A review on general introduction to medicinal plants,its phytochemicals and role of heavy metal and inorganic constituents

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Abstract: Plants play an important role in the development of new drugs. Phytochemicals are the natural compound occur in plants, vegetables and fruits, that work with nutrients and fibers to act against diseases or more specifically to act against diseases. As the plants are directly in contact with air, water and soil, the constituents of these sources might contaminate the plants. In addition to the toxic elements such as mercury, arsenic, lead, nickel and cadmium which might be present in some plants and threatened the consumer health, especially the children and elderly. Useful elements such as calcium, magnesium, zinc, manganese and iron are also usually present in plants which help the good health. Many countries have already evaluated their popular herbal medicines with regard to toxic heavy metals.

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Introduction

Plants, which have one or more of its parts having substances that can be used for treatment of diseases, are called medicinal plants (Sofowora, 1982). Medicines derived from plants are widely famous due to their safety, easy availability and low cost (Iwu et al., 1999). Herbal medicines may include whole parts of plant or mostly prepared from leaves, roots, bark, seed and flowers of plants. They are administered orally, inhaled or directly applied in the skin (Westh et al., 2004). Medicinal herbs are more significant to the health of individual and community.

The medicinal value of these plants lies in bioactive phytochemical constituents that produce definite physiological action on the human body (Hill, 1952). Some of the most important bioactive phytochemical constituents are alkaloids, essential oils, flavonoids, tannins, terpenoids, saponins, phenolic compounds and many more (Solecki & Shanidar, 1975).These natural compounds formed the foundations of modern prescription drugs as we know today (Bensky & Gamble, 1993).

Use of plants based drugs for curing various ailments is as old as human civilization and is used in all cultures throughout history. The primitive man started to distinguish between useful and harmful are poisonous plants by trail and errors. A well defined herbal pharmacopoeia was developed by tribal people, which was based on information collected from local flora, religion and culture. The knowledge of medicinal plants was gradually developed and passed on from one individual to other, which foundation for traditional medicine throughout the world.

Classification of herbal medicines:

Herbal medicines are classified into;

1. Ayurvedic Herbalism (Ayurveda meaning science of life) which is derived from Sanskrit word. This system originated from Indian medicines about 500 years ago and was practiced in its neighboring countries like Srilanka.
2. Chinese Herbalism
3. African Herbalism
4. Western Herbalism, Greece and Rome were their originating countries which were then spread to Europe, North and South America Plants based medicine play an important role in world health. Medicinal plants are distributed worldwide but they are very rich in tropical countries. Modern medicine from high plants either directly or indirectly derived is estimated 25% (Cassileth, 1998; Crag et al., 2001). Herbal medicines might be considered as “diluted drugs”. An adequate amount is required by an individual for specified period of time in order to achieve the desire benefits of herbal medicines. Every herb is different from other herb; some herbs are safe and effective for specified use while other are not. This is not a true preparation that the herbal medicines are very safe and free from any side effect because they can produce side effects and can be toxic. As each part of plant will have many active constituents and some of its constituents may be toxic, however, a high dose is required to cause toxicity because they are not potent. Also their adverse effects are relatively infrequent as

compared to manufactured drugs (Ackerknecht, 1973; WHO, 2005).

Until the nineteenth century, the main source of products used to maintain health were medicinal plants when accidentally Friedrich Wohler in 1928 synthesized urea while attempting to prepare ammonium cyanate from silver cyanide and ammonium chloride and this was the first organic synthesis in history and hence leaded to the era of synthetic compounds. With this discovery, the western scientists give their full concentration to the newly discovered synthetic lines and ignored a little bit to the phytomedicines but after some time they compelled to bounce back to the phytomedicines as they observed that the earlier has less side effects as compared to synthetic medicines.

However, plants derived medicines are far superior than the well defined drugs. For example, the quality and availability of raw materials is always a problem, the principles of handling are also unknown and also the quality control, i.e. standardization and stability are practically applicable but not too much easy. Herbal medicines are for superior than the synthetic drugs because they are naturally occurring, easily available without cost and have minimum side effects. Majority of plants have medicinal properties, i.e. most pharmaceutical drugs are originally derived from plants. The scientific study of indigenous medicines is called Ethno pharmacology, which is an interdisciplinary science practiced all over the world. Standardization herbal preparation is termed as phototherapeutic agents or pytho-medicine which contains active constituents, or complex mixture of plant materials in the raw or processed form. Phototherapeutic agents are usually not recommended to use in emergency treatment because of the fact that they normally do not possess an immediate or strong pharmacological action. The modern field of phytoscience comprise of the use of medicinal plants and their bioactive phyto-compounds. This science is developed from merging of vast range of disciplines that have never been linked before combining several different areas of economic, biochemistry, physiology, microbiology medicines and agriculture.

