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CHEMICAL MARKERS AND BIOACTIVE COMPOUNDS FROM PLANTS: AN OVERVIEW

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ABSTRACT

Nature is a never-ending source of healing plants and, without a doubt, the best chemist on the planet. The phytomedicines or chemical markers or bioactive compounds derived from herbal plants constitutes the chemical compounds obtained from plant parts that can be used to improve health and treat ailments. They play a crucial role in evaluating the quality of herbal medicines, and are used in many research areas, including authentication of genuine species, search for new resources or substitutes of raw materials, structure elucidation and purity determination. Herbal medicine quality control seeks to assure consistency, safety, and efficacy. Systematic investigations using chemical markers may lead to discoveries and development of new drugs. This article deals with an overview about the chemical markers, their mother plants, advantages, limitations and future perspective.

KEYWORDS: Herbal medicines, Chemistry, Bioactive Compounds, Chemical Markers, Quality control.

INTRODUCTION

The worldwide trend of returning to nature has piqued interest in the creation of botanical drugs for the prevention and treatment of complex disorders. Unlike chemical pharmaceuticals, which usually have a single active pharmaceutical ingredient, botanical components typically comprise a complex blend of phytochemical substances, which poses a significant quality assurance.[1]

Thanks to the rapid development of analysis technologies and procedures so that characterizing and measuring the chemical constituents of botanical remedies is no longer a

challenge. Thousands of plant-derived bioactive chemicals determine a plant's effectiveness, and these components are also essential for human survival, thus ground-breaking research in this area must continue. Recent breakthroughs in the realm of bioactive chemicals have cleared the way for the development of effective medications to treat both human and plant illnesses.[2,3]

Medicinal plants or herbs or most specifically the phytomedicine are the plants or plant parts that are used in the prevention, diagnosis, & treatment of many diseases. These items include herbal material (essential oils, and resins), herbal preparations (extracts, tinctures, and oils from herbal materials), and finished herbal products.

Chemical markers

Phytochemicals are chemical substances found inside plants that work alone in concert to enhance the effect of one another, and their pharmacological action provides the scientific basis for their usage in modern medicine. Leaves, flowers, roots, rhizomes, stems, barks, fruits, grains, and seeds, as well as fully harvested, processed (dried), and stored plant material, are frequently used as medication or in the manufacture of medicines. Alkaloids, glycosides, polyphenols, antioxidants, tannin, and other active plant components are employed in medicine.[4,5]

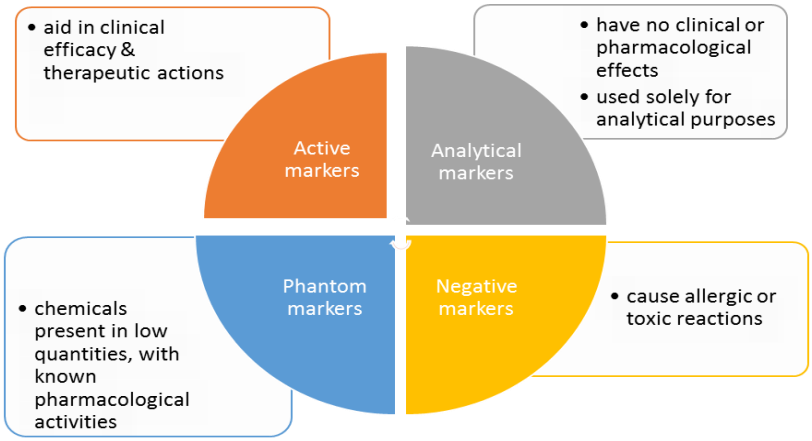
Thousands of chemicals have been discovered as a result of ethnobotany research into plants utilised by indigenous peoples for medicinal purposes. A variety of physiologically active medications have been discovered as a result of research into diverse plant sections (leaves, roots, barks, fruits, and seeds). A great deal of research has been done on the resistant character of phytoconstituents present in plants, as well as the causes of their reduced mechanism of action.[6]

