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Text Book of Applied Phytology

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Text Book of Applied Phytology

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PREFACE

India is considered as one of the megadiverse countries of the World. The floral andthe vegetational diversity of this country not only provides an endless opportunity to studythe plant systematics but it also opens several new vistas of plant sciences like Ethnobotany,Biotechnology, Endemism, Phytogeography and Biodiversity and its conservationalstrategies, etc. However, all these present subjects had initiated their journey as the branchesof Botanical Science.

Vrikshyayurveda " (Science of plants and plants life) of Parashara(800B.C.) is oneof the earliest treatises dealing with the plants from the scientific view point. It was the basisof the botanical teaching, preparatory to medical studies in ancient India. This book isembodied with several chapters, dealing with different aspects of the plant sciences like immunostimulatn, herbal medicine, pharmacology, and description of the plant parts, nature and types of the applications.

The principal objectives of this seminar were to search and to identify the scope andrecent development of plant sciences, interconnecting with other allied and apparently nonallied subjects.

Dr Govindharajan Sattanathan, Ph.D.,

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1. INTRODUCTION

Humans have been exploring their environment since ancient times for plants that could be used to meet all their basic needs: food, shelter, fuel and health. This has led to the use of a large number of plants; the extensive breeding of food plants has resulted in high-yield crops in particular. In the case of medicinal plants, such breeding has largely not yet taken place, as a sufficient supply can be provided by nature. It has been estimated that the number of medicinal plants is about 40,000 to 70,000. Which means that somewhere in the world, almost 25 percent of all plant species have some kind of medicinal use. In Western medicine, this heritage from our ancestors has continued to develop and has led to the isolation and production of pure active compounds (e.g. morphine, atropine and digoxin) and later to the development of novel synthetic compounds based on this knowledge (e.g. local anaesthetics based on cocaine, analgesics based on morphine). Some of these natural-based synthetics have been very successful, such as acetylsalicylate, which was developed using Salix bark as an analgesic. In other cases, the results, such as the acetyl derivative of morphine, have not been so successful (heroin). This shows that, as occurred in the European/Mediterranean region, many drugs in the West originated from phytotherapy.

Moreover, the statistics on novel drugs developed in recent decades show that natural products are a major source of inspiration for the development of drugs, with pure synthetics being only 30 percent of all novel molecules (of the 1184 so-called novel chemical entities or NCEs) introduced on the market in the period 1981-2006 and all other natural products or related natural products. These statistics also show that every year, the number of novel chemical compounds that reach the market is decreasing. High costs (approx. EUR 1000 million) and long duration (more than 10 years), as well as the fact that the development of novel drugs by the pharmaceutical industry is hampered by good medicines already available for most major illnesses. Recent problems with serious side effects have led to the marketing of several novel medicines shortly after their introduction. This also does not help to increase efforts to develop novel drugs.

At the same time, strong emerging economies have led countries such as India and China to become more interested in local healthcare systems, which are even considered to be an important (cheap) alternative to costly Western drug treatment. In addition, after thousands of years of extensive and widespread use of traditional medicines, the question arises as to why we should not use all the tools of

modern science to consider these medicines again. Further studies may lead to the discovery of novel modes of action, novel biologically active compounds, confirmation of traditional use, or, in the worst case scenario, the absence of any activity and even the risk of toxicity from the use of a given medicine.

It makes sense to devote much more resources to such studies, with 80 percent of the world's population using such traditional medicine. Approximately 30 years ago, the discovery of the antimalarial compound artemisinin in traditional Chinese medicine led to an efficient new medicine used to treat malaria. But it has also led to completely new potential applications, such as cancer treatment. Through research into traditional medicine, many more hidden gems can be found. The completely different healthcare systems they are embedded in, such as different ways of classifying diseases, personalized medicines, and the complex mixtures of ingredients in traditional medicines, are one of the problems in the study of traditional medicines. Some interesting high-activity compounds may be picked up by current drug development approaches, but high-throughput screening (HTS) will only detect compounds with strong affinity to a target enzyme or receptor; prodrugs will be missing; (such as salicin the compound in Salix bark that in

the human body is converted via glucolysis and oxidation into salicylate). Synergies between compounds will also not be observed in HTS, as artemisinin may be expected to have synergies with other anti-tumor compounds in a plant, for example. Stermitz's study showing synergies between berberine and 5 methoxyhydnocarpin is now a classic example of synergies between two single-plant compounds.

The manner in which traditional Chinese medicines are produced and the various roles traditionally believed to be played by each plant actually point to the possible importance of synergy between ingredients. A recent study on the effects of ginkgo on peripheral blood flow is a beautiful example of such a traditional medicine and present-day Western pharmacology's entirely different concept of activity. In a placebo-controlled, double-blind clinical trial, Boelsma (2000) showed that a standardized ginkgo preparation caused various effects in various subjects, which would be unacceptable to the Western way of thinking. Their system-biology-type approach, however, showed that the preparation actually reduced peripheral blood flow in those individuals who had an above-average peripheral blood flow rate, increased it in those who had an under-average blood flow rate, and produced no effect in the case of the average level.

In other words, using the single-target, single-

compound paradigm, ginkgo normalizes peripheral blood flow, a concept that does not match the reductionist approach of drug development. On the other hand, in their respective receptor binding assays, HTS may pick up well-known compounds such as adenosine and GABA, thereby making possible other active compounds, but it would confirm the rationale behind the traditional use of a traditional medicine used to treat hypertension. In fact, the holistic concepts of traditional healthcare systems require a holistic approach to their activities to be studied. First, clinical trials could be considered as a way to confirm activity before trying to understand the activity, instead of trying to find an active compound. Such experiments could be done in relation to current treatments in well-established ancient healthcare systems, such as in Asia. The fact that these medicines have been used for several thousand years and are still used extensively means that it is unlikely that acute toxicity will occur, although some further research could point to long-term toxicity.

The biology of systems enters the picture in an approach using clinical studies. Systems biology aims, without a working hypothesis, to study an organism under different conditions. Instead, one tries to measure as many parameters as possible and to evaluate all the data and draw conclusions

from it using multivariate analysis or other related statistical tools, i.e. the hypothesis comes afterwards. Such data may include physiological parameters (e.g., blood pressure, pulse), chemical parameters (e.g., metabolites in body fluids, metabolites in medicinal plants), proteomes, and transcriptomes using metabolomics. Prodrugs and synergies can be found using such a holistic approach. In this way, new modes of action may also be revealed. In any case, I believe that the various medical systems can learn from each other and take some major steps forward in this way, becoming the source of new ideas and concepts. It would be to the great advantage of all people's healthcare the world over to combine the best of all approaches.

That said, one may also wonder why traditional medicine shows such little interest in the pharmaceutical industry. In addition to the fact that the problems of prodrugs and synergism described above do not suit their current drug development expertise, patents could be the main reason. It is not impossible that a conventional medicine's activity is due to a well-known compound, e.g. GABA or adenosine, which, therefore, would not give rise to a new active and patentable compound.

Moreover, it could be difficult to patent a traditional medicine, as a patent requires some kind of innovation,

something unexpected. It would therefore not be accepted as an innovation to find antidiabetic activity in traditional antidiabetes medicine, and even a compound isolated for such a plant may be difficult to patent. It would be of great value to all of humanity if some years of protection would also be given to any industry developing a traditional medicine with a view to evidence-based medicine to be able to earn back the enormous investment required to develop a traditional evidence-based medicine. Ginkgo may serve as an example again. There is one ginkgo preparation that has been extensively studied and demonstrated to be active in clinical trials. An analysis of six different preparations for sale on the Dutch market as an over-the-counter drug, one of which was a proof-based preparation, showed that the other five had lower, and some very low, levels of the compounds considered to be involved in the activity, but the health claims were the same as those proven.

2. MEDICINAL PLANTS

In the next 10 to 15 years, the world's population will be more than 7.5 billion. This population increase will mostly occur in the southern hemisphere, where 80% of the population still relies on a traditional herbal drug based medicine system. In Egypt, the Middle East, India and China, as civilizations grew from 3000 BCE onwards, the use of herbs became more sophisticated and written records were prepared. Through oral history, the specific plants to be used and the methods of application for specific ailments were passed down. Later on, information was recorded in herbals concerning medicinal plants. Historically, as tinctures, poultices, powders and teas followed by formulations, herbal drugs were used, and finally as pure compounds. Since time immemorial, medicinal plants or their extracts have been used by humans for various diseases and have provided valuable medicinal products such as analgesics (morphine), antitussives (codeine), antihypertensives (reserpine), cardiotonics (digoxin), antineoplastics (vinblastine and taxol) and antimalarial medicinal products (quinine and artemisinin). Cedrus spp., Cupressus sempervirens, Glycirrhiza glabra, Commiphora wightii and Papaver somniferum are some of the plants that continue to be used from the Mesopotamian civilization to this day. During the period 2000-2005,

approximately two dozen new drugs derived from natural sources were approved by the FDA and launched on the market, including cancer, neurological, cardiovascular, metabolic and immunological diseases, and genetic disorders. Taxus species taxol, Catharanthus *roseus vinblastine* and *vincristine*, *Camptotheca accuminata topotecan* and *irinotecan*, and *Podophyllum peltatum etoposide* and *teniposide* are seven plant-derived drugs currently used clinically for various types of cancers. The worldwide market potential for herbal drugs is estimated to be around US$40 billion. For plant-based food additives, fragrances and biopesticides, a similar situation also exists. Herbal drugs are mostly collected from the wild, and relatively few species are grown. Overexploitation of plants has endangered 4,000 to 10,000 species of medicinal plants, particularly when roots, tubers and bark are used for commercial purposes. Alternative biotechnological methods and sustainable practices have been recommended to counter overexploitation of natural resources and the consequent threats to biodiversity. Guidelines for the collection and use of medicinal plants have been set up by several world organizations and governments.