The development and introduction of new drugs like antibiotics, immuno-stimulants and anti tumor agents have led to dramatic success in control of many diseases. The drugs derived from plants, however, still from the mainstay of medical treatment in the developing countries. According to the June 1983, issue of world Health, it is estimated that more than half of the world's population relies mainly on traditional remedies. Natural products and the medicinal agents derived there from, are also an essential feature in the health care system of the remaining of the population residing mainly in developed countries, More than 50% of all drugs in clinical use have a natural product origin (Bisset, 1994). Natural products continue to play an important role in drug discovery programs of the pharmaceutical industry and other research organizations (Pal, 2003; Hudson, 1989). More than 600 botanical items have been recognized in various editions of the United Sates Pharmacopoeia (Phillpson & wright, 1991).The fact that most of the plant materials have been used over the ages for treatment of diseases is convincing evidence that many of the herbal prescriptions are reasonable safe but scientific toxicological trials are still necessary (Chawira et al., 1987).

Phytochemicals

The world is fertile with natural and medicinal plants. Medicinal plants are now more focused than ever because they have the capability of producing many benefits to society indeed to mankind, especially in the line of medicine and pharmacology. The medicinal power of these plants lies in phytochemical constituents that cause definite pharmacological action on human body. Some of the most significant bioactive phytochemicals are alkaloids, flavonoids, tannins, saponins, glycosides, phenolic compounds and many more (Edeogo et al., 2005).These natural compounds form the foundation of modern prescription drugs as we know today (Chopra et al., 1986). Phytochemical is a natural compound occur in plants such as medicinal plants, vegetables and fruits, that work with nutrients and fibers to act against diseases or more specifically to protect against diseases. Phytochemicals are mainly divided into two groups, which are primary and secondary constituents according to their activity in plant metabolism. Primary constituents contain common sugars, amino acids, proteins and chlorophyll while secondary constituents comprise of alkaloids, flavonoids, saponins, tannins, phenolic compounds and many more (Krishnaiah et al., 2007).

Alkaloids

One of the largest groups of chemical arsenals produced by plants is the alkaloids. Many of these metabolic by-products are derived from amino acids and include an enormous number of bitter nitrogenous compounds. According to (Raffauf, 1996) more than 10,000 different alkaloids have been discovered in species from over 300 plant families. Alkaloids often contain one or more rings of carbon atoms, usually with a nitrogen atom in the ring. The position of the nitrogen atom in the carbon ring varies with different alkaloids and with different plant families. In some alkaloids, such as mescaline, the nitrogen atom is not within a carbon ring. In fact, it is the precise position of the nitrogen atom that affects the properties of these

alkaloids (Bentley, 1966). Although they undoubtedly existed long before humans, some alkaloids have remarkable structural similarities with neurotransmitters in the central nervous system of humans, including dopamine, serotonin and acetylcholine. The amazing effect of these alkaloids on humans has led to the development of powerful pain-killer medications, spiritual drugs, and serious addictions by people who are ignorant of the properties of these powerful chemicals (Cordell, 1981; Hesse, 1981).

Flavonoids

Flavonoids also referred to as bioflavonoids, are polyphenol antioxidants found naturally in plants. They are secondary metabolites meaning they are organic compounds that have no direct involvement with the growth or development of plants. More simply, flavonoids are plant nutrients that when consumed in the form of fruits and vegetables are non-toxic as well as potentially beneficial to the human body. Till now more than 300 differentflavonoids has been isolated from vegetables. The flavonoids are a common group of contentions in all plants and it plays an important role in the metabolism (limested et al., 2007).

