 groups, highlighting the presence of aliphatic compounds
- 1080.52 cm^{-1} – peak may be attributed to C–O stretching, indicating the presence of alcohols, esters, or ethers
- 619.06 cm^{-1} – peak characteristic of out-of-plane C–H bending in benzene rings, associated with aromatic compounds

FTIR - Azaleeas Flowers (Azalee 2): FTIR spectral analysis of Azalea flowers confirms the presence of key functional groups such as –OH, C–H, and C=O, suggesting a chemical composition similar to that observed in Azalea leaves. The identification of these functional groups indicates the presence of phenols, alcohols, esters, and alkenes, compounds commonly found in the floral structures of plants.

- 3311.12 cm^{-1} – peak characteristic of –OH groups, indicating the presence of alcohols and phenols, specifically phenolic compounds
- 2927.78 cm^{-1} – peak corresponds to C–H stretching of methyl and methylene groups, indicating the presence of aliphatic chains
- 2853.12 cm^{-1} – peak may be attributed to C–H stretching from aldehydes and ketones
- 1736.48 cm^{-1} – distinct peak for carbonyl (C=O) groups, indicating the presence of esters, aldehydes, or ketones
- 1661.77 cm^{-1} – peak specific for C=C stretching in aromatic compounds or alkenes
- 1461.01 cm^{-1} – peak associated with CH_2 and CH_3 groups, highlighting the presence of aliphatic compounds
- 1080.52 cm^{-1} – peak may be attributed to C–O stretching, indicating the presence of alcohols, esters, or ethers
- 619.06 cm^{-1} – peak characteristic of out-of-plane C–H bending in benzene rings, associated with aromatic compounds

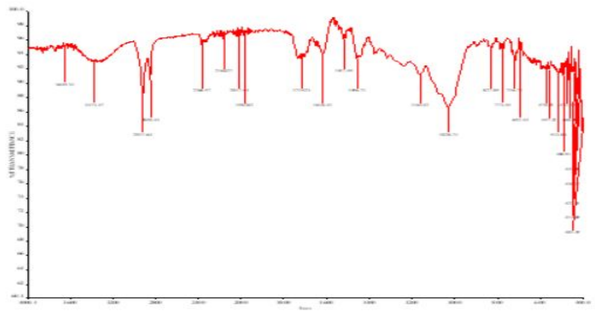


Figure. FTIR of Prunus Laurocerasus leaves.

The FTIR spectrum of Prunus laurocerasus leaves confirms the presence of a variety of chemical compounds, including water, lipids, carboxylic acids, esters, phenolic compounds, and aromatics, reflecting the diverse biochemical composition of this plant.

- 3600–3200 cm^{-1} – broad and intense band indicating the presence of hydroxyl (O–H) groups associated with water and phenols
- 2920 cm^{-1} and 2850 cm^{-1} – two bands due to C–H stretching vibrations of organic compounds (particularly lipids)
- 1750–1700 cm^{-1} – distinct band characteristic of carbonyl (C=O) stretching vibrations, specific to esters and carboxylic acids
- 1600–1500 cm^{-1} – bands due to C=C stretching vibrations in aromatic structures, indicating the presence of phenolic compounds and flavonoids
- 1400–1300 cm^{-1} – bands associated with bending vibrations of CH_2 and CH_3 groups
- 900–700 cm^{-1} – bands due to C–H stretching vibrations in aromatic compounds, confirming the presence of aromatic structures in the leaves

Conclusions

This study addresses aspects relevant to forensic investigations. Its main objective was to describe, analyze, and deepen the understanding of the chemical structure and physicochemical properties of toxic compounds present in the studied ornamental plants, as well as to explore their potential benefits in the medical field.
The physicochemical properties of the toxic substances were analyzed in detail, highlighting the mechanisms by which these compounds interact with living organisms and produce toxic effects.
In conclusion, this study makes a significant contribution to the understanding and characterization of the phytochemical and physicochemical properties of ornamental plants, offering new perspectives for their study and application in medicine and toxicology.

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