2.1 Traditional Use of Medicinal Plants

Traditional medicine is the sum total of knowledge, skills and practices based on indigenous theories, beliefs and

experiences of different cultures used in health maintenance, disease prevention and physical and mental illness improvement. In practice, the following components are referred to in traditional medicine: acupuncture (China), Ayurveda (India), Unani (Arab countries), traditional medicine for birth attendants, medicine for mental healers, herbal medicine, and different forms of indigenous medicine. A broad set of healthcare practices that are not part of the country's own tradition and are not integrated into the dominant healthcare system are referred to as complementary or alternative medicine. In all regions of the developing world, traditional medicine has maintained its popularity and its use is rapidly spreading in industrialized nations. Knowledge of plants and of healing has been closely linked since the earliest social and cultural groupings of human beings. Typically, the medicine man was an accomplished botanist. Even in historical times, to the benefit of both sciences, botany and medicine continued to be practically one and the same discipline until about 1500 CE, when they began to separate from their close association. Knowledge of the medicinal plants used in traditional medicinal systems (TSM) drugs has been of great significance, particularly as a guide to the discovery of new single-molecule medicinal products for the modern medical system. Isolation of a

substance in its pure form using different separation techniques, chemical properties and spectral characteristics is a prerequisite for determining the chemical nature of such compounds in order to establish its correct structure. Thus, in the preparation of drugs in various systems, medicinal plants are used in crude or purified form. Plant-based formulations occupy an important place in health management in countries such as India, China and others with well-founded traditional medicine systems.

However, due to advances in instrumentation and bioinformatics (computational methods), the recent broadening of the horizons of drug discovery has opened up new avenues for the use of this knowledge in drug development research. Common features of plant drugs are structural novelty and new modes of action. Anticancer agents such as vinblastine, vincristine and paclitaxel, cardiovascular agents such as forskolin, anti-HIV agents such as calanoid, and anti-hyperlipidemic agents such as guggulsterones.

2.2 Ancient Systems of Medicine

2.2.1 Traditional Indian Medicine

The word Ayurveda comes from 'Ayur' which means life, and 'veda' which means knowledge. The science of life means ayurveda. It is an ancient health care and longevity

scheme. The holistic view of human beings, their health and disease is taken by Ayurveda. It is aimed at beneficial health, defined as a well-balanced metabolism coupled with a healthy state of being. Disease can arise from the body and/or mind due to external factors or intrinsic causes, according to Ayurveda.

As an organic whole, Ayurvedic treatment is aimed at the patient and treatment consists of the salubrious use of medications, diet and certain practices. When science was not developed enough to understand even the human body, let alone drug molecules, this doctrine was conceived. Ayurveda is probably older than traditional Chinese medicine, perhaps the most ancient of all medicine traditions.

In prehistoric antiquity, the origin of Ayurveda was lost, but in ancient India, its characteristic concepts seem to have matured between 2500 and 500 BCE. In Rigveda and Atharvaveda, dating back to 2000 BCE, the earliest references to drugs and diseases can be found. The forerunner of Ayurveda is considered to be Atharvaveda, consisting of 6599 hymns and 700 prose lines.

3. IMMUNOSTIMULANTS

Immunostimulants, also referred to as immunostimulators, are substances (drugs and nutrients) that stimulate the immune system by causing any of its components to activate or increase activity. By enhancing the non-specific defence mechanism, immunostimulants could increase the resistance of fish to infectious diseases. It is possible to administer immunostimulants by injection, bathing or orally, with the latter appearing to be the most feasible. It will boost the vaccine's potency, thereby reducing the dose necessary for the same effect. Larval fish immunomodulation has been proposed as a potential method for improving larval survival by increasing innate responses until the adaptive immune response of larval fish is sufficiently developed to provide an effective pathogen response. To this end, it has been suggested that the use of immunostimulants as a dietary supplement for larval fish could be of considerable benefit, with little damage to the developing animal, in boosting the inherent defenses of the animal. Galeotti (1998) suggested that to elucidate the mechanisms of immunostimulation, in vitro screening methods should be used and then in vivo methods should be used to determine whether the benefits occur in live fish. Total serum IgM levels were statistically higher for fish fed

with assayed immunostimulant-supplemented diets than for fish fed with non-supplemented diets. In aquaculture, the addition of diverse food additives such as vitamins, carotenoids and herbal remedies to fish feed has been tested.

The overall beneficial effects are decreasing the stress response, increasing the activity of innate parameters and improving disease resistance. The two distinct immune response measuring factors are the in vivo and in vitro effects. There are many studies reporting that a variety of substances can be used as immunostimulants to enhance the non-specific immune system of cultured fish species, including synthetic, bacterial, animal and plant products. In order to improve inherent immunity in fish, various types of plant-active compounds such as saponin, glycyrrhizin aloe and azadirachtin have been reported. Some plants, such as volatile oils, saponins, phenolics, tannins, alkaloids, polysaccharides and polypeptides, are rich sources of compounds. The various activities of these natural plant products include anti-stress, appetizers, tonics, anti-microbials, and immunostimulants. There is a growing interest in using immunostimulants as an alternative to the drugs, chemicals and antibiotics currently being used to control fish diseases, partly because immunostimulants increase the innate (or non-specific) immune response, as

opposed to vaccines. In order to understand the molecular mechanism behind the immune system of crustaceans, genomic organization and characterization of immune-related genes and their expression through different immunostimulants (zymozan, peptidoglycan, b-glucan) have been studied over the last decade.

Commercial fish species have been intensively cultivated in narrow or enclosed areas, such as ponds, cages or tanks, under conditions of overcrowding or high density, causing adverse health effects in potentially stressful environments and infectious diseases. Infectious disease outbreaks in cultured fish have emerged as barriers to aquaculture development. These events have spread through the uncontrolled movement of live aquatic animals, resulting in pathogenic organisms being transferred between countries. Antibiotics and chemotherapy have been used in aquaculture for about 20 years to prevent or control bacterial infections. Unfortunately, due to increased antibiotic resistance in bacteria, negative effects on indigenous microflora of juveniles or adult fish, the accumulation of antibiotic residues in fish tissue and the environment causing human and animal health problems, antibiotic treatment is not successful and sustainable. In fish farming, vaccination is an effective prophylactic treatment for infectious diseases, but it can be

very costly and stressful for fish. A single vaccine is effective against only one specific type of pathogen, but, because of its complex antigenic structure, it limits the effectiveness of a wide range of pathogens. Therefore, alternative techniques for eco-friendly disease prevention have to be taken into consideration. The application of immunostimulants in aquaculture is one such promising alternative technique to strengthen fish immune systems.

3.1 Leave extract as immunostimulant

In aquaculture, scores of plant extracts have recently been tested and used in the control of bacterial and viral diseases with good results. Fourteen herbs were tested against the infection of *Aeromonas hydrophila* in *Oreochromis niloticus*, including the highest anti-microbial activity of the ethanol extract of *Psidium guajava*. Stimulation of specific and non-specific immunity and protection of the ethanol and petroleum ether extracts of *T. cordifolia* against the fish pathogen *Aeromonas hydrophila* in *Oreochromis mossambicus* was observed. The impact of *Echinacea* on the rate of growth and disease resistance in Nile tilapia was studied by Salah and Mohamed (2008). The experiment was conducted on 1200 tilapia of the Nile, raised in earth ponds. Intraperitoneal inoculation also resulted in a controlled infection with *Pseudomonas fluorescens*. A significant increase in body weight

gain, specific growth rate, haematocrit values, lysozyme activity and total leukocytic count was observed in the test group. In the experimental group prior to and postinoculation, the survival rate was significantly improved.

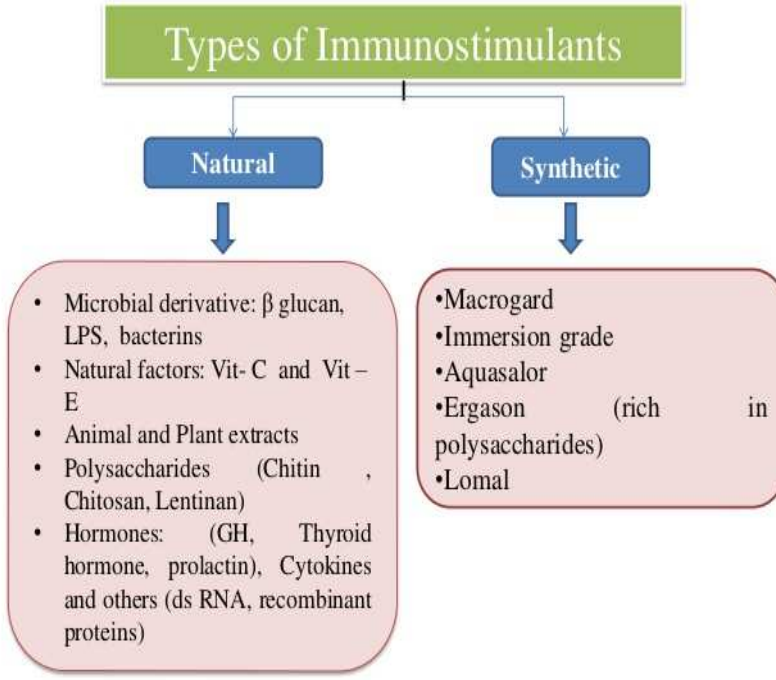


Fig. 1: Types of Immunostimulants

The phagocytic activity of leucocytes isolated from Nile tilapia was significantly increased by the extract of *Astragalus membranaceus* within 1 week of being given to the fish, and this increased activity was maintained throughout the experiment. Compared with control fish, after a challenge

with *Aeromonas hydrophila*, carp fed with *A. membranaceus* extract showed improved survival. Feeding *Oreochromis niloticus* with two herbal extracts (*A. membranaceus* and *Lonicera japonica*) has significantly increased the phagocytic and respiratory burst activity of phagocytic blood cells alone or in combination in treatment groups compared to the control group (Ardo et al. 2008).