Tannins

Tannins are the complex organic, non-nitrogenous derivatives of polyhydroxy benzoic acids which are widely distributed in the plant kingdom. They are present in aerial parts, e.g. leaves, bark, fruits and stem. Generally, it occurs in immature fruits but disappear during ripening process. New leaves of deciduous plants contain high concentration of tannins. They probably serve as a protective to the plant during growth and destroyed or deposited as end product of metabolism in some dead tissues of the mature plant. Some phenolic substances, such as gallic acid and catachins often occur in complex with tannins and are called as pseudotannins. Most of the true tannins have the molecular weight in between 1000 to 5000 (Buzzini et al., 2008). Tannins precipitate and combine with proteins. The protein-tannin complex is resistant to proteolytic enzymes. This property is known as astringent. During healing process of burns, the proteins of the exposed tissues are precipitated producing a mild antiseptic and protective layer under which the new tissues are regenerated. Tannins are used in tanning process of animal hides to convert them to leather. They are used as healing agents in inflammation, leucorrhoea, gonorrhea, burn, piles, and diarrhea and as antidote in the treatment of alkaloidal poisoning (Serrano, 2009).

Saponins

The name saponin is derived from the Latin word 'sapo', which means the plant that consists of frothing agent when diluted in aqueous solution. Saponins comprise of polycyclic aglycones. The sapogenin or the aglycone part is either a triterpene or steroid. The combination of sapogenin, hydrophobic or fat-soluble, hydrophilic or water-soluble sugar part enhances the foaming ability of saponins. Some toxic saponins are known as sapotoxin (Riguera, 1997). Saponins are an important group of glycosides which are widely distributed as plant constituents. Most of the saponins are neutral and soluble in water. Like other glycosides, saponins are hydrolyzed to form a sugar and an aglycon, generally known as sapogenin. Their aqueous solution form forth on shaking produce stable emulsion on shaking with oil and fats; absorb and retain in solution a volume of gas, e.g. CO_2 several times greater than absorb by an equal volume of water. An aqueous solution added to red blood corpuscles causes' haemolysis, i.e. disintegration and solution of the corpuscles to form a clear red liquid (Kensil, 1996; Yoshiki et al., 1998).

Phenols

Phenols are very wide spread in nature and are probably the largest group of secondary plant metabolites. These range from simple structures having a simple aromatic ring to highly complex polymeric structures and often exist in glycosidic forms (Williamson et al., 2005). Phenols may be divided into several classes. Those of pharmaceutical importance are the simple phenolic compounds. Simple phenolic compounds consist of a single phenolic ring and often possess alcoholic, aldehydic and carboxylic acid groups. Examples include vanillin which is a phenolic aldehyde and silycylic acid that is a phenolic acid. Vanillin is found in the unripe fruit's of various species of *Vanilla*. Capsacin is found in the dried ripe fruit of different species of *Capsicum*. It has been used internally for dyspepsia and flatulence. Externally, it is frequently used as counterirritant (Mattila et al., 2007).

Heavy Metals

Pollution is a very great threat for the survival of human beings and the most important dispute of our era (Wang et al., 2004). The pollutants are discharged to the environment through industrial activities, automobile exhaust, heavy duty electric power generators, refuse burning and pesticides used in agriculture, etc. The main cause of contamination of environment is a presence of wide range of inorganic and organic compounds. These compounds may be heavy metals, the combustible substances, petroleum products, and explosive hazardous wastes (Ghosh &

Singh, 2005). Heavy metals are the main constituents of the inorganic contamination. The term heavy metal defined as commonly held for those metals which have specific weights more than 5g/cm^3 (Lide, 1992). Heavy metals are kept under environmental pollutant category due to their toxic effects in plants, human and food. There are 35 metals that concern us out of these, 23 are the heavy elements or "heavy metals" which includes Sb, As, Bi, Cd, Cr, Co, Cu, Ga, Au, Fe, Pb, Mn, Hg, Ni, Pt, Ag, Tl, Sn, V and Zn (Glanze, 1996). Interestingly, small amounts of these elements are common in our environment and diet and are actually necessary for good health, but large amounts of any of them may cause acute or chronic toxicity (poisoning). Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver, and other vital organs. Long-term exposure may result in slowly progressing physical, muscular, and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy, and multiple sclerosis. Allergies are not uncommon and repeated long-term contact with some metals or their compounds may even cause cancer (International Occupational Safety and Health Information Centre, 1999).

Heavy metals can be classified into three major groups.

a) Essential
Fe, Co, Cu, Mn, Mo, Zn.
b) Possibly essential
As, Cr, Ge, Ni, Rb, Se, Sn, Sr, V.
c) Non essential
Au, Be, Ce, Dy, Er, Eu, Ga, Gd, Hf, Hg, Ho, In
Ir, La, Li, Lu, Nb, Nd, Os, Pd, Po, Pr, Pt, Ra, Re
Rh, Rn, Sc, Sm, Ta, Tb, Te, Th, Ti, Tl, Tm, U, W, Y, Yb, Zn.

