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GREEN CHEMISTRY IN MEDICINAL PLANT COMPOUND ANALYSIS: STRUCTURES, EFFECTS, POLLUTION

Name – Satya Kishore Batchu

Supervisor Name - Dr Pranjali Shinde

Department of Chemistry

Institute Name - Malwanchal University, Indore

Abstract

The utilization of medicinal plants for therapeutic purposes has been an integral part of traditional medicine for centuries. Modern pharmacology acknowledges the profound potential of medicinal plant compounds in drug discovery and development. However, the conventional methods employed for extracting, isolating, and analyzing these bioactive compounds often involve hazardous chemicals, high energy consumption, and generate copious amounts of waste, posing environmental and health risks. The integration of green chemistry principles into the analysis of medicinal plant compounds offers a sustainable approach towards drug discovery. Green chemistry emphasizes the design of chemical processes that minimize the use of hazardous substances, reduce energy consumption, and generate minimal waste. This abstract explores various green chemistry methodologies such as microwave-assisted extraction, supercritical fluid extraction, and ultrasound-assisted extraction, which have gained prominence in the extraction of bioactive compounds from medicinal plants. Additionally, green analytical techniques including high-performance liquid chromatography (HPLC) coupled with green solvents and eco-friendly detection methods contribute to reducing the environmental footprint of medicinal plant compound analysis. By adopting green chemistry principles, researchers can enhance the sustainability of medicinal plant compound analysis while maintaining the efficacy and safety of therapeutic agents. This abstract underscores the importance of integrating green chemistry practices in the pharmaceutical industry to promote environmentally benign approaches to drug discovery and development.

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Introduction

Green chemistry principles have gained significant attention in recent years due to the growing awareness of environmental sustainability and the need for eco-friendly practices across various industries. In the field of medicinal plant compound analysis, the application of green chemistry principles holds immense promise in advancing research while minimizing environmental impact. Medicinal plants have been a rich source of bioactive compounds for centuries, contributing significantly to traditional medicine systems and modern drug discovery. However, the conventional methods employed for the extraction, isolation, and analysis of these compounds often involve the use of hazardous solvents and generate substantial waste, posing environmental and health risks.

The integration of green chemistry principles into the analysis of medicinal plant compounds offers a paradigm shift towards more sustainable and environmentally benign methodologies. Green chemistry emphasizes the design of chemical processes and products that reduce or eliminate the use and generation of hazardous substances. This approach aligns perfectly with the objectives of medicinal plant compound analysis, aiming to harness the therapeutic potential of natural compounds while mitigating adverse environmental impacts. One of the fundamental aspects of green chemistry in medicinal plant compound analysis is the development of alternative solvent systems that are non-toxic, renewable, and biodegradable. Solvent selection plays a crucial role in extraction and isolation processes, and the replacement of conventional solvents such as chloroform and methanol with greener alternatives like ethanol, water, or supercritical carbon dioxide can significantly reduce environmental footprint and health hazards. Moreover, techniques such as microwave-assisted extraction and ultrasound-assisted extraction further enhance the efficiency of solvent usage, reducing extraction times and energy consumption.

In addition to solvent selection, green chemistry approaches also emphasize the utilization of sustainable energy sources and the optimization of process conditions to minimize waste generation. Techniques such as solid-phase microextraction (SPME) and accelerated solvent extraction (ASE) enable the extraction of medicinal plant compounds with minimal solvent usage and shorter extraction times. Furthermore, the integration of analytical techniques such as high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), and nuclear magnetic resonance (NMR) spectroscopy facilitates the rapid and precise analysis of complex compound mixtures, allowing for the identification and

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quantification of bioactive constituents with high sensitivity and selectivity. the application of green chemistry principles in the analysis of medicinal plant compounds represents a significant advancement towards sustainable and eco-friendly practices in drug discovery and development. By adopting greener solvent systems, optimizing process conditions, and employing efficient analytical techniques, researchers can enhance the efficiency and sustainability of medicinal plant compound analysis while minimizing environmental impact and promoting the utilization of natural resources in a responsible manner.

