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An Introduction on Phytochemical Analysis and their Types

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ABSTRACT

In this updated review discussion of modern techniques and analysis for phytochemicals investigation and their properties. Elaborate the analysis of phytochemicals and their types. There is still a limited research available on its phytoconstituents and therapeutic benefits. The current study examined the qualitative and quantitative overview of the most important biologically active compounds of initiative. Antimicrobial activity, anti-diabetic, antifertility, antiulcer, antitumor, and fungicidal activities are among the pharmacological properties. The goal of this review is to provide a thorough review of traditional uses, phytoconstituents and pharmacological effects.

Keywords: Phytochemical analysis, Qualitative and quantitative analysis, Phytoconstituents.

INTRODUCTION

Phytochemicals are isolated from the plants, which are useful and effective for us in this era. We highly recommended for ayurveda, which innovate from the idea of the plants. In India the treatment of microbial diseases, fungal diseases, deficiency diseases was treated by the assistance of plants crude extract but now this idea has been spread everywhere in the world. Ayurveda is also a traditional strength in india and many research scholars now endorse for natural remedies in regards to some diseases that were already completely treated with the help of phytochemical components. Every clinical expert is planning to give effective treatment and researches also increasing in plant species. Throughout human history herbal remedies have been used to treat a variety of infectious diseases. Plant products either as pure compounds or as standardized plant extracts provide unlimited opportunities for brand spanking new drug leads due to the unequalled availability of chemical diversity. India is a medicinal plant varietal emporium and one of the world's richest countries in terms of medicinal plant genetic resources. It also has a varied topography and weather conditions that are demonstrated in the plants and floristic morphology. Besides that the agro-climatic conditions are conducive to the initiation and cultivation of new exotic plant varieties [1]. Potent bioactive metabolites, previously unknown in concepts of pharmacological action, have been widely researched as a source of medicinal agents in recent years.

A natural medicine is used for primary health care by nearly 80% of the world's population, primarily in developing countries. In light of the current state of the health-care system the shortcomings of synthetic drugs are likely to become more apparent in the coming years [2]. Phytochemical analysis is extremely beneficial to the next generation of scientists. To determine how much phytochemicals will be effective for new diseases like COVID-19, we must develop new methods for analysing phytochemicals.

Plant cells primary and secondary metabolites are the final recipients of biological information flow. These metabolites qualitative and quantitative measurements reflect the cellular state under defined conditions, providing critical insights into the cellular mechanisms that regulate the biochemical phenotype of the cell, tissue, or entire organism. In several fundamental ways, metabolomics differs from previous targeted phytochemical analysis [3]. Plant metabolomics uses fundamental analytical technologies and range of digital data analysis techniques as a research tool to study various aspects of plant biology. The phytochemical analysis is essential for identifying bioactive constituents in plants in order to develop new therapies and treatments. It should also be investigated whether there is a common systemic signalling cascade and biomarker for all types of cancer. A detailed metabolomics and pharmacokinetics study of this plant material is also required to investigate its potential as a potent anticancer drug molecule [4].

THEORY OF PHYTOCHEMICALS ANALYSIS

The phytochemical analysis consist three main developing stages [5].

- Sample preparation.
- Feature extraction using analytical methods.
- Data collection using chemo metric methods followed by compound identification.

Sample preparation: The preparation of sample is important step in converting a sample into a sample solution, it can be investigated, and major contributes. The process consist of many developing stages which including sampling techniques and cultivation of plants, procedures for drying or enzyme quenching, biochemical extraction, and sampling for analysis are all part of the process. The biological question that the researcher wishes to investigate is the primary determinant of plant material selection. Phytochemicals have a wide plethora of different characteristics, resulting in an extremely complex spectral range of biomolecules with varying sizes, solubility, volatility, polarity, quantity, and stability.

Feature extraction using analytical methods: Solvent extraction, supercritical fluid extraction, high pressure homogenization, and solid phase extraction are some of the most common extraction methods. Furthermore, no all-inclusive extraction method exists that can recover all constituents with greater precision and durability. Hence, extraction methods may be used in conjunction to provide broad list of various classes of metabolites.

Data collection using chemo metric methods followed by compound identification: The analytical framework selected is primarily determined by the research topic, considering the group of compounds, their chemical and physical properties, and type and concentration. As a result, the most commonly used techniques are nuclear magnetic resonance spectroscopy and chromatography combined to mass spectrometry [6].

There are two major types of phytochemicals analysis they are qualitative and quantitative analysis. Phytochemicals can be analysed qualitatively and quantitatively using Gas Chromatography-Mass Spectroscopy (GCMS). GCMS can assess solid, liquid, and gaseous samples. The samples are first converted to a gaseous state before being analysed using the mass to charge ratio. High performance liquid chromatography can be used to analyse compounds that are soluble in solvents. High efficiency thin layer chromatography can be used to

disassociate, detect, and analyse phytochemicals qualitatively and quantitatively [7]. In phytochemicals, a variety of quantitative advanced technology may be used [8]. Gas Chromatography-Mass Spectrometry (GC-MS), Capillary Electrophoresis-Mass Spectrometry (CE-MS), Liquid Chromatography-Mass Spectrometry (LC-MS), Nuclear Magnetic Resonance (NMR) spectroscopy, LC-NMR, Direct Infusion Mass Spectrometry (DIMS), and Fourier analysis are all examples of mass spectrometry techniques. The most common are chromatography-mass spectrometry and NMR [9] Colorimetric tests for phytoconstituents, gas chromatography assays for target compounds, chlorophyll quantification, total phenolic compounds, and individual phenols were all performed on crude extracts of plant leaves (HPLC) [10].

SCREENING OF PHYTOCHEMICALS

The phytochemical tests performed on four distinct tinctures of plant-hexane (Quantitative standard-VETEC), ethanolic (Quantitative standard-VETEC), hot aqueous (100°C), and cold aqueous (25°C) [11]. Alkaloids were identified using dragendorff, mayer, reducing sugars with fehling's reagent, quinones with borntrager's test, saponins with irreversible absorbent presentation, mucilaginous with gelatinous uniformity after cooling, coumarins with bajlet's test, steroids or triterpenoids with liebermann-test, buchard's resins with precipitation test, flavonoid with shinoda's test.

GC-MS is used to characterize and estimate the compounds found in a solvent polarity gradient that chosen based on method permission. The gas phase is moving, while the liquid phase is still stationary. The samples were synthesized and analysed by making comparisons their UV radiation transmittance and emission spectra data. UV spectroscopy is usually implemented to compounds or synthetic complexes in solution because it is energetic enough to promote outer electrons to higher energy levels. This is caused by a change in the electronic energy level [12]. This descriptive application necessitates the capture of at least a fraction of the Luminescence spectral range in order to evaluate the imaging or electronic characteristics of materials.

1 D and 2 D-NMR techniques, as well as ultra-performance liquid chromatography–tandem mass spectrometry, used to identify primary and secondary metabolites. Maximize the herb's initial chemical profile adherence and high standards, methods of processing must be optimized. Using a bio analytical approach based on Nuclear Magnetic Resonance (NMR) [13]. Rapid innovations in pulse field gradients and chemical inhibition, as well as advancements in sensor technologies. The development of high magnetic, had already provided an impetus to this approach, that has originated as a very accurate technique for the on-line characterization of biomolecules that since 1990. In phytochemical analysis, LC-NMR provides a particularly intriguing companion approach to LC-UV-MS for comprehensive on-line structural exploration of bioactive substances. Modern techniques have adequately demonstrated the technique's utility [14].

X-ray crystallography is a technology that utilizes advantage of the fact that X-rays are light scattered by crystals. X-rays have the appropriate wavelength (in the Angstrom range 8-10) to be scattered by an atom's electron cloud of equivalent size. After that, a method is gradually transformed into the investigational electron density, simplified against the statistical information, and the result is a very accurate and precise structure [15].Spectral analysing and x-ray crystallography was used to define the structure and comparative stereochemistry of compound [16].

TYPES OF PHYTOCHEMICALS

The remaining organic chemicals, such as alkaloids, terpenes, flavonoids, lignans, plant steroids, curcumines, saponins, phenolics, flavonoids, and glycosides, is considered as secondary components. According to an analysis of relevant literature, phenolics are the most various and chemically diverse plant phytochemicals [17]. Whereas phytochemicals is categorized based on their function, a single compound may serve as both an antioxidant and an antibacterial agent.

Phenolic: Since the late nineteenth century, when the French paradox was attributed with the high consumption of phenolic content

observed in red wine, researchers have been focused in plant phenolics as ant carcinogenic and curative against chronic and degenerative diseases. Ever since, studies investigated the biosynthesis, bioactivities, detoxification, and chemical identification of phenolic content in different plants. Furthermore, analysis on the durability of phenolic content in food industry and collection has become a primary concern [18].

Phenolic are the most abundant phytochemicals and are found throughout the kingdom Plantae. Phenolics are a group of chemical compounds that contain hydroxyl groups, where the (OH) group is directly bonded to an aromatic hydrocarbon group. Flavonoids, phenolic acids, and polyphenols are the three most important types of dietary phenolic [19]. Many agronomic, pharmacological, chemical, and medical investigations have been performed on phenolics compounds and functions [20].

Flavonoids: Flavonoids are derived from flavones and have two benzene rings separated by a propane unit. In general, they are water-soluble compounds. The more complexed the compound, the more vibrant it is. They are widely obtained from plants as glycosides, which can consider formation persistence more nearly impossible [21]. Flavonoids have gained popularity in recent years due to its wide pharmacological activities, anticancer activities to exert multiple biological properties such as antimicrobial, cytotoxicity, anti-inflammatory.

Tannins: Tannins are phenolic compounds with high specificity ranging from 500 Da to more than 3000 Da identified in plants' leaves, bark, fruit, wood, and roots, mainly in the lysosomes. Plant defence mechanisms against mammalian herbivores, birds, and insects have been linked to them. Tannins are classified into two types based on their chemical characteristics and composition: hydrolysable tannins and condensed tannins [21]. Tannin-containing phytoconstituents is used as exfoliates, diuretics, antitumor of the gastrointestinal system, as well as anti-inflammatory properties, antibacterial, free radical scavenging, and haemostatic therapies. Tannins are used in the food products to clarify wine, beer, and fruit juices.

Terpenoids: Terpenoids, already identified as isoprenoids, are the most diverse and abundant natural remedies in terms of structure.2-methylbuta-1,3-diene is the chemical formula for isoprene, the "building block" of terpenoids (C_5H_8) [22]. Several terpenoids are industrially interesting due to their use as flavours and fragrances in edible products and cosmetics, including such menthol and sclareol, as well as because they are essential for agro-based quality product, such as the taste of fruits and the aroma of flowers, such as linalool [17].

Terpenoids classification is based on the number of isoprene units present. Monoterpenoids, sesquiterpenes, diterpenes, triterpenes, and tetraterpenoids. According to preliminary research, terpenes play an important role in plant signalling and growth regulation. Terpenoids may also have medicinal benefits such as anti-mutagenic, anti-ulcer, hepaticidal, antimicrobial, or diuretic activity, as well as the sesquiterpenoid antimalarial drug artimisinin and the diterpenoid anticancer drug taxol [17].

Saponins: Saponins have been found in a variety of plants as well as in a little under marine sources such as starfish sea cucumber and fish [23]. Saponins are divided into two categories based on the nature of their aglycone skeleton. The first category contains of steroidal saponins, which are mostly primarily found in monocotyledonous angiosperms. The second group consists of triterpenoid saponins, which are the most abundant and are found primarily in dicotyledonous angiosperms [24].

Saponins are easily identified in phytoconstituents by their haemolytic activity and ability to generate stable foams in aqueous medium, but for unequivocal recognition, thin layer chromatography with a wide range of spray reagents is required. Thin layer chromatography is also the preferred method for quantitative saponin analysis. Older approaches, such as those based on haemolytic activity are not as accurate as they once were [25].

CONCLUSION

For phytochemical screening, liquid chromatography is unquestionably the dominant technique. Because of its benefits in chemical identification, sensitive detection, and low cost, it will become a standard approach for phytochemical analysis. Gas chromatography is now the only technique for evaluating volatile and non-volatile substances derivatives. Several highly complex analytical techniques, such as 2 D-gas chromatography and 2 D-liquid chromatography, have been used to study various natural compounds. It is to be assumed that they will be used more frequently. The assimilation of biological and chemical identification may have been a course of action for research instruments, contributing significantly to the extremely simple efficiency of adverse effect evaluation.

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