O. sanctum acetone extract was found to improve the anti-sheep red blood cell (SRBC; sheep erythrocytes) antibody response in *O. mossambicus*, while the water extract stimulated both the specific and non-specific immune mechanisms. *O. sanctum* leaves contain phenolic compounds that are water-soluble and various other constituents, such as eugenol, methyl eugenol and caryophyllene.

The administration of *O. sanctum* leaf extract to tilapia *O. mossambicus*, simultaneously with or after vaccination, resulted in changes in the magnitude of antibody response and increased protection against experimental *A. hydrophila* infection on the day of peak antibody response (Logambal et al. 2000).

The effects of water and hexane soluble fractions of *S. trilobatum* on non-specific immune mechanisms and tilapia disease resistance revealed that, following a challenge with *Aeromonas hydrophila*, all doses of water-soluble fraction

significantly increased the production of reactive oxygen and reduced the percentage mortality rate.

Increased phagocytosis of the white blood cells resulted in the addition of plant extracts of four Chinese herbs (*Rheum officinale*, *A paniculata*, *Isatis indigotica* and *L. japonica*) to crucian carp feed. A significant increase in serum glucose, cholesterol and total protein was observed by dip treatment in goldfish with *Azadirachta indica* aqueous leaf extract.. Dip treatment with aqueous leaf extract of *A. indica* with *Cyprinus carpio* significantly increased serum protein levels and protected the fish from infection with *Aeromonas hydrophila*. In juvenile grouper, Epinephalus tauvina larviculture, methanolic extracts from the herbals *O sanctum*, *W somnifera* and *Myristica fragrans* herbs significantly enhanced the immune parameters such as phagocytic activity, serum bactericidal activity, albumin-globulin (A/G) ratio and leucocrit against *Vibrio harveyi* challenge. The acetone extracts of four plants *C. dactylon*, *A. marmelos*, W. *somnifera* and *Z. officinale* were screened for their inhibitory activity against seven fish Vibrio pathogens V. *alginolyticus, V. parahaemolyticus, V. mimicus, V. campbelli, V. vulnificus, V. harveyi and P. damselae,* and these extracts were mixed with fish feed in proper ratio; as a result, there was an enhancement in leucocrit, phagocytic and lysozyme activities in the blood of *O. mossambicus* fed with

experimental diet compared with the control diet-fed fish.

In *Fenneropenaeus indicus*, the five herbs *Acalypha indica*, *H spinosa, P kurooa, T cordifolia and Z officinale* were selected to screen for in vitro immunostimulant activity against the shrimp pathogen Vibrio harveyi, and the herbal extract improved total haemocyte count (THC), phagocytosis, haemagglutinin phenol oxidase (PO), and bacterial clearance activity. Yin et al. (2009) reported that the complementary carp vaccine with Ganoderma and Astragalus showed significantly improved phagocytic cell respiratory burst activity as well as increased plasma phagocytosis and lysozyme activity.

The specific immune response was also increased, although there were no significant differences between the vaccinated group not fed with herb extracts and the vaccinated fish fed with herb extracts. The herbal plant extracts of *A. indica*, *C. dactylon*, W. *somnifera*, *Z. officinalis* and *P. kurooa* having anti-viral and immunostimulant characteristics, which offer better growth and immunostimulation and act as anti-viral during the dual administration against the WSSV infection in Penaeus monodon. Fish fed with both herbs and vaccine showed best survival against infection with A. *hydrophila*. The herbal immunostimulants *Emblica officinalis, C. dactylon* and *Adhathoda*

vasica improved the immune system and reduced microbial infection in the goldfish *Carassius auratus*. Punitha et al. (2008) screened the herbal plant extracts of *C. dactylon, Piper longum P. niruri, Tridax procumbens* and *Z. officinalis* testing immunostimulant activity in grouper E. tauvina against V. harveyi infection, and the petroleum ether extract is very effective against vibrio pathogens in *invitro* screening. Herbal extracts have a potential application as an immunostimulant in fish culture, primarily because they can be easily prepared, are inexpensive and act against a broad spectrum of pathogens.

It is possible to administer most of the herbs and herbal extracts orally, which is the most convenient immunostimulation method. The effect is dose dependent, however, and there is always a potential for overdosing. It was observed that the plant extract could act as an immunostimulant directly on the immunopoietic cells.

3.2 Plant parts as immunostimulant

Medicinal properties are present in many parts of plant materials. In aquaculture, numerous plant materials are widely used to prevent diseases by controlling pathogenic microbes and improving immunity. *A hydrophila* infection has been controlled by garlic in rainbow trout (*O. mykiss*). At the 0.5 and 1.0 mg/g feed inclusion level, a 4 percent reduction in

mortality was observed compared to the control group.

Garlic can help in the control of bacteria and fungi and increase the welfare of fish. Nya and Austin (2009) used ginger to control an experimental infection of *A. hydrophila* in rainbow trout, and mortality was reduced to zero compared with the control group. They have also recorded the enhancement of growth rate, feed conversion and protein efficiency in the rainbow trouts fed with ginger.

Hemapriya (1997) reported that the acetone extract of P. emblica enhanced the anti-SRBC antibody response in tilapia, while Balasubramani and Michael (2002) found that both crude extracts and a water-soluble fraction of *P. emblica* fruit had a stimulatory effect on the immune response of tilapia. *P. emblica* fruit pulp contains large proportion of vitamin C, which has also been identified as an immunostimulant. Achyranthes aspera seed was incorporated into the diet of *Labeo rohita*, rohu fingerlings, and the results indicated that *A. aspera* seed stimulated immunity and increased resistance to *A. hydrophila* infection in fish. Dorucu et al. (2009) reported that black cumin seed extract enhances the total immunoglobulin level in *Oncorhynchus mykiss* after 3 weeks feeding period. Natural immunostimulants are biocompatible, biodegradable and safe for both the environment and human health. Moreover, they possess an

added nutritional value. Rainbow trout fed with *Z. officinale* (ginger) extract had significantly higher extracellular activity of phagocytic cells in blood and in trout fed with nettle, and mistletoe extracts increased the production of extracellular superoxide anion.

3.3 Herbal drugs as immunostimulators

Resveratrol (RESV; trans-3,5,40-trihydroxystilbene), a natural polyphenol, was first isolated in 1940 as a constituent of the roots of white hellebore, but since then, it has been found in various plants, including grapes, berries and peanuts. It was found that RESV strongly inhibited intracellular and extracellular myeloperoxidase (MPO) activity, behaving as a non-competitive and reversible inhibitor, and also induced a decrease in MPO mRNA levels in Turbot Psetta maxima neutrophils.

Papaya leaf meal contains an enzyme, namely papain, which increases the protein digestion, food conversion ratio, specific growth rate and weight gain in 16 % unsoaked papaya meal diet fed to P. monodon post-larvae. Edahiro et al. (1991) reported that yellowtail fish treated orally with glycyrrhizin showed increased protection against *Edwardsiella seriola* infection, although lysozyme activity of blood and phagocytic activities of macrophages were not enhanced. Glycyrrhizin is a glycosylated saponin, containing one

molecule of glycyrrhetinic acid, which has anti-inflammatory and antitumour activities, mediated by its immunomodulatory activities. Livol (IHF-1000) is a herbal growth promoter containing different plant ingredients such as Boerhavia diffusa, Solanum nigrum, Terminalia arjuna, Colosynth and black salt and has been found to significantly improve digestion, thereby leading to better growth, production and health in cultivable fishes. The herbal extracts from *Astragalus membranaceus*, *Portulaca oleracea*, *Flavescent sophora* and *A. paniculata* act as an antistressor and induce the immunological parameters such as serum lysozyme activity, SOD, NOS and levels of total serum protein, globulin and albumin in *Cyprinus carpio*. *Azadirachtin*, a triterpenoid derived from *A. indica*, enhanced respiratory burst activities, the leucocyte count and the primary and secondary antibody response against SRBC in tilapia.

3.4 Concept of Immunostimulant

Immunostimulants, also known as immunostimulators, are substances comprising of drugs and nutrients that activate the immune system by increasing activity of any of its components. During the last two decades very intensive investigations have been carried out for the production in producing a novel category of biologically active substances, the immunostimulants these are the

products derived from natural sources or synthetically made with different chemical characteristics and varied modes and mechanism of action. Immunostimulants activate different components and mechanisms of the immune system of humans and animals reinforce the body's natural resistance in order to successfully and amiably cope with various viral and bacterial infections on help in the treatment of disastrous and chronic ailments and severe immune suppression. Thus, an immunostimulant is a chemical, drug, or stressor that enhances the innate (nonspecific) immune response by interacting directly with cells of the system activating them. Immunostimulants can be grouped as chemical agents, bacterial preparations, polysaccharides, animal or plant extracts, nutritional factors and cytokines.

Immunostimulants promote synthesis of specific antibodies and cytokines and represent an emerging class of drugs for treatment of infectious disorders. The two main categories of immunostimulants include: (i) Specific immunostimulants, which provide antigenic specificity in immune response such as vaccines or any antigen. (ii) Non-specific immunostimulants, which act irrespective of antigenic specificity to augment immune response of other antigen or stimulate components of the immune system without antigenic specificity, such as adjuvants and non-

specific immunostimulators. Pathogens successfully controlled by using immunostimulants in fish are bacteria such as *Aeromonas hydrophila, Aeromonas salmonicida, Edwardsiella tarda, Edwardsiella ictaluri, Vibrio anguillarum, Vibrio vulnificus, Vibrio salmonicida, Yersinia ruckeri, Streptococcus spp.*; virus such as infectious hematopoietic necrosis, yellow head virus, viral hemorrhagic septicemia and parasite *Ichthyophthirius multifiliis*. Immunostimulants are dietary additives that enhance the innate (non-specific) defense mechanisms and increase resistance to specific pathogens.