Research Methodology

Parameters to be researched

a. Physico-chemical soils - (Temperature, water extent, Mass density, soil moisture, pH, electric conductivity, Chloride)

b. Heavy metals withinside the extraction pit and agricultural soil - (Cu, Cd, Mn, Fe, Ni, Pb, and Zn)

Chemicals & Glass Materials:

The chemical compounds used withinside the cutting-edge take a glance at are at a classy degree of evaluation and are supplied via way of means of E. Merck India, S.D. great chemical compounds and BDH, India. All glassware used withinside the corning grade, synthetic via way of means of Borosil India Ltd. All glassware and jars are cleaned or washed with soda and acid and rinsed with water 2-three times.

Instruments:

The following contraptions are utilized in the course of the take a glance at

Name of Manufacturer of Instruments

1. Best Spectrophotometer
2. Roy Electronic balance
3. Tasco Chipset running meter
4. Atomic spectrophotometer absorbing ecil
5. Sunvic warm plate
6. Scientific Modern warm air oven
7. Clothing Heater A. J. Enterprises

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8. pH meter Tasco
9. Godrej refrigerator

Sampling methods:

Soil trying out is an vital a neighborhood of land useful resource management. Each pattern accumulated need to be a actual consultant of the pattern area. the utilization of consequences received in laboratory evaluation relies upon at the specifics of the pattern. Therefore, it is consider to acquire an enormous sort of samples so as that the pattern of the favored length could also be received with alittle pattern. Typically, sampling is performed on the charge of 1 pattern keep with hectare of hectares. However, as a minimum one pattern must be accumulated for an area of 5 hectares. within the soil take a glance at work, samples are accumulated from the profile consultant to the encircling soil.

Points to think about

1. Collect a pattern of soil at some point of plowing.
2. during a status plant, gather samples among rows.
3. Sampling in numerous locations with a zig-zag sample guarantees consistency.
4. Fields, comparable in appearance, manufacturing and former control procedures, could also be grouped right into a unmarried pattern unit.
5. Collect distinctive samples in distinctive fields through color, slope, water, out of hand techniques consisting of lining, gypsum installation, fertilizer application, trimming device etc.
6. Avoid sampling in lifeless ditches, wetlands, regions on the brink of the first bund, trees, piles of compost and irrigation stations.
7. For shallow plants, gather samples up to fifteen cm deep. For deeper plants, gather samples the maximum amount as 30 cm deep. For tree plants, gather profile profiles.
8. Always gather a pattern of the soil within the front of the farm proprietor who is conscious of the farm better

Procedure

1. Divide the sphere into separate homogeneous devices based totally on statement and therefore the farmer's experience.
2. Remove the top trash from the pattern vicinity.

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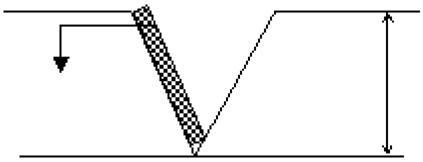
3. Drive the auger to a intensity of 15 cm and draw a soil pattern.
4. Collect at the smallest amount 10 to fifteen samples in every pattern unit and region them during a bucket or tray.
5. If an auger isn't available, make a 'V' dry reduce 15 cm deep withinside the pattern vicinity the utilization of a spade.
6. Remove the thick portions of soil from the top to rock bottom of the uncovered floor of the 'V' pillar and region it during a easy container.



1 inch / 2.5 cm 6 inches (15 cm)

7. Mix the samples nicely and postpone the surface fabric inclusive of roots, stones, pebbles and stones.
8. Reduce the pile to approximately 1/2 of to 1 pound in step with zone or through room divisions.
9. Separation is accomplished through dividing a nicely-blended pattern into 4 same parts. The opposing housings are discarded and therefore the refore the last additives are blended and the method is repeated till the favored pattern length is obtained.
10. The department of the branches is accomplished through flippantly spreading the soil over a easy stable floor and dividing it into smaller portions through drawing strains during the amount and width. In every room alittle quantity of soil is gathered. This method is repeated till the required quantity of pattern is obtained.
11. Wrap the pattern during a easy material or polythene bag.
12. Fill withinside the bag with info inclusive of farmer's call, farm location, survey range, beyond harvest, modern-day crop, subsequent season's harvest, harvest date, pattern call etc.

Collection of soil samples

(1) After the profile is exposed, easy one floor of the hollow cautiously with a spade and see the gathering and intensity of each space.

(2) Touch the ground with a knife or the edge of a shovel to suggest shape, colour and consistency.

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(3) Collect samples beginning from the decrease horizon first through protecting an enormous basin at rock bottom of the environment whilst the top soil is loosened through khurpi.

(4) Assemble the pattern and switch it to a polythene or material bag and label it.

Results and Discussion

Heavy Metals Concentration In Control Site Agricultural Soil

Copper (ppm)

The overall minimum, maximum and standard deviation values of Cu in agricultural soil. The concentrations of Cu in agricultural soil were recorded maximum 28.806 ±2.662 during Summer-2019 and minimum 12.61 ±5.388 during Winter-2018-2019.

Cadmium (ppm)

The values of Cd in agricultural soil were recorded in the range from 0.907-2.17 during the study period 2018-19. The minimum value (0.957 ±0.063) of was observed during Monsoon-2019 and maximum value (2.172 ±0.041) of Cd was observed during Summer-2019. The seasonal variation of Cd during the study.

Manganese (ppm)

The present study showed the Mn concentration in agricultural soil in the range of 4.98-11.90 during the study period 2018-19. The minimum value of Mn (4.98 ±2.09) was observed during Winter-2018-19 and maximum value of Mn (11.90 ±0.131) was observed during Summer-2019. The seasonal variation of Mn during the study.

Iron (ppm)

The lowest value of iron content in agricultural soil was found 20.986 ±0.601 during Monsoon-2019 and highest was found 70.59 ±2.678 during Summer-2019. The seasonal variation concentration of iron (2018-19).

Nickel (ppm)

The concentrations of nickel in agricultural soil were recorded minimum 4.320 ±0.936 during Winter-2018-19 and maximum 12.76 ±0.440 during Summer-2019. The seasonal variation of nickel concentration in agricultural soil during the study period (2018-19).

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Lead (ppm)

The overall minimum, maximum and standard deviation values of lead in agricultural soil. The lead concentrations in agricultural soil were recorded minimum 20.017 ±5.146 during Winter-2018-19 and minimum 55.18 ±3.705 during Summer-2019.

Zinc (ppm)

The values of zinc concentration in agricultural soil were recorded minimum 7.791 ±4.216 during Winter-2018-19 and maximum 15.61 ±0.499 during Summer-2019. The seasonal variation of zinc during the study period (2018-19).

Table-1:- Seasonal Variations In Physico-Chemical Characteristics of Agricultural Soil Around Industrial Area

Parameters	Unit	Summer-2018	SD(±)	Monsoon-2018	SD(±)	Winter2018-19	SD(±)	Summer-2019	SD(±)	Monsoon-2019	SD(±)	Winter 2019-19	SD(±)
Temperature	^{0}C	26.43	1.96	24.18	1.01	18.78	1.66	26.66	2.01	24.12	1.00	20.40	2.73
WHC	%	40.70	1.18	35.103	1.03	36.20	2.02	41.55	1.95	36.10	1.04	37.15	2.33
Bulk density	mg/cm^3	1.09	0.07	1.20	0.04	1.16	0.04	1.11	0.03	1.22	0.01	1.20	0.02
Soil moisture	%	3.63	0.59	10.24	0.98	6.30	1.63	3.59	0.40	11.15	2.82	6.05	1.99
pH	-	7.24	0.11	7.06	0.11	7.03	0.09	7.45	0.32	7.30	0.18	7.29	0.27
Conductivity	mho/cm	27.93	1.53	25.10	1.05	22.68	0.69	27.99	1.28	26.57	1.70	24.70	1.67
Chloride	mgL^{-1}	720.58	9.94	638.89	3.12	541.55	53.67	664.50	22.44	655.97	5.01	551.19	50.20

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Table 2:- Seasonal Variations In Physico-Chemical Characteristics of Agricultural Soil Around Hyderabad Area