Table-1: Content of Elements in Adult Human Body their Biological Role and their Medicinal Uses.

S.No	Element	Total Amount	Biological Role	Medicinal Uses	Ref.
1.	Arsenic	---------	Essential for growth in animals	Amoebiosis	----
2.	Chromium	6mg	Activates Insulin	Diagnostic tool for determining RBC volume	(Hikino & Kiso, 1988).
3.	Cobalt	1.5mg	Constituent of vit B-12	Not known	(Fletcher, 1991).
4.	Copper	50-120mg	Constituent of oxidative enzymes	Fungicidal, insecticidal and pesticidal	(Bisset, 1994).
5.	Iron	4-5g	Involve in oxygen and electron transport	Anemia	(Rygan et al., 1994).
6.	Lead	121mg			(Muriel et al., 1992).
7.	Magnesium	19g		Antacid, Cathartic	(Chandra & Tandon, 1974).
8.	Manganese	10-20mg	Participates in mucopolysaccaride metabolism.	Multimineral supplementation	(Mar, 1997; Leonards, 1996).
9.	Molybdenum	9mg	Constituent to Xanthin,Aldehyde and Sulfide oxidases	Not known	(Hikino & kiso, 1988).
10.	Nickel	10mg	Interferes with iron absorption.	Not Known	(Hikino & kiso, 1988).
11.	Phosphorus	580mg		Reduction of urinary calcium	(Emsley & John, 2001).
12.	Potassium	245g		Hypercalcemia,Myasthema gravis	(Chandra & Tandon, 1974).
13.	Selenium	20mg	Component of glutathione peroxydases and interact with Heavy metals	Not known	(Hikino & Kiso, 1988).
14.	Silicon	18g	Possible role in connective tissue formation.	Not known	(Hikino & Kiso, 1988).
15.	Sodium	105g		Replacement Therapy	(Chandra & Tandon, 1974).
16.	Sulphur	140g		Fungicidal and parasiticidal	(Fletcher, 1991).
17.	Tin	17mg	Essential for growth in animals	Tapeworm infestation	(Hikino & Kiso, 1988).
18.	Vanadium	25mg	Same above	Not known	(Hikino & Kiso, 1988).
19.	Zinc	2-3g	Constituent of over 100 enzymes	Acrodermatitis, Enteropathica, Astringent, Antiseptic	(Hikino & (Kiso, 1988; Muzes et al., 1990).

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elements such as calcium, magnesium, zinc, manganese and iron are also usually present in plants which help the good health. Many countries have already evaluated their popular herbal medicines with regard to toxic heavy metals (Caldas &Machado, 2004).

The presence of heavy metals in the human body always draws scientific concern as these are considered responsible for affecting health, especially in these days where the release of toxic wastes in the environment has been increased (Bires et al., 2004).The heavy metals are mobilized by human activities such as mining and discarding industrial waste in nature, and they pose a potential threat to organisms (Agoramoorthy, 2006). Heavy metals are known to affect biological communities (Hsu et al., 2006). When the level of heavy metals exceed in plants and animals, it can induce a variety of acute and chronic effects in wide range of organisms and in various ecosystems. The presence of heavy metals beyond the allowed upper and lower limits can cause metabolism disturbance (Becking, 1996). Thus deficiencies of essential minerals particularly those which involve the metabolism of carbohydrates for example chromium, manganese, zinc, potassium and magnesium are found in diabetics. Chromium helps to lower cholesterol and triglyceride levels and increases insulin sensitivity (Hoehn et al., 2009).The excess iron can cause oxidative stress and damage the pancreas and thus affect insulin secretion, Manganese is involved in energy metabolism, high levels of zinc may increase glycosylation (Mertz et al., 1994). Recommends that medicinal plants which produce the raw materials for the finished products may be checked for the presence of heavy metals, furthermore it regulates the maximum possible limits of toxic metals like arsenic, cadmium and lead which are 1.0, 0.3 and 10 ppm respectively (WHO, 1989; WHO, 1998).

Inorganic Constituents

The entire world facing the complexity and diversity of the present day increase in the fall on of the dangerous metabolic diseases pattern which casts obscure shadows over human life in the form of cancer, cardiovascular diseases and AIDS. It is not surprising that all human sources should have been focused towards the development of techniques that would help oppose this life threatening enemy. The improvements in science and technology have resulted in the availability of sensitive, sophisticated research instrumentation and reliable analytical methodology as a consequence of which various health and disease related aspects have come to light. This has opened an increasing number of situations in which excess or deficiencies of specific elements are a primary cause of disease.

The discovery of elements in living organisms dates back to a century (Harless et al., 1847). It was in fact the discovery by Raulin (Church et al., 1869). Of the essentiality of zinc in *Aspergillus Niger* nutrition, the existence of the link between Iodine content and human Goiter due to inadequate intake of food and water (Harless et al., 1847). Along with the discloser of iron as a blood constituents (Mendel et al., 1905). That stimulated investigations on the importance of elements in human body, nutrition, disease, health as well as the environment surrounding human life.

The attention for the investigation of elements was drawn by Hakim Abdul Hamid originator of the discipline "Elementology" (Salrito et al., 2001). According to him health depends upon the organized state of elements in the body and their imbalance causes diseases (Golden, 1988). He believes that the restoration of balance by drug can cure diseases. The remarkable progress that has been made in the science of Medical Elementology during the past few decades has not only opened avenues for research on human health related aspects but also aroused the interest of the pharmaceutical industries to reap the benefits of this research by formulations containing elements reported to be essential for human health. A variety of such formulations are available worldwide.

Elements in Human Body

It has been reported that out of 110 known elements, 81 were present in living organism which were then biologically classified (Vohora, 1981). The classification is listed in table 2.

Table-2: List of Essential, Possibly Essential and Non-Essential Elements.

S. No.	Elements	Major/ Bulk Elements	Trace Elements
1	Essential Elements	C, Ca, Cl, Fe, H ,K, Mg, N, Na, O, P, S	Co, Cu, F, I, Mn, Mo, Zn
2	Possibly Essential Elements	Si	As, B, Ba, Br, Cr, Ge, Ni, Rb, Se, Sn, Sr, V
3	Non –Essential Elements	Ag,Al,Bi,Cd,Pb,Sb	Au, Be, Ce, Dy, Er, Eu, Ga, Gd, Hf, Hg, Ho, In, Ir, La, Li, Lu, Nb, Nd, Os, Pd, Po, Pr, Pt, Ra, Re, Rh, Rn, Sc, Sm, Ta, Tb, Te, Th, Ti, Tl, Tm, U, W, Y, Yb, Zn.

Medicinal uses, excess or deficiency of 81 elements (Vohora, 1982) was reported to affect at least 235 diseases or functions of the body.

Table-3: List of Some Highlighted Essential or Possibly Essential Elements Their Medicinal Uses and Pharmacological action by their Deficiency and Excess.

Element	Medicinal uses	Deficiency	Excess
Calcium	Osteoporosis	Menopausal problem, Cardio vascular disease	Hypercalcemia, Kidney stone
Bromine	Epilepsy	Insomnia Osteoporosis	Not known
Carbon	Atelectasis	Not known	Not known
Chlorine	Antiseptic and profuse sweating	Maintenance of pH and osmotic equilibrium	Maintain PH and Osmotic equilibrium
Fluorine	Dental caries	Dental caries	Convulsion, Hypoclcaemia
Hydrogen	Not known	Maintenance of optimum pH of body fluids	Maintain pH of body Fluids
Iodine	Cuts and burn	Goiter	Thyrotoxicosis
Magnesium	Antacid, Cathartic	Pancreatitis, convulsion	CNS and GIT Disturbance
Phosphorus	Reduction of urinary calcium	Disturbance of growth and repair, Metabolism of CHO, Protein, Fats	Coma, GIT disturbance
Potassium	Hypercalcemia, Myasthema gravis	Anorexia, Lung disease	Acidosis
Sodium	Replacement Therapy	Dehydration, decrease blood volume	Hypertention, Cardiac failure

A Varity of such formulations are available worldwide. These general tonics are beyond the reach of the major indigent segment of the 117.32 million populations having a per capita income of only Rupees 10,358. (Government of Pakistan, 1991-92). Though expensive medicines cannot be made available to the entire population but efforts could be directed towards exploring the possibilities, within economic provisions, for the development of economical and efficacious substitutes from within the available natural resources. Medicinal properties have been attributed to a large verities of plants cultivated in different parts of world. The active constituents especially inorganic elements present in plants are very variable in quantity if grown under favorable or unfavorable conditions and different type of varieties used for cultivation (Gauch, 1972). Keeping these factors in view, standardization of medicinal plants is essential to provide drugs of good average quality for obtaining desired results.

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