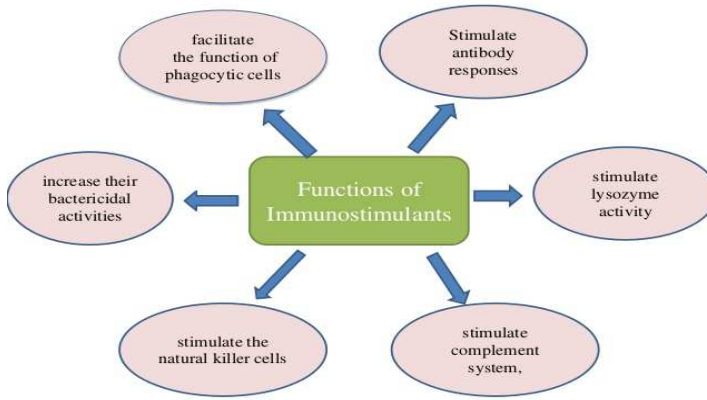


Fig. 2: Functions of Immunostimulants (https://www.slideshare.net/mandeepkaur151/immunostimulants-role-in-aquaculture)

4. HERBAL MEDICINE

Herbal medicine (HM) is the fulcrum of complementary and alternative medicine, which in recent times is increasingly gaining widespread popularity all over the world and gradually streaming toward integration into the mainstream healthcare systems. The use of HM cuts across gender, social and racial classes in both developing and developed countries of the world. Due to the increasing popularity of HM, stakes in the world markets (local and international) are also rapidly increasing and the annual sale is rapidly approaching US $62 billion. An important driver in this upsurge in patronage and use includes low cost, the wide acceptance due to its status of being a natural product with the acclaim of low toxicity, efficacy in certain challenging diseases, flexibility in its accessibility, preparation and use. HM includes preparations of biologically active natural products that consist largely of herbs or herbal materials, some recipes may contain materials such as fungal and bee products, as well as minerals (kaolin, bentonite), ash, shells, insects and animal parts, and are used for the maintenance of health and management of various diseases. HMs can elicit numerous benefits just as some can cause adverse effects. The pharmacologic and most of the toxic effects that are elicited by HMs have been linked to the activities of the

secondary metabolites.

In many instances, HMs have been appropriately used, misused and sometimes misunderstood. The benefits of HMs as a means of healthcare depends largely on the correct and adequate knowledge, and experiences while misuse as well as misunderstanding have been tracked to the knowledge gap on herbal medicines especially as it relates to their benefits and potential drawbacks by the primary healthcare professionals: doctors, pharmacists, nurses and the public. The attraction to herbal medicine will continue to increase across the globe for various reasons, hence the urgent need for appropriate and enough information on HM especially that which highlights on important topics such as benefits, efficacy, safety, toxicity, research and development, formulation, regulation, analytical techniques, quality control, economic importance, and so on. This book harnesses important information on various aspects of HM, thus, serving as a compendium to enlighten scientists, healthcare professionals and lay users appropriately.

With many people now using herbal medicine, safety issues are also becoming an important concern. Indeed, certain HM have been implicated in some important adverse events relating to cardio-, neuro- and nephro-toxicities as well cancers. Toxicity due to HMs may occur and their seriousness

may vary depending on the type of herb or herbal material, preparation and user: varying from minor to severe and sometimes fatal. Adulterations and concomitant use of herbal medicines with conventional medicines constitute another area of attention, thus, the need for a strict regulation and enlightenment and control.

4.1. Benefits of herbal medicine

Herbal medicines (HM) include herbs, herbal materials, herbal preparations and finished herbal products that contain as active ingredients parts of plants, or other plant materials, or combinations and are used especially for the prevention and treatment of diseases. In contemporary times, HM remains a major component of the primary healthcare in many rural African and Asian communities. It also constitutes an integral part of the culture of many societies of the world. Many herbs and herbal recipes have a long traditional history of folk uses and claims of health benefits. Scientific research has shown that HMs contain complex chemical compounds that are responsible for the pharmacological activities, which corresponds to health benefits and/or toxicity they elicit. HMs have been used as prophylaxes for the passive maintenance of health as well as for radical treatment of varieties of mild to serious diseases.

In contemporary times, HMs are prepared and used in

different forms, which also affect their activity outcomes.

The dosage form of herbal medicines varies widely depending on such factors as the type of disease to be treated, route of application, patient, culture and even philosophical backgrounds. In homes and traditional medicine clinics, HMs are prepared often from fresh or dried herbs which are commonly made into infusions, decoctions, poultices, powders to be poured into open wounds or incorporated into native beverages, puddings, and so on. Conventional commercial HMs products are commonly available as pills, capsules, tablets, powders/granules, creams, ointments, and so on. The presentation of HMs in pharmaceutical dosage forms is expected to enhance accurate dosing, esthetics as well as compliance by enticing usage.

Safety and efficacy is another important factor overriding the use and commercialization of HMs. The quality of herbal products is essentially dependent on the safety and efficacy of the herbal material in relation to the intrinsic chemical components, type of contaminants as well as the production processing. The chemical compounds that are contained in herbal materials have shown a wide range of benefits in the management of various diseases including challenging diseases/conditions such as HIV/AIDS, cancer, sickle cell disease, malaria and other infectious diseases as well

as noninfectious diseases such as diabetes, obesity, infertility, and so on. Despite the wide acceptance, benefits and sometimes the misconceptions: there is a compelling need for a decisive control of HMs to ensure that enough and correct information on herbal materials and herbal products are always available to especially healthcare providers and the general public particularly on subjects such as identification, quality, safety and efficacy of the HM.

4.2. Poly herbal

In contrast to the pharmaceutical drugs which often consist primarily of single chemical entity (pure compounds), HMs are typically made up of numerous compounds usually in the crude, unpurified state. Many finished herbal products are made from folk recipes often containing more than one herbal material as the active component. The polynomial constitution of most HMs may be the reason for many of their benefits. The constituent polynomial ingredients of many HMs as indicated in many folk recipes are often important for the completeness of the product if desired effects are to be produced. The multicomponent ingredients may boost benefits by enhancing simultaneously certain important pharmacological activities such as absorption, distribution, metabolism and elimination of bioactive components. Also, some constituents may act on more than

one receptor or physiological system: probably the reason why many HMs show a wide range of therapeutic benefits.

4.3. Efficacy

In general, HMs are used for cure, mitigation, treatment and prevention of diseases especially those endemic to the local environment of the herbs. Numerous plants species with folk claims of health benefits/cure abound, however only few have scientific proof or corroboration of efficacy. All the activities of HMs benefits and toxicities are linked to the presence of especially the secondary metabolites. The increasing attention on HM has also stimulated increased research in this area resulting in more information as far as efficacy and folk claims are concerned. Many research efforts have corroborated claims resulting in the commercialization of many herbal products and their nomination as leads in the development of pharmaceutical drugs. Nevertheless, many native HMs still remain untested and their benefits unauthenticated.

The limited knowledge on these products has made information on the therapeutic benefits and side effects very limited thus heightening the doubt of their health benefits. It is also common knowledge that many people use HM concurrently with pharmaceutical drugs and for many HM information on the likely outcome of this practice is not

available because no study has been carried out. Hence, there is a need for information regarding the likely outcomes of the interactions of sundry HM and the commonly used conventional medicines. This information should be generated during the research and development stage of all commercialized HM and enforced by regulation. Such interactions should also be disclosed in package inserts of products.

4.4 Secondary metabolites

The pharmacological activities of HMs are responsible for their benefits and for most of their toxicities. These bioactivities are essentially due to the presence of certain complex chemical entities: the secondary metabolites. While some are responsible for the radical active actions, others act as buffers which modulate and modify the pharmacological actions produced by active components to make them less toxic or more active. This is probably responsible for the reason why several plant extracts or recipes may not be reproduced by the isolated purified chemical constituents of the herb or recipe. The various complex compounds elicit a long range of different activities in man and, animal models and cell cultures. In many instances the degree of activities of the active secondary metabolites vary depending on such factors as the plant

species, parts of the plant, geographic origin, time of collection, method of preparation, amount ingested, and so on.

Plant secondary metabolites (PSM) are a large group of compounds that are synthesized and concentrated optimally in certain plant species and organ. The primary functions of these compounds in the plants in which they occur includes defense against such adversaries as herbivores, bacteria, fungi and viruses. Many also show variable degrees of antioxidants and UV protectants effect against harmful elements, while some also play important roles during pollination to attract pollinating and seed-dispersing factors or signaling agents. This wide group of chemicals contains reactive functional groups in their chemical structures that are capable of forming covalent bonds with other biocompounds such as proteins, peptides and sometimes DNA. PSMs are primarily organic compounds and can simply be grouped into three major classes, terpenes: volatiles, cardiac glycosides, carotenoids and sterols; phenolics: phenolic acids, coumarins, lignans, stilbenes, flavonoids, tannins and lignin; nitrogen containing compounds: alkaloids and glucosinolates.

4.5 Health benefits of herbal medicines

Correspondingly to conventional medicines, the indications of folk HMs are diverse, being employed for the

treatment of a wide range of diseases. The indications spread from simple health conditions such as cold, pain, surface wounds to serious conditions such as psychosis, diabetes, malaria, sickle cell disease, tuberculosis, cancer, hypertension, infertility, and so on. In certain communities, HM is a major component of the primary healthcare. Indeed, up to 80% of the rural population in Africa use herbal-based traditional medicines for most of their healthcare. In Ghana, Mali, Nigeria and Zambia, the first line of treatment for 60% of children with high fever resulting from malaria and other diseases is HM, which are often administered at home. Rural South Africa also has a strong culture of traditional medicine that is based on HM.