Parameters	Unit	Summer-2018	SD(±)	Monsoon-2018	SD(±)	Winter2018-19	SD(±)	Summer-2019	SD(±)	Monsoon-2019	SD(±)	Winter 2019-19	SD(±)
Temperature	^{0}C	26.00	1.70	23.11	1.01	17.00	1.55	27.00	2.01	20.10	1.00	20.40	2.73
WHC	%	42.50	1.10	32.10	1.03	33.20	2.00	40.50	1.95	30.15	1.04	37.15	2.30
Bulk density	mg/cm^3	1.45	0.05	1.15	0.04	1.10	0.03	1.50	0.03	1.22	0.01	1.20	0.03
Soil moisture	%	3.60	0.55	9.24	0.98	5.30	1.43	4.50	0.40	10.20	2.82	6.05	1.50
pH	-	7.40	0.10	7.00	0.11	7.03	0.09	7.85	0.32	7.50	0.18	7.29	0.27
Conductivity	mho/cm	29.00	1.50	24.10	1.05	20.60	0.60	27.10	1.20	28.57	1.70	24.70	1.60
Chloride	mgL^{-1}	730.50	9.00	700.80	3.12	520.50	10.60	664.00	20.45	680.96	5.01	561.19	15.20

Table 3:- Seasonal Variations In Heavy Metals Concentration In Composite Industrial Effluents.

Metals	Unit	Summer-2018	SD(±)	Monsoon-2018	SD(±)	Winter2018-19	SD(±)	Summer-2019	SD(±)	Monsoon-2019	SD(±)	Winter 2019-19	SD(±)
Cu	ppm	0.404	0.026	0.269	0.038	0.158	0.062	0.409	0.045	0.332	0.008	0.163	0.082
Cd	ppm	0.050	0.006	0.023	0.003	0.015	0.006	0.051	0.003	0.025	0.002	0.016	0.003
Mn	ppm	0.113	0.009	0.092	0.013	0.127	0.023	0.120	0.006	0.102	0.004	0.132	0.014
Fe	ppm	0.513	0.082	0.231	0.066	0.249	0.063	0.510	0.054	0.219	0.075	0.258	0.038
Ni	ppm	0.036	0.004	0.017	0.004	0.027	0.006	0.036	0.005	0.048	0.003	0.032	0.009
Pb	Ppm	0.427	0.008	0.237	0.013	0.369	0.078	0.454	0.006	0.317	0.005	0.374	0.038

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Zn	ppm	0.158	0.005	0.103	0.006	0.177	0.037	0.169	0.002	0.146	0.011	0.266	0.065

Table-4 Seasonal Variations In Heavy Metals Concentration In Agricultural Soil Around Industrial Area.

Metals	Unit	Summer-2018	SD(±)	Monsoon-2018	SD(±)	Winter2018-19	SD(±)	Summer-2019	SD(±)	Monsoon-2019	SD(±)	Winter 2019-19	SD(±)
Cu	Ppm	30.890	1.618	26.436	1.414	16.615	5.388	31.826	2.662	26.686	1.935	16.370	4.898
Cd	Ppm	3.097	0.084	0.957	0.063	1.404	0.350	3.172	0.041	1.101	0.088	1.693	0.281
Mn	Ppm	12.915	0.100	9.866	0.110	5.989	2.093	12.979	0.131	11.372	1.431	6.294	2.357
Fe	Ppm	68.917	2.664	24.986	0.601	27.700	2.761	74.597	2.678	25.429	1.391	28.607	1.286
Ni	Ppm	9.35	0.283	6.644	0.190	5.320	0.936	10.766	0.440	7.112	0.097	5.752	0.710
Pb	Ppm	55.377	1.801	34.876	1.56158	23.017	5.146	56.138	3.705	38.170	1.091	26.426	4.961
Zn	Ppm	10.641	0.499	15.403	0.568	8.791	4.216	11.481	0.849	16.384	0.995	9.218	3.739

Table-5:- Seasonal Variations In Heavy Metals Concentration In Agricultural Soil Around City (Control Site)

Metals	Unit	Summer-2018	SD(±)	Monsoon-2018	SD(±)	Winter2018-19	SD(±)	Summer-2019	SD(±)	Monsoon-2019	SD(±)	Winter 2019-19	SD(±)
Cu	Ppm	25.80	1.618	23.436	1.414	12.615	5.388	28.806	2.662	23.686	1.935	15.370	4.898
Cd	Ppm	2.097	0.084	0.907	0.063	1.404	0.350	2.172	0.041	1.10	0.088	1.6593	0.281
Mn	Ppm	10.15	0.100	8.00	0.110	4.989	2.093	11.90	0.131	9.320	1.431	5.294	2.357
Fe	Ppm	67.917	2.664	20.986	0.601	25.700	2.761	70.59	2.678	22.429	1.391	22.607	1.286
Ni	Ppm	10.35	0.283	5.604	0.190	4.320	0.936	12.76	0.440	6.112	0.097	4.752	0.710

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Pb	Ppm	50.377	1.801	30.876	1.56158	20.017	5.146	55.18	3.705	30.170	1.091	22.426	4.961
Zn	Ppm	15.610	0.499	13.403	0.568	7.791	4.216	8.481	0.849	14.384	0.995	8.218	3.739

Table 6: Correlation Between Heavy Metals of Composite Effluents And Composite Industrial Drain Sediments.

Metals	Cu	Cd	Mn	Fe	Ni	Pb	Zn
Cu	0.663	0.864	0.363	0.961	0.338	0.919	0.107
Cd	0.979	0.976	-0.323	0.845	0.319	0.455	-0.402
Mn	0.264	0.584	0.694	0.820	0.067	0.932	0.433
Fe	0.707	0.905	0.301	0.988	0.306	0.878	0.123
Ni	0.377	0.650	0.661	0.841	0.282	0.962	0.514
Pb	0.959	0.974	-0.259	0.857	0.308	0.510	-0.403
Zn	0.694	0.576	-0.597	0.405	0.250	-0.027	-0.525

Table- 7: Correlation Between Heavy Metals and Physico-Chemical Characteristics of Composite Industrial Effluents

Metals	Temperature	pH	Conductivity	TDS	Free-CO$_2$	Alkalinity	T. Hard	Ca	Mg	DO	BOD	COD	Chloride	Potassium	Nitrate	Nitrite
Cu	0.964	0.622	0.387	0.387	0.933	0.798	0.258	0.238	0.194	-0.573	0.645	0.536	0.008	0.063	0.378	0.050
Cd	0.830	0.707	0.068	0.068	0.999	0.557	-0.064	-0.045	-0.057	-0.774	0.385	0.240	-0.321	-0.290	0.051	-0.279
Mn	-0.533	-0.347	-0.830	-0.830	-0.120	-0.863	-0.782	-0.911	-0.454	-0.308	-0.849	-0.870	-0.825	-0.749	-0.914	-0.741
Fe	0.596	0.648	-0.255	-0.255	0.935	0.243	-0.382	-0.322	-0.307	-0.884	0.068	-0.084	-0.617	-0.589	-0.287	-0.577
Ni	0.458	-0.381	0.168	0.168	0.334	0.229	0.162	-0.047	0.259	-0.202	0.203	0.240	-0.072	0.229	0.088	0.061

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Pb	0.209	0.171	-0.533	-0.533	-0.633	-0.240	-0.641	-0.744	-0.374	-0.826	-0.386	-0.494	-0.851	-0.752	-0.649	-0.754
Zn	-0.487	-0.565	-0.799	-0.799	-0.268	-0.815	-0.494	-0.642	-0.240	0.058	-0.608	-0.581	-0.641	-0.415	-0.738	-0.507

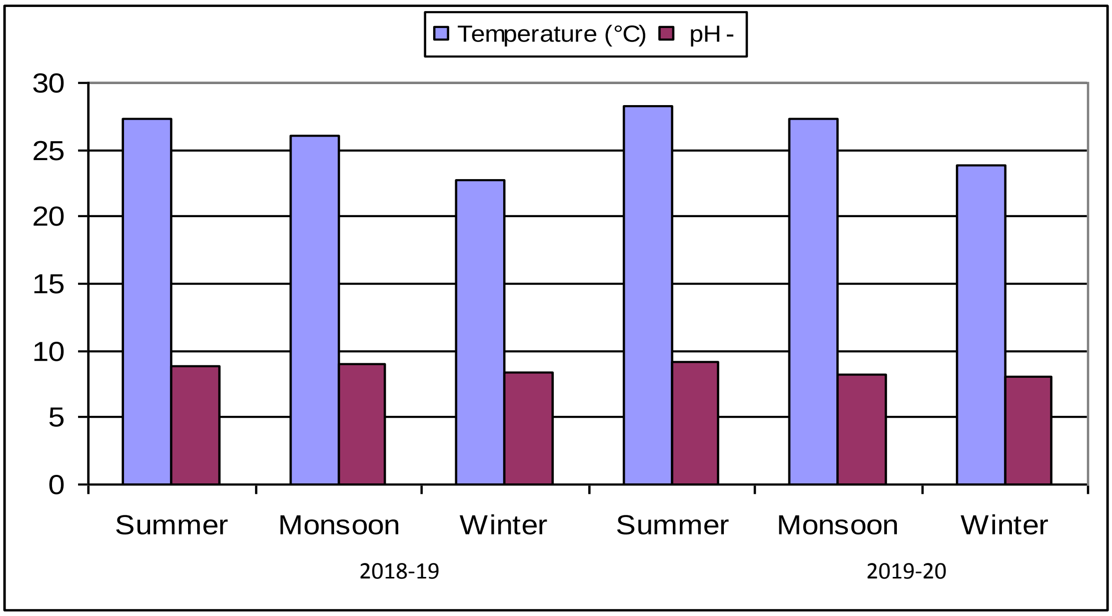

Fig. 1 - Seasonal variation in temperature and pH of composite industrial effluents.

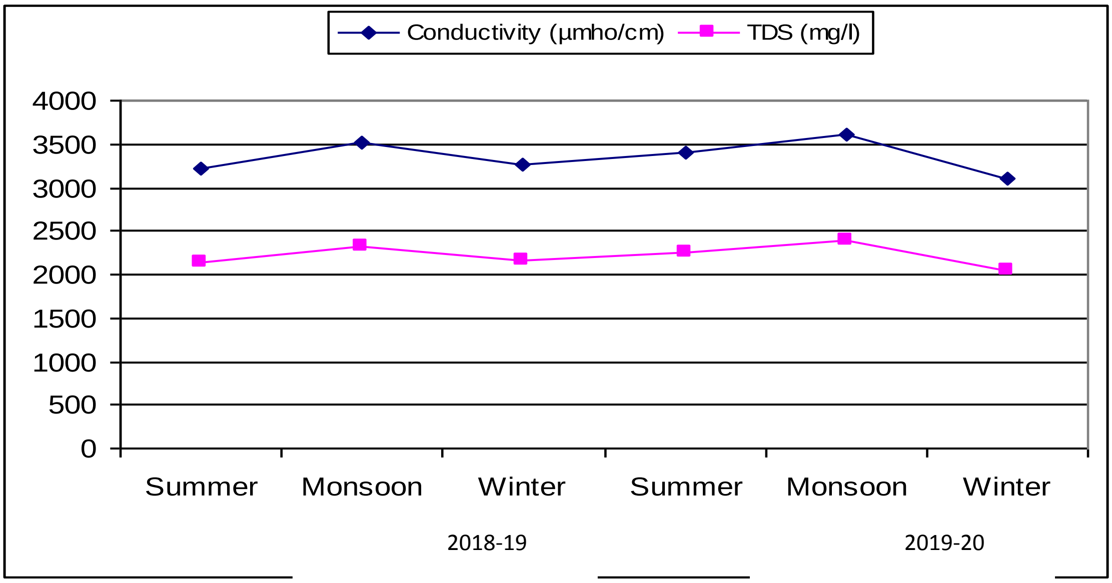

Fig 2- Seasonal variation in conductivity and TDS of composite industrial effluents.

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Conclusion

The application of green chemistry principles in the analysis of medicinal plant compounds presents a promising avenue for sustainable drug discovery and development. By employing techniques that prioritize efficiency, safety, and environmental responsibility, researchers can mitigate the negative impacts associated with traditional analytical methods. Moreover, the utilization of renewable resources and non-toxic solvents reduces pollution and minimizes harm to both human health and the environment. Through the elucidation of chemical structures and biological effects of medicinal plant compounds, green chemistry facilitates the identification of potential therapeutic agents with reduced side effects and improved efficacy. This approach aligns with the growing demand for safer and more sustainable pharmaceuticals in today's society. the adoption of green analytical methodologies contributes to the overall reduction of chemical waste and energy consumption, thereby lowering the carbon footprint of the pharmaceutical industry. By promoting the development of eco-friendly processes, green chemistry supports the transition towards a more environmentally conscious approach to drug discovery and manufacturing. integrating green chemistry principles into the analysis of medicinal plant compounds not only enhances the efficiency and safety of pharmaceutical research but also addresses concerns regarding pollution and environmental degradation. Embracing these principles fosters innovation and sustainability in the field of drug development, paving the way for a healthier and greener future.

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