Markers are chemically defined components of a herbal medication that are of interest for quality control purposes regardless of whether or not they have therapeutic efficacy. If a marker has been quantitatively determined in the herbal drug or preparation when the beginning materials are tested, it may be used to compute the amount of active component in the end product.[7]

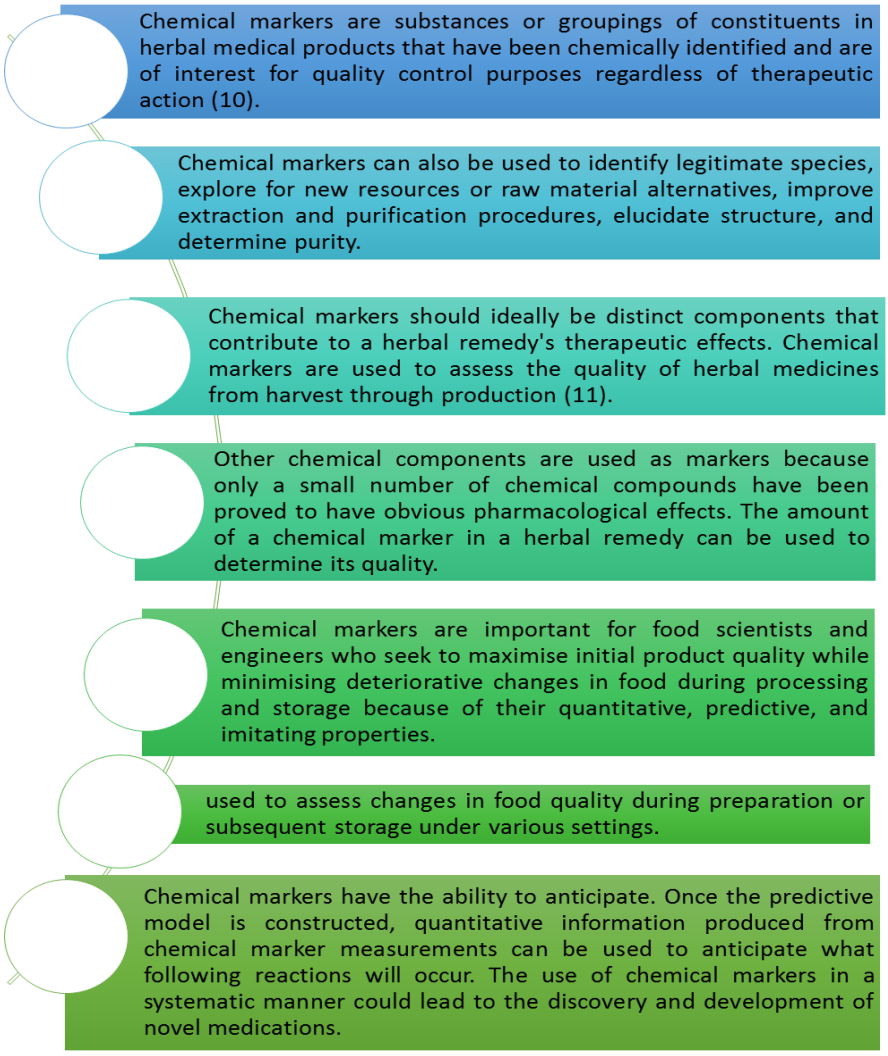
The active principles or main chemicals, as well as the chromatographic fingerprints, should be used to standardise the bioactive extract (TLC, HPTLC, HPLC and GC). Chemical and

instrumental analyses are frequently employed for assessing synthesised pharmaceuticals to ensure their legitimacy in the standardisation of crude pharmacological ingredients.[8,9]

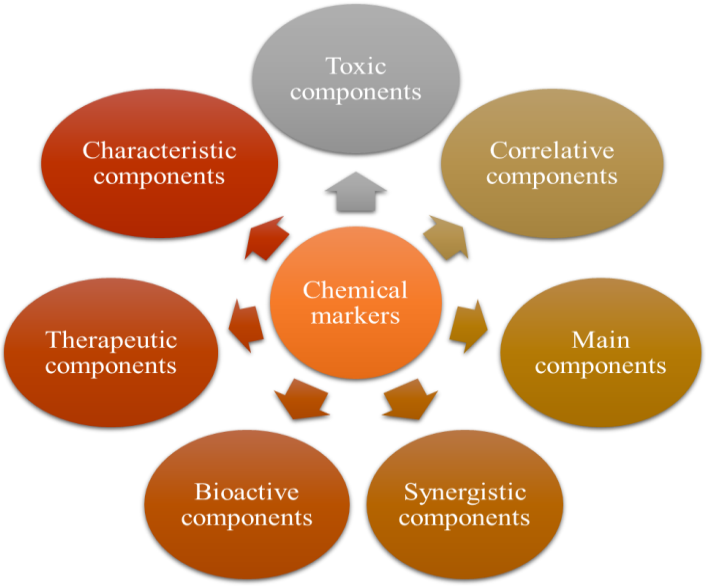
Types of chemical markers uses in herbal plant analysis



Features of chemical markers



Classification of Chemical Markers



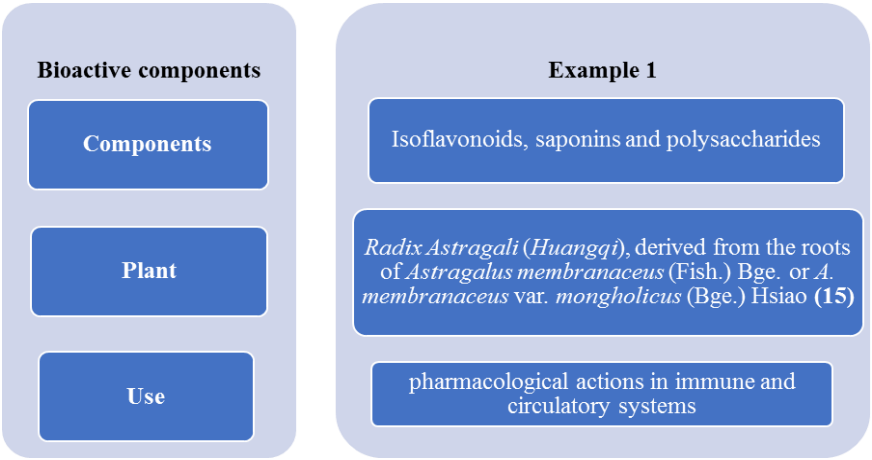
a. Therapeutic components

The medicinal components of herbal medicine have immediate therapeutic advantages. Chemical markers can be used in both qualitative and quantitative analyses.

Therapeutic components	Example 1	Example 2
components	polysaccharides	Artemisinin
Plant	*Bulbus Fritillariae* (*Beimu*) (family Liliaceae) **(12)**	*Herba Artemisiae Annuae* (*Qinghao*) **(13)**
Use	antitussive and expectorant	Potent anti-malarial activity. Artemisinin inhibits *Plasmodium falciparum* and *Plasmodium vivax*, two pathogens that cause malaria
chromatographic techniques	flame ionization detection (GC-FID), direct GC-FID, gas chromatography – mass spectrometry (GC-MS), high-performance liquid chromatography – evaporative light scattering detection (HPLC-ELSD) and high-performance liquid chromatography – mass spectrometry (HPLC-MS) methods.	HPLC-ELSD, GC-FID and GC-MS for assessing the quality of the plant (parts and whole) at various stages, including the green and dead leaves of the plant.

b. Bioactive components

Bioactive chemical markers (BCM) are a type of chemo-marker with overall therapeutic activity similar to that of botanical medicine. Controlling the contents of these BCM indicates a set of promising quality assessment/control markers for botanical drugs' pharmacological qualities, which suggests a set of promising quality assessment/control markers for botanical pharmaceuticals' pharmacological characteristics.[14]



While individual components may not have direct therapeutic benefits, a herbal medication's therapeutic effects are enhanced by the combination of their bioactivities. Bioactive components have the potential to be used as chemical markers to assess quality and quantity.

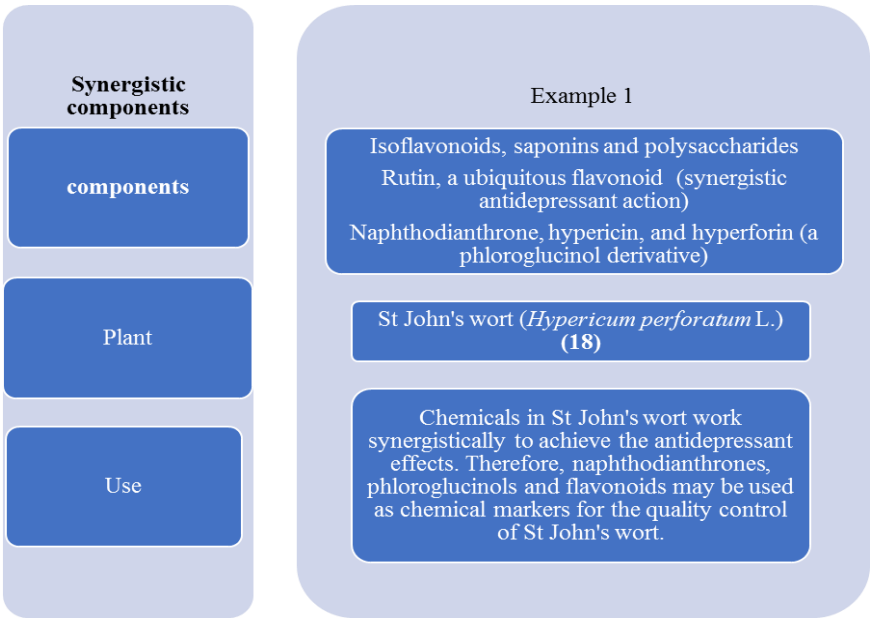
Bioactive substances produced from a variety of medicinal plant species have been demonstrated to have antimicrobial and parasitic properties. Around 400,000 plant species are known to have bioactive chemicals, however scientists have only looked into a small portion of this vast number. To examine and evaluate their therapeutic efficacy, they are screened and separated using rigorous scientific investigations and characterizations.

Extensive research into these natural substances and their derivatives has resulted in the development of high-value pharmaceutical medications. Bioactive chemicals can be generated in a variety of ways, although their activity differs greatly from that of plant materials. As a result, bioactive chemicals have completely transformed the medical field.[16]

c. Synergistic components

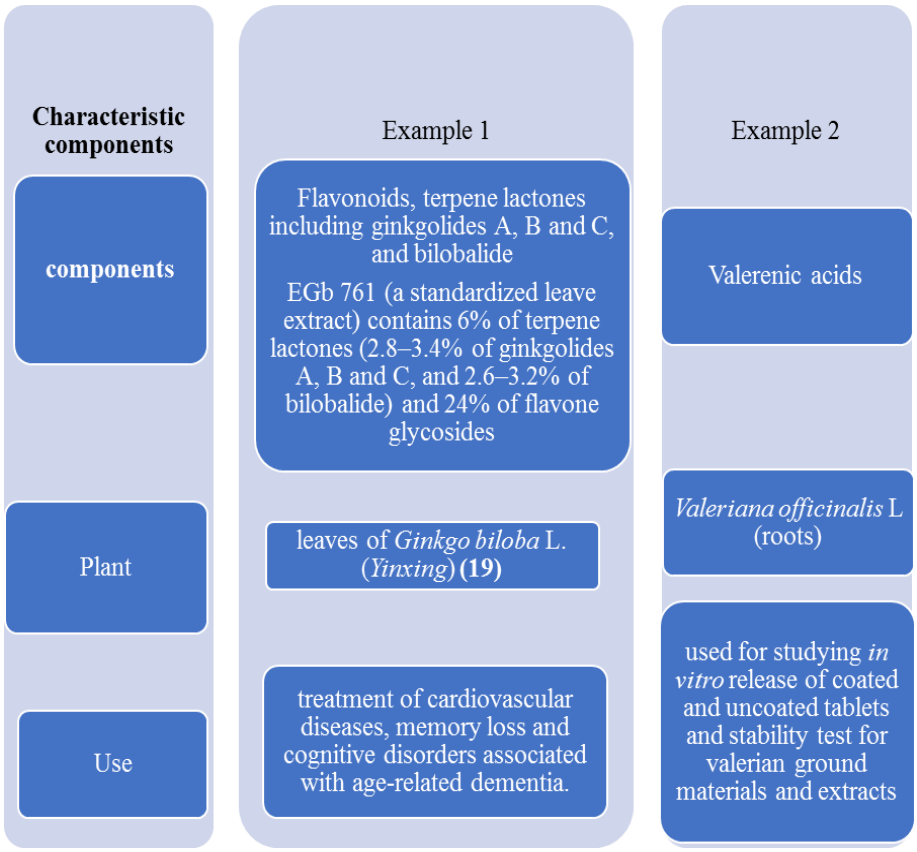
Synergistic components do not contribute directly to medicinal or bioactivities advantages. They do, however, collaborate to enhance the bioactivities of other components, hence

controlling the therapeutic advantages of herbal medicine. Chemical markers with synergistic components can be used to examine qualitative and quantitative data.[17]



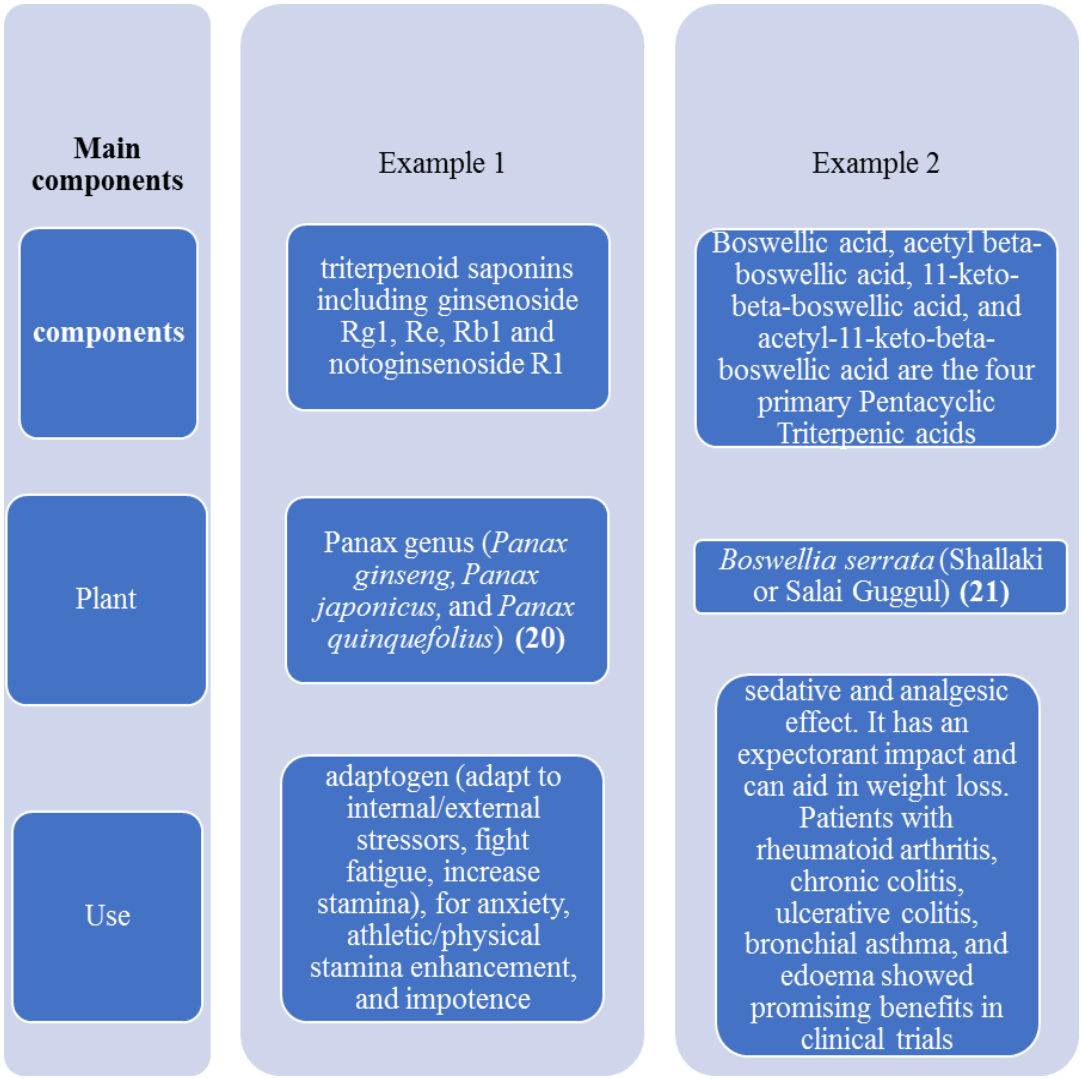
d. Characteristic components

While distinct components may contribute to therapeutic benefits, they must be particular and/or unique constituents of herbal medicine.



e. Main components

The major ingredients in a herbal cure are the ones that are most plentiful (or significantly more abundant than other components). They're not common ingredients, and it's probable that their bioactivities are unknown. Herbal remedies' major components can be used for both qualitative and quantitative analysis, especially for determining the stability.

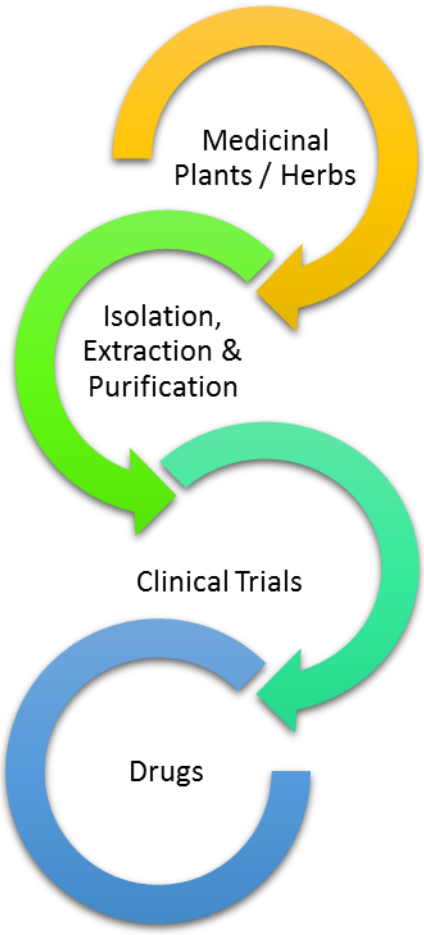


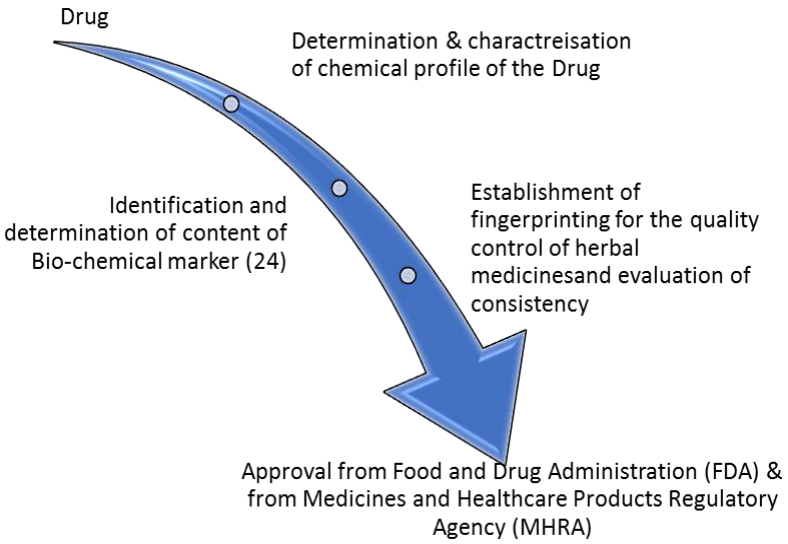
f. Correlative components

The correlative components of herbal treatment are inextricably linked. For example, these elements could be precursors, products, or metabolites of a chemical or enzymatic reaction. Correlative components can be used as chemical indicators to assess the quality of herbal medicines that have been maintained for variable amounts of time and come from distinct geographical regions.

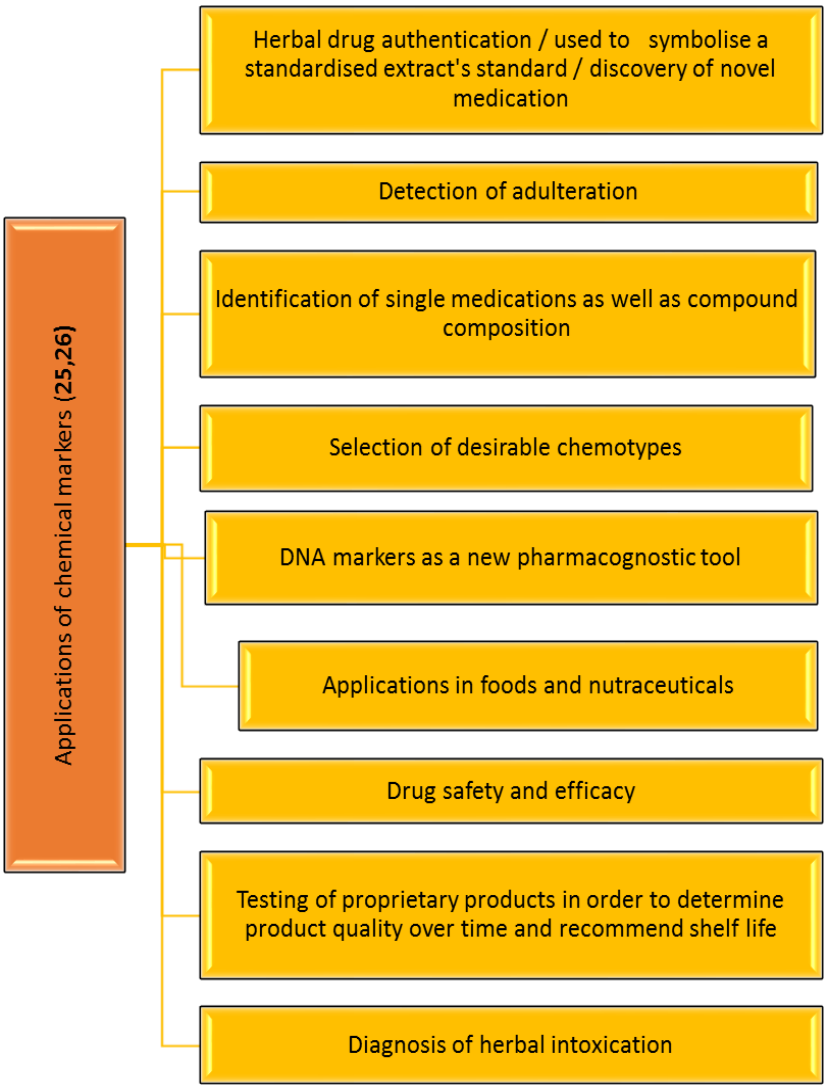
Correlative components	Example
Components	glycosides, psoralenoside and isopsoralenoside
Plant	*Fructus Psoraleae* (*Buguzhi*) **(22)**
Use	Seed and extract powder are used as diuretic, anthelminthic, laxative, and for healing wounds

A basic flow chart of identification of Chemical Markers from medicinal plants (23)





Applications of chemical markers



Limitations and Future Prospective

Understanding the role of active chemicals and the discovery of new specialised metabolites will be the world's hope in the future. The manufacture of chemical markers presents numerous technical obstacles, like temperature, light, and solvents can cause pure components to degrade or transform. Many factors, including inherent ones like genetics and extrinsic factors like cultivation, harvesting, drying, and storage conditions, can influence the final chemical composition of any herb. Secondary metabolites are only given a qualitative description in routine chemotaxonomic research. The use of unique markers that can be easily evaluated to identify various kinds remains a favoured choice for quantitative studies. Marker compounds are pure, isolated compounds containing terpenes, steroid, alkaloid, flavonoid aromatic hetero aromatic frameworks, and glycosides with alcoholic, carbonyl, olefinic, acid, ester, and amide functionalities that are particularly beneficial for single / crude drugs: In multiherbal formulations, it may or may not survive.[27]

These metabolites could be therapeutically active or not, but they should ideally be unaffected by environmental factors and management approaches. A standardised extract indicates that the maker has confirmed the presence of the active element assumed to be present in the herb in the preparation, as well as the potency and volume of the active ingredient.

One of the key objectives of the 2014–2023 World Health Organization's Traditional Medicine strategy is to "promote the safety, efficacy and quality of traditional medicine by expanding the knowledge base, and providing guidance on regulatory and quality assurance standards".[28] Hence, quantitative research, molecular docking, and dynamic simulation studies and optimization of these compounds should be conducted as a scientifically gratifying task.

Through the correct analysis of the relationship between chemical structure and molecular bioactivity, computational chemistry has simplified and enhanced medication design, particularly in the pharmaceutical industry, computational approaches of drug enhancement are currently leading the way. They have the advantage of reducing the risk of discovering strong medications and of shortening the time that it takes to screen and search for bioactive chemicals. The knowledge gained from the computational analyses is utilised to aid in the development of new high-potency medications. For the examination and modelling of chemical substances, the researchers used computer techniques.

Studies of the rates and mechanisms of specific components, together with novel methodologies for achieving optimal product quality of new pharmaceuticals derived from plants, are gaining popularity. A revolutionary study should be done by the creation and implementation of computational designs and models in predicting the behaviour of these bioactive elements. It is also necessary to optimise the various active compounds for maximum product quality in order to achieve continued scientific advancement.[29,30]

CONCLUSION

Pharmacology and therapeutics have their origins and foundations in traditional medicinal plants. Natural compounds found thus far have proven to be extremely beneficial to human health. Because they have fewer adverse effects and are more effective, they have become the medications of choice. The structural diversity based on phytochemistry is the most striking property of plants as medications in relation to their long-term usefulness in drug discovery. Herbal medication seeks to verify their quality, safety, and efficacy as the chemical markers are critical in today's quality control procedures. Authentication and identification of species, collecting and harvesting, quality evaluation, stability assessment, diagnosis of intoxication, and detection of lead compounds are all examples of where chemical markers should be employed in the creation and manufacture of herbal medicines.

Despite the fact that countries in the twenty-first century are becoming more modern and urbanised, the people must understand to conduct safe waste disposal and the importance of medicinal plant planting, not only in rural areas but also in urban areas.

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