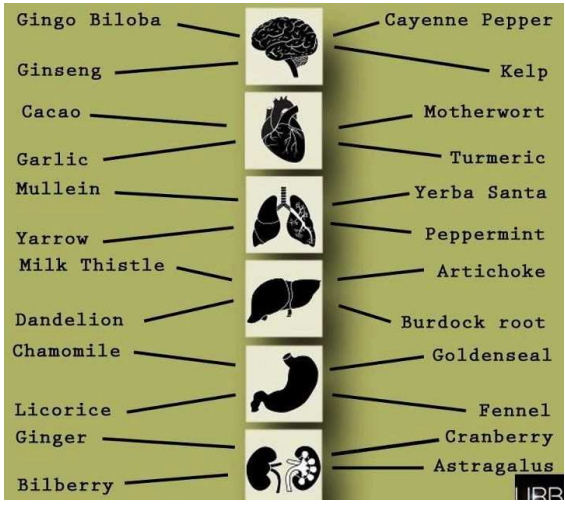


Fig. 2: Herbs for Organs

In China and India, HM accounts for about 50% of the total health product consumption. With the increasing attention to HM all over the world, the list of medicinal herbs and products is increasing so also is the consumption rate even in societies where conventional healthcare is available and easy to access. Also, in the USA, about 40% of the adult population has used herbal medicine. The sales output of HM in Canada , Australia and Europe especially in Germany and France is rapidly increasing.

5. CHEMICAL CONSTITUENTS OF HERBAL MEDICINES

All living organisms produce numerous chemical substances that are termed natural products. Those natural products that are common to all life forms are known collectively as primary metabolites and are exemplified by carbohydrates, proteins and fats. Thus, many of the chemical building blocks of primary metabolism are found in all medicinal plants (e.g. amino acids, common sugars, such as glucose, and fatty acids). In addition to primary metabolites, plants also produce other compounds with a more restricted distribution and these are referred to collectively as secondary metabolites. Plants are a rich source of secondary metabolites and some of these are of such limited distribution that they are found only in a particular genus or even in only a single species. On the other hand, some secondary metabolites are widely distributed throughout many of the plant families. It is not always understood why particular plants produce specific secondary metabolites, but some of them are known to have definite functions; for example, some are toxic and form a defence against predators, while some are attractive to insects and aid pollination. Whatever their roles are within plants, many of them have pharmacological actions and this has been exploited to provide medicinal drugs such as codeine,

morphine, digoxin and quinine. Some secondary metabolites have proved to be too toxic for human use (e.g. aconitine from aconite), but investigations of their mode of action have stimulated research into synthetic analogues as potential therapeutic agents.

For more details of plant secondary metabolites, the reader is recommended to consult specialist texts, for example on the biosynthesis of medicinal natural products, on scientific background to herbal medicines and on specific chemical structure, Dictionary of Natural, Numerous secondary metabolites are derived from a common biosynthetic precursor; for example, shikimic acid is involved in the formation of coumarins, lignans, phenylpropanes and tannins. Although each of these groups of secondary metabolites is different chemically they all contain a common structural feature, namely a C6–C3 moiety. Among the most prevalent of secondary metabolites are alkaloids, glycosides and phenols. Examples of these types of secondary metabolite can be found in many of the medicinal plants.

5.1 Alkaloids

A typical alkaloid is chemically basic (alkaline) and contains a secondary or tertiary amine function within a heterocyclic ring (e.g. codeine). Alkaloids may be classified by their chemical skeleta (Figure 1) into the following major

types: pyrrolidine (e.g. betonicine from white horehound); pyridine (e.g. gentianine from gentian); piperidine (e.g. lobeline from lobelia); pyrrolizidine (e.g. symphytine from comfrey); quinolizidine (e.g. sparteine from broom); quinoline (e.g. quinine from cinchona); isoquinoline (e.g. boldine from boldo); indole (e.g. harman from passionflower); tropane (e.g. hyoscine from belladonna); imidazole (e.g. pilocarpine from jaborandi); and xanthine (e.g. caffeine from maté). Biosynthetically related compounds that do not follow the above definition of an alkaloid may also be referred to as alkaloids, for example phenylalkylamines that do not contain an N-heterocyclic ring (e.g. ephedrine from ephedra), or that are not basic (e.g. colchicine from colchicum). Examples of medicinal plants that contain alkaloids. For further information on alkaloids the reader is referred to other texts.

5.2 Glycosides

A glycoside consists of two components, an aglycone (non-sugar) part and a sugar part. The aglycone portion may be of several different types of secondary metabolite, including coumarin (scopolin from horse-chestnut), flavonoid (e.g. rutin from buchu), or hydroxyanthracene. The sugar moiety is linked to the aglycone by a direct carbon-to-carbon bond (C-glycoside), or through an oxygen-to-carbon bond (O-glycoside). Cyanide glycosides, (e.g. amygdalin from

apricot) release toxic hydrogen cyanide when cells are damaged and act as a defence mechanism. Glucosinolates (e.g. sinigrin from horseradish) contain nitrogen and sulfur and are pungent. Hydroxyanthracene glycosides are the active principles of the laxative herbs cascara and senna.

5.3 Phenolics

Many of the aromatic constituents of plants contain hydroxyl substituents and are phenolic. There is a wide variety of phenolics in medicinal plants and they range in chemical structure from simple phenolic acids, e.g. caffeic acid from artichoke, to complex tannins. Where chemical structures are included in a monograph they may be the active principles or they may be compounds that can be used as chemical markers for that plant, i.e. they are present in significant quantities or are otherwise characteristic for a particular plant. As some compounds are of common occurrence in medicinal plants, their chemical structures are not necessarily included within a monograph.

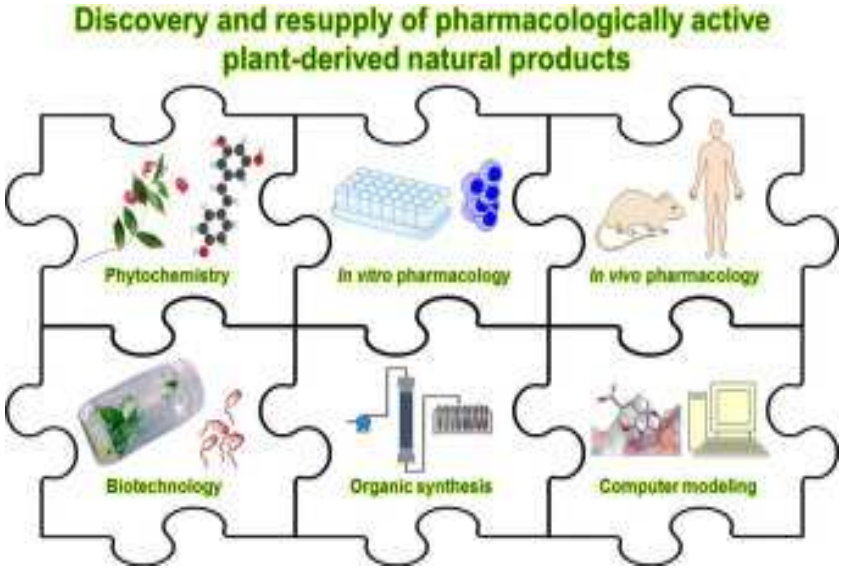


Fig 3. Active plant derived of Herbal products

5.4 Terpenes

Terpenes are derived from two C5 units (isopentane), dimethylallylpyrophosphate and isopentenylpyrophosphate. The monoterpenes contain two isopentane units (C10) and are constituents of many volatile oils. Some of the more common monoterpenes are shown in Figure 4. Sesquiterpenes contain three isopentane units (C15) and occur as different skeletal types, e.g. eudesmane, germacrene, guaiane. A large number of sesquiterpenes contain a g-lactone ring and these are known as sesquiterpene lactones. Some sesquiterpene lactones are allergenic. Examples of different skeletal types of molecule, including eudesmolide,

germacranolide and guaianolide (e.g. constituents of comfrey) and pseudoguaianolide (e.g. matricine, chamomile), are illustrated in Figure 5. Diterpenes are derived from four isopentane units (C20) and examples of abietane (e.g. carnosic acid from sage), daphnane, kaurene, labdane (e.g. rotundifarine from agnus castus), taxane and tigliane are given in Figure 6. The ginkgolides from ginkgo are examples of complex diterpenes. Triterpenes are derived from six isopentane units (C30), and some commonly occurring compounds are illustrated in Figure 7, e.g. campesterol, b-sitosterol, stigmasterol, a- and b-amyrin, oleanoic and ursolic acids.

5.5 Flavonoids

Flavonoids are biosynthesised from a phenylpropane unit (C6–C3), derived via shikimic acid and phenylalanine, and a C6 unit from three molecules of malonyl–CoA. They are widely distributed in the plant kingdom and occur in many medicinal plants. There are five major types: chalcones, flavanones, flavones, flavonols and anthocyanins. The flavones and their 3-hydroxy analogues (flavonols) are the most widespread. The five aglycones kaempferol, quercetin, myricetin, apigenin and luteolin, as well as the quercetin glycosides quercitrin and rutin are among the most commonly present in medicinal plants.

5.6 Tannins

Tannins are also common constituents of many medicinal plants and they occur as two major types –the hydrolysable tannins and the non-hydrolysable (condensed) tannins. The hydrolysable tannins are esters of sugars with phenolic acids and they are either gallotannins (galloyl esters of glucose), e.g. pentagalloyl glucose, or ellagitannins (hexahydrodiphenic acid, derived from two units of gallic acid, esters with glucose), e.g. agrimoniin from agrimony. Non-hydrolysable tannins, also known as condensed tannins or proanthocyanidins, are polymers of catechin or gallocatechin linked by C–C bonds (e.g. cola tannins).

6. PLANTS USED AS MEDICINE

The ability to synthesize a wide variety of chemical compounds that are used to perform important biological functions, and to defend against attack from predators such as insects, fungi and herbivorous mammals is called herbal medicine. Many of these phytochemicals have beneficial effects on long-term health when consumed by humans, and can be used to effectively treat human diseases. At least 12,000 such compounds have been isolated so far; a number estimated to be less than 10% of the total.

These phytochemicals are divided into (1) primary metabolites such as sugars and fats, which are found in all plants; and (2) secondary metabolites compounds which are found in a smaller range of plants, serving a more specific function. For example, some secondary metabolites are toxins used to deter predation and others are pheromones used to attract insects for pollination. It is these secondary metabolites and pigments that can have therapeutic actions in humans and which can be refined to produce drugs examples are inulinfrom the roots of dahlias, quinine from the cinchona, morphine and codeine from the poppy, and digoxin from the foxglove.

Chemical compounds in plants mediate their effects on the human body through processes identical to those already well understood for the chemical compounds in conventional drugs; thus herbal medicines do not differ greatly from conventional drugs in terms of how they work. This enables herbal medicines to be as effective as conventional medicines, but also gives them the

same potential to cause harmful side effects.

In Europe, apothecaries stocked herbal ingredients for their medicines. In the Latin names for plants created by Linnaeus, the word officinalis indicates that a plant was used in this way. Ayurvedic medicine, herbal medicineand traditional Chinese medicine are other examples of medical practices that incorporate medical uses of plants. Pharmacognosy is the branch of modern medicine about medicines from plant sources. Plants included here are those that have been or are being used medicinally, in at least one such medicinal tradition

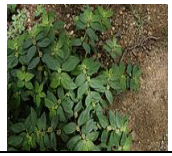
7. LIST OF PLANTS

Scientific name	Name	Description	Picture
Acacia senegal	Gum arabic	A natural gum sourced from hardened sap of various species of acacia tree used as a binder and emulsifier.	
Achillea millefolium	Common yarrow	Purported to be a Diaphoretic, Astringent, Tonic, Stimulant And Mild Aromatic	
Actaea racemosa	Black cohosh	Historically used for arthritis and muscle pain, used more recently for conditions related to menopause and menstruation.	
Aesculus hippocastanum	Horse chestnut	Its seeds, leaves, bark, and flowers have been used medicinally for many centuries. The raw plant materials are toxic unless processed.	
Ageratina altissima	White snakeroot	Root tea has been used to treat diarrhea, kidney stones, and fever. A root poultice can be used on snakebites.	

Scientific name	Name	Description	Picture
Alcea rosea	Common hollyhock	Believed to be an emollient and laxative. It is used to control inflammation, to stop bedwetting and as a mouthwash in cases of bleeding gums.	
Alisma plantago-aquatica	Water-plantain	Used for the urinary tract.	
Allium sativum	Garlic	Widely used as an antibiotic and, more recently, for treating cardiovascular disease Garlic is a monoamine oxidase inhibitor and has antidepressant-like effects on mice so might be used as a herbal antidepressant or anxiolytic in humans.	
Aloe vera	Aloe vera	Leaves are widely used to heal burns, wounds and other skin ailments.	
Althaea officinalis	Marsh-mallow	Used for over 2,000 years as both a food and a medicine	

Scientific name	Name	Description	Picture
Amorphophallus konjac	Konjac	Significant dietary source of glucomannan, which is used in treating obesity, constipation, and reducing cholesterol.	
Anemone hepatica	Common hepatica	Historically used to treat liver diseases, it is still used in alternative medicine today. Other modern applications by herbalists include treatments for pimples, bronchitis and gout.	
Angelica archangelica	Garden angelica	Roots have been used in the traditional Austrian medicine internally as tea or tincture for treatment of disorders of the gastrointestinal tract, respiratory tract, nervous system, and also against fever, infections, and flu.	
Angelica sinensis	Dong quai	Used for thousands of years in Asia, primarily in women's health.	
Apium graveolens	Celery	Seed is used only occasionally in tradition medicine. Modern usage is primarily as a diuretic.	

Arnica montana	Arnica	Used as an anti-inflammatory and for osteoarthritis. The US Food and Drug Administration has classified *Arnica montana* as an unsafe herb because of its toxicity.	
Astragalus propinquus	Astragalus	Long been used in traditional Chinese medicine to strengthen the immune system, and is used in modern China to treat hepatitis and as an adjunctive therapy in cancer.	
Atropa belladonna	Belladonna	Although toxic, was used historically in Italy by women to enlarge their pupils, as well as a sedative, among other uses. The name itself means "beautiful woman" in Italian.	
Azadirachta indica	Neem	Used in India to treat worms, malaria, rheumatism and skin infections among many other things. Its many uses have led to neem being called "the village dispensary" in India.	
Bellis perennis	Daisy	Flowers have been used in the traditional Austrian medicine internally as tea (or the leaves as a salad) for treatment of disorders of the gastrointestinal and respiratory tract.	
Berberis vulgaris	Barberry	Long history of medicinal use, dating back to the Middle Agesparticularly among Native Americans.	

Scientific name	Name	Description	Picture
Borago officinalis	Borage	Used in hyperactive gastrointestinal, respiratory and cardiovascular disorders, such as gastrointestinal (colic, cramps, diarrhea), airways (asthma, bronchitis), cardiovascular, (cardiotonic, antihypertensive and blood purifier), urinary.	
Broussonetia kurzii	Salae	Known as *Salae* in Thailand where this species is valued as a medicinal plant.	
Calendula officinalis	Marigold	Also named calendula, has a long history of use in treating wounds and soothing skin	
Cannabis	Cannabis	Used worldwide since ancient times as treatment for various conditions and ailments including pain, inflammation, gastrointestinal issues such as IBS, muscle relaxation, anxiety, Alzheimer's and dementia, ADHD, autism, cancer, cerebral palsy, recurring headaches, Crohn's disease, depression, epilepsy, glaucoma, insomnia, and neuropathy	

Scientific name	Name	Description	Picture
Capsicum annuum	Cayenne	Type of chili that has been used as both food and medicine for thousands of years. Uses have included reducing pain and swelling, lowering triglyceride and ch olesterol levels and fighting viruses and harmful bacteria, due to high levels of Vitamin C.	
Capsicum frutescens	Chili	Its active ingredient, capsaicine, is the basic of commercial pain-relief ointments in Western medicine. The low incidence of heart attack in Thais may be related to capsaicine's fibronolytic action(dissolving blood clots).	
Carica papaya	Papaya	Used for treating wounds and stomach troubles.	
Cassia occidentalis	Coffee senna	Used in a wide variety of roles in traditional medicine, including in particular as a broad-spectrum internal and external antimicrobial, for liver disorders, for intestinal worms and other parasites and as an immune-system stimulant.	
Catha edulis	Khat	Mild stimulant used for thousands of years in Yemen, and is banned today in many countries. Contains the amphetamine-like substance cathinone.	

Scientific name	Name	Description	Picture
Cayaponia espelina	São Caetano melon	It is a diuretic and aid in the treatment of diarrhea and syphilis.	
Centaurea cyanus	Cornflower	In herbalism, a decoction of cornflower is effective in treating conjunctivitis and as a wash for tired eyes.	
Chrysopogon zizanioides	Vetiver	Used for skin care.	
Cinchona spec.	Cinchona	Genus of about 38 species of trees whose bark is a source of alkaloids, including quinine. Its use as a febrifuge was first popularized in the 17th century by Peruvian Jesuits.	
Citrus × aurantium	Bitter orange	Used in traditional Chinese medicine and by indigenous peoples of the Amazon for nausea, indigestion and constipation.	
Digitalis lanata	Digitalis or foxglove	It came into use in treating cardiac disease in late 18th century England in spite of its high toxicity. Its use has been almost entirely replaced by the pharmaceutical derivative Digoxin, which has a shorter half-life in the	

		body, and whose toxicity is therefore more easily managed.	
Echinacea purpurea	Purple coneflower	This plant and other species of *Echinacea* have been used for at least 400 years by Native Americans to treat infections and wounds, and as a general "cure-all" (panacea). It is currently used for symptoms associated with cold and flu	
Equisetum arvense	Horsetail	Dates back to ancient Roman and Greek medicine , when it was used to stop bleeding, heal ulcers and wounds, and treat tuberculosis and kidne y problems.	
Eriodictyon crassifolium	Yerba Santa	Used by the Chumash people to keep airways open for proper breathing.	
Eschscholzia californica	Californian poppy	Used as an herbal remedy: an aqueous extract of the plant has sedative and anxiolytic a ctions	
Eucalyptus globulus	Eucalyptus	Leaves were widely used in traditional medicine as a febrifuge. Eucalyptus oil is commonly used in over-the-counter cough and cold medications, as well as for an analgesic.	

Euonymus atropurpureus	Wahoo	Plant is a purgative and might affect the heart.	
Euphorbia hirta	Asthma-plant	Used traditionally in Asia to treat bronchitic asthma and laryngeal spasm. It is used in the Philippines for dengue fever.	
Euterpe oleracea	Açai	Although açai berries are a longstanding food source for indigenous people of the Amazon, there is no evidence that they have historically served a medicinal, as opposed to nutritional role. In spite of their recent popularity in the United States as a dietary supplement, there is currently no evidence for their effectiveness for any health-related purpose.	
Frangula alnus	Alder buckthorn	Bark (and to a lesser extent the fruit) has been used as a laxative, due to its 3 – 7% anthraquinone content. Bark for medicinal use is dried and stored for a year before use, as fresh bark is violently purgative; even dried bark can be dangerous if taken in excess.	
Fumaria officinalis	Fumitory	Traditionally thought to be good for the eyes and to remove skin blemishes. In modern times herbalists use it to treat skin	

		diseasesand conjunctivitis, as well as to cleanse the kidneys. However, Howard (1987) warns that fumitory is poisonous and should only be used under the direction of a medical herbalist.	
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Galanthus	Snowdrop	It contains an active substance called galantamine, which is an acetylcholinesterase inhibitor. Galantamine (or galanthamine) can be helpful in the treatment of Alzheimer's disease, though it is not a cure.	
Geranium robertianum	Robert geranium	In traditional herbalism, it was used as a remedy for toothache and nosebleeds[83] and as a vulnerary (used for or useful in healing wounds).	
Ginkgo biloba	Ginkgo	The leaf extract has been used to treat asthma, bronchitis, fati gue, Alzheimer's and tinnitu s.	

Glechoma hederacea	Ground-ivy	It has been used as a "lung herb".Other traditional uses include as an expectorant, astringent, and to treat bronchitis. The essenti al oil of the plant has been used for centuries as a general tonic for colds and c oughs, and to relieve congestion of the mucous membranes.	
Glycyrrhiza glabra	Licorice root	It has a long history of medicinal usage in Eastern and Western medicine. Uses include stomach ulcers, bronchitis, and sore throat, as well as infections caused by viruses, such as hepatitis.	
Hamamelis virginiana	Common witch-hazel	It produces a specific kind of tannins called *hamamelitannins*. One of those substances displays a specific cytotoxic activity against colon cancer cells.	
Hippophae rhamnoides	Sea buckthorn	The leaves are used as herbal medicine to alleviate cough and fever, pain, and general gastrointestinal disorders as well as to cure dermatologic disorders. Similarly, the fruit juice and oils can be used in the treatment of liver disease, gastrointestinal disorders, chronic wounds or other dermatological disorders.	
Hydrastis canadensis	Goldenseal	It was used traditionally by Native Americans to treat skin diseases, ulcers, and gonorrhea. More recently, the herb has been used to treat the respiratory	

		tract and a number of other infections.	
Hypericum perforatum	St. John's wort	Widely used within herbalism for depression. Evaluated for use as an antidepressant, but with ambiguous results.	
Hyssopus officinalis	Hyssop	It is used for digestive and intestinal problems including liver and gallbladder conditions, intestinal pain, intestinal gas, colic, and loss of appetite. It is also used for respiratory problems including coughs, the common cold, respiratory infections, sore throat, and asthma.	
Ilex paraguariensis	Yerba mate	It has been claimed to have various effects on human health and these effects have been attributed to the high quantity of polyphenols found in mate tea. Mate contains compounds that act as an appetite suppressant, increases mental energy and focus, and improves mood.[100] Yerba mate also contains elements such as potassium, magnesium, and manganese.	

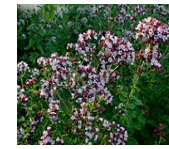
Scientific name	Name	Description	Picture
Illicium verum	Star anise	It is the major source of the chemical compound shikimic acid, a primary precursor in the pharmaceutical synthesis of anti-influenzadrug	
Inula helenium	Elecampane	It is used in herbal medicine as an expectorant and for water retention.	
Jasminum officinale	Jasmine	It is used in dermatology as either an antiseptic or anti-inflammatory agent.	
Knautia arvensis	Field scabious	The whole plant is astringent and mildly diuretic. An infusion is used internally as a blood purifier and externally for treating cuts, burns and bruises.	
Larrea tridentata	Chaparral	The leaves and twigs are used by Native Americans to make a herbal tea used for a variety of conditions, including arthritis, cancer an d a number of others. Subsequent studies have been extremely variable, at best. Chaparral has also been shown to have high liver toxicity, and has led to kidney failure, and is not recommended for any use by the U.S. Food and Drug Administration (FDA)	

Scientific name	Name	Description	Picture
Laurus nobilis	Bay laurel	Aqueous extracts of bay laurel can be used as astringents and even as a reasonable salve for open wounds. In massage therapy, the essential oil of bay laurel is reputed to alleviate arthritis and rheumatism, while in aromatherapy it is used to treat earaches and high blood pressure.	
Lavandula angustifolia	Lavender	It was traditionally used as an antiseptic and for mental healthpurposes. It was also used in ancient Egypt in mummifying bodie s. There is little scientific evidence that lavender is effective for most mental health uses.	
Lawsonia inermis	Henna	The plants exhibits potential antibacterial activity. The alcoholic extract of the root has antibacterial activity due to the presence of flavonoid and alkaloids. Henna is also thought to show anti-inflammatory, antipyretic, and analgesic effects in experimental animals.	
Leucojum aestivum	Summer snowflake	It is known to contain Galantamine (Nivalin, Razadyne, Razadyne ER, Reminyl, Lycoremine in pharmaceutical format). It is used for the treatment of mild to moderate	

		Alzheimer's disease and various other memory impairments, in particular those of vascular origin.	
Magnolia officinalis	Magnolia-bark	The bark contains magnolol and hono kiol, two polyphenolic compounds. Preclinical studies have evaluated their various potential applications including antioxidant, anti-inflammatory, antitumor, and antimicrobial properties.	
Malva sylvestris	Mallow	The seeds are used internally in a decoction or herbal tea as a demulcent and diuretic, and the leaves made into poultices as an emollient for external applications.	
Matricaria recutita and *Anthemis nobilis*	Chamomile	It has been used over thousands of years for a variety of conditions, including sleeplessness, anxiety, and gastrointestinal conditions such as upset stomach, gas, and diarrhea.	
Medicago sativa	Alfalfa	The leaves are used to lower cholesterol, as well as forum kidneyand urinary tract ailments, although there is insufficient scientific evidence for its efficacy.	

Melaleuca alternifolia	Tea tree oil	It has been used medicinally for centuries by Australian aboriginal people. Modern usage is primarily as an antibacterial or antifungal agent.	
Melissa officinalis	Lemon balm	It is used as a sleep aid and digestive aid.	
Mentha × piperita	Peppermint	Its oil, from a cross between water mint and spearmint, has a history of medicinal use for a variety of conditions, including nausea, indigestio n, and symptoms of the common cold.	
Mitragyna speciosa	Kratom	Kratom is known to prevent or delay withdrawal symptoms in an opioid-dependent individual, and it is often used to mitigate cravings thereafter. It can also be used for other medicinal purposes. Kratom has been traditionally used in regions such as Malaysia, Thailand, and Indonesia.	
Momordica charantia	Bitter melon	The plant is used as an agent to reduce the blood glucose level.	
Morinda citrifolia	Noni	It has a history of use as for joint pain and skin conditions.	

Scientific name	Name	Description	Picture
Nasturtium officinale	Watercress	It may be diuretic and antibacterial.	
Nelumbo nucifera	Lotus	Sacred lotus has been the subject of a number of in-vitro and animal studies, exploring its pharmacologic effects, including antioxidant, hepatoprotective, immunomodulatory, anti-infective, hyperlipidemic, and psychopharmacologic activity, although clinical trials are lacking.	
Nigella sativa	Nigella, black-caraway, black-cumin, and *kalonji*	It has efficacy as a therapy, mainly using the seed oil extract, volatile oil, and isolated constituent thymoquinone.[125] One meta-analysis of clinical trials concluded that *N. sativa* has a short-term benefit on lowering systolic and diastolic blood pressure.	
Moringa oleifera	Drumstick tree	It is used for food and traditional medicine. It is undergoing preliminary research to investigate potential properties of its nutrients and phytochemicals	

Nasturtium officinale	Watercress	It may be diuretic and antibacterial.	
Ocimum tenuiflorum	Tulsi or Holy Basil	It is used for a variety of purposes in medicine tulasi is taken in many forms: as herbal tea, dried powder, fresh leaf or mixed with ghee. Essential oil extracted from Karpoora tulasi is mostly used for medicinal purposes and in herbal cosmetics.	
Oenothera	Evening primrose	Its oil has been used since the 1930s for eczema, and more recently as an anti-inflammatory.	
Origanum vulgare	Oregano	Used as an abortifacient in folk medicine in some parts South American countries, though no evidence of efficacy exists in Western medicine. Hippocrates used oregano as an antiseptic, as well as a cure for stomach and respiratory ailments.	
Panax spec.	Ginseng	Used medicinally, in particular in Asia, for over 2,000 years, and is widely used in modern society.	

Papaver somniferum	Opium poppy	The plant is the plant source of morphine, used for pain relief. Morphine made from the refined and modified sap is used for pain control in terminally ill patients. Dried sap was used as a traditional medicine until the 19th century.	
Passiflora	Passion flower	Thought to have anti-depressant properties. Unknown MOA. Used in traditional medicine to aid with sleep or depression.	
Peganum harmala	Syrian Rue (aka Harmal)	Can be used as an antidepressant, but carries significant risk. Used in traditional shamanistic rites in the amazon, and is a component of Ayahuasca, Caapi or Yajé (which is actually usually *Banisteriopsis caapi* but has the same active alkaloids).	
Pelargonium sidoides	Umckaloabo, or South African Geranium	It is used in treating acute bronchitis	
Piper methysticum	Kava	The plant has been used for centuries in the South Pacific to make a ceremonial drink with sedative and anesthetic pro perties. It is used as a soporific, as well as for asthma and urinary tract infection	
Plantago lanceolata	Plantain	It is used frequently in herbal teas and other herbal remedies.[134]A tea from the leaves is used as a highly effective cough medicine. In the traditional Austrian medicine *Plantago lanceolata* leaves	

		have been used internally (as syrup or tea) or externally (fresh leaves) for treatment of disorders of the respiratory tract, skin, insect bites, and infections.	
Platycodon grandiflorus	Platycodon, balloon flower	The extracts and purified platycoside compounds (saponins) from the roots may exhibit neuroprotective, antimicrobial, anti-inflammatory, anti-cancer, anti-allergy, improved insulin resistance, and cholesterol-lowering properties.	
Polemonium reptans	Abscess root	It is used to reduce fever, inflammation, and cough.	
Psidium guajava	Guava	It has a rich history of use in traditional medicine. It is traditionally used to treat diarrhea; however, evidence of its effectiveness is very limited.	
Ptelea trifoliata	Wafer Ash	The root bark is used for the digestive system. Also known as hoptree.	
Quassia amara	Amargo, bitter-wood	A 2012 study found a topical gel with 4% *Quassia* extract to be a safe and effective cure of rosacea.	

Reichardia tingitana	False sowthistle	Uses in folk medicine have been recorded in the Middle East, its leaves being used to treat ailments such as constipation, colic and inflamed eyes.	
Rosa majalis	Cinnamon rose	It yields edible hip fruits rich in vitamin C, which are used in medicine and to produce rose hip syrup.	
Rosmarinus officinalis	Rosemary	It has been used medicinally from ancient times.	
Ruellia tuberosa	Minnieroot, fever root, snapdragon root	In folk medicine and Ayurvedic medicine it has been used as a diuretic, anti-diabetic, antipyretic, analgesic, an tihypertensive, gastroprotective, and to treat gonorrhea.	
Rumex crispus	Curly dock or yellow dock	In Western herbalism the root is often used for treating anemia, due to its high level of iron. The plant will help with skin conditions if taken internally or applied externally to things like itching, scrofula, and sores. It is also used for respiratory conditions, specifically those with a tickling cough that is worse when exposed to cold air. It mentions also passing pains, excessive itching, and that it helps enlarged lymphs.	

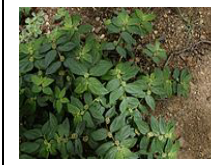
Salix alba	White willow	Plant source of salicylic acid, white willow is like the chemical known as aspirin, although more likely to cause stomach upset as a side effect than aspirin itself which can cause the lining in your stomach to be destroyed. Used from ancient times for the same uses as aspirin.	
Salvia officinalis	Sage	Shown to improve cognitive function in patients with mild to moderate Alzheimer's disease	
Sambucus nigra	Elderberry	The berries and leaves have traditionally been used to treat pain, swelling, infections, c oughs, and skin conditions and, more recently, flu, common cold, fevers, constipation, and sinus infections.	
Santalum album	Indian sandalwoo d	Sandalwood oil has been widely used in folk medicine for treatment of common colds, bronchitis, skin disorders, heart ailments, general weakness, fever, infection of the urinary tract, inflammation of the mouth and pharynx, liver and gallbladder complaints and other maladies.	
Santolina chamaecyparis sus	Cotton lavender	Most commonly, the flowers and leaves are made into a decoctionused to expel intestinal parasites.	

Saraca indica	Ashoka tree	The plant is used in Ayurvedic traditions to treat gynecological disorders. The bark is also used to combat oedema or swelling.	
Satureja hortensis	Summer savory	Its extracts show antibacterial and antifungal effects on several species including some of the antibiotic resistant strains.	
Satureja hortensis	Summer savory	Its extracts show antibacterial and antifungal effects on several species including some of the antibiotic resistant strains.	
Sceletium tortuosum	Kanna	African treatment for depression. Suggested to be an SSRI or have similar effects, but unknown mechanism of activity.	
Senna auriculata	Avaram senna	The root is used in decoctions against fevers, diab etes, diseases of urinary system and constipation. The leaves have laxativeproperties. The dried flowers and flower buds are used as a substitute for tea in case of diabetes patients. The powdered seed is also applied to the eye, in case of chronic purulent conjunctivitis.	

Sesuvium portulacastrum	Shoreline purslane	The plant extract showed antibacterial and anticandidal activities and moderate antifungal activity.	
Silybum marianum	Milk thistle	It has been used for thousands of years for a variety of medicinal purposes, in particular liver problems.	
Stachytarpheta cayennensis	Blue snakeweed	Extracts of the plant are used to ease the symptoms of malaria. The boiled juice or a tea made from the leaves or the whole plant is taken to relieve fever and other symptoms. It is also used for dysentery, pain, and liver disorders. A tea of the leaves is taken to help control diabetes in Peru and other areas.[159]Laboratory tests indicate that the plant has anti-inflammatory properties	
Stellaria media	Common chickweed	It has been used as a remedy to treat itchy skin conditions and pulmonary diseases. 17th century herbalist John Gerardrecommended it as a remedy for mange. Modern herbalistsprescribe it for iron-deficiency anemia (for its high iron content), as well as for skin diseases, bronchitis, rheumatic p ains, arthritis and period pain.	
Strobilanthes callosus	Karvy	The plant is anti-inflammatory, antimicrobial, and anti-rheumatic.	

Symphytum officinale	Comfrey	It has been used as a vulnerary and to reduce inflammation.[165] It was also used internally in the past, for stomach and other ailments, but its toxicity has led a number of other countries, including Canada, Brazil, Australia, and the United Kingdom, to severely restrict or ban the use of comfrey.	
Syzygium aromaticum	Clove	The plant is used for upset stomach and as an expectorant, among other purposes. The oil is used topically to treat toothache.	
Tanacetum parthenium	Feverfew	The plant has been used for centuries for fevers, headaches, stomach aches, toothaches, insect bites and other conditions.	
Taraxacum officinale	Dandelion	It was most commonly used historically to treat liver diseases, kidney diseases, and spleen problems.	
Teucrium scordium	Water germander	It has been used for asthma, diarrhea, fever, intestinal parasites, hemorrhoids, and wounds.	

Thymus vulgaris	Thyme	The plant is used to treat bronchitis and cough. It serves as an antispasmodic and expectoran t in this role. It has also been used in many other medicinal roles in Asian and Ayurvedic medicine, although it has not been shown to be effective in non-respiratory medicinal roles.	
Tilia cordata	Small-leaved linden	In the countries of Central, Southern and Western Europe, linden flowers are a traditional herbal remedy made into an herbal tea called tisane.[172]	
Tradescantia zebrina	Inchplant	It is used in southeast Mexico in the region of Tabasco as a cold herbal tea, which is named *Matali*. Skin irritation may result from repeated contact with or prolonged handling of the plant, particularly from the clear, watery sap (a characteristic unique to *T. zebrina* as compared with other types).	
Trema orientalis	Charcoal-tree	The leaves and the bark are used to treat coughs, sore throats, asthma, bronchitis, gono rrhea, yellow fever, toothache, and as an antidote to general poisoning.	

Trifolium pratense	Red clover	The plant is an ingredient in some recipes for essiac tea. Research has found no benefit for any human health conditions.	
Trigonella foenum-graecum	Fenugreek	It has long been used to treat symptoms of menopause, and digestive ailments. More recently, it has been used to treat diabetes, loss of appetite and other conditions[176]	
Triticum aestivum	Wheatgrass	It may contain antioxidant and anti-inflammatory compounds.	
Turnera subulata	White buttercup	It is used for skin, gastrointestinal, and respiratory ailments. Laboratory tests showed it has some inhibitory activity against various fungi, such as *Candida glabrata*, *Aspergillus flavus*, *A. niger*, *A. fumigatus*, *Penicillium chrysogenum*, and *Candida albicans*	
Uncaria tomentosa	Cat's claw	It has a long history of use in South America to prevent and treat disease.	

Urtica dioica	Common nettle, stinging nettle	It has been used in the traditional Austrian medicine internally (as tea or fresh leaves) to treat disorders of the kidneys and urinary tract, gastrointestinal tract, locomotor system, skin, cardiovascular system, hemorrhage, influenza, rheumatism, and gout.	
Vaccinium spec.	Blueberries	They are of current medical interest as an antioxidant and for urinary tract ailments.	
Vaccinium macrocarpon	Cranberry	It was used historically as a vulnerary and for urinary disorders, diarrhea, diabetes, stomach ailments, and liver problems. Modern usage has concentrated on urinary tract related problems.	
Vaccinium myrtillus	Bilberry	It is used to treat diarrhea, scurvy, and other conditions.	
Valeriana officinalis	Valerian	It has been used since at least ancient Greece and Rome for sleep disorders and anxiety.	

Verbascum thapsus	Common mullein	It contains glycyrrhizin compounds with bactericide and potential anti-tumoral action. These compounds are concentrated in the flowers.	
Verbena officinalis	Verbena	It is used for sore throats and respiratory tract diseases.	
Vernonia amygdalina	Bitter leaf	The plant is used by both primates and indigenous peoples in Africa to treat intestinal ailments such as dysentery.	
Veronica officinalis	Veronica	The plant is used for sinus and ear infections.	
Viburnum tinus	Laurustinus	*V. tinus* has medicinal properties. The active ingredients are viburnin (a substance or more probably a mixture of compounds) and tannins. Tannins can cause stomach upset. The leaves when infused have antipyretic	

Viola tricolor	Wild pansy	It is one of many viola plant species containing cyclotides. These small peptides have proven to be useful in drug development due to their size and structure giving rise to high stability.	
Viscum album	European mistletoe	It has been used to treat seizures, headaches, and other conditions.	
Vitex agnus-castus	Chasteberry	It has been used for over thousands of years for menstrual problems, and to stimulate lactation.	
Vitis vinifera	Grape	The leaves and fruit have been used medicinally since the ancient Greeks.	
Withania somnifera	Ashwagandha	The plant's long, brown, tuberous roots are used in traditional medicine. In Ayurveda, the berries and leaves are applied externally to tumors, tubercular glands, carbuncles, and ulcers.	

Youngia japonica	Japanese hawkweed	The plant is antitussive and febrifuge. It is also used in the treatment of boils and snakebites.	
Zingiber officinale	Ginger	The plant is used to relieve nausea	

8. ANTICANCER PROPERTIES OF HERBAL MEDICINE

Natural products especially plants have been used for the treatment of various diseases for thousands of years. Terrestrial plants have been used as medicines in Egypt, China, India and Greece from ancient times and an impressive number of modern drugs have been developed from them. The first written records on the medicinal uses of plants appeared in about 2600 BC from the Sumerians and Acadians 1. According to World Health Organization, 80% of the people living in rural areas depend on medicinal herbs as primary healthcare system. The synthetic anticancer remedies are beyond the reach of common man because of cost factor. Herbal medicines have a vital role in the prevention and treatment of cancer and medicinal herbs are commonly available and comparatively economical. A great deal of pharmaceutical research done in technologically advanced countries like USA, Germany, France, Japan and China has considerably improved quality of the herbal medicines used in the treatment of cancer. Some herbs protect the body from cancer by enhancing detoxification functions of the body.

Certain biological response modifiers derived from herbs are known to inhibit growth of cancer by modulating the activity of specific hormones and enzymes. Some herbs reduce toxic side effects of chemotherapy and radiotherapy. Scientists all over the world are concentrating on the herbal medicines to boost immune cells of the body against cancer. By understanding the complex

synergistic interaction of various constituents of anticancer herbs, the herbal formulations can be designed to attack the cancerous cells without harming normal cells of the body 2, 3. Today, despite considerable efforts, cancer still remains an aggressive killer worldwide. Moreover, during the last decade, novel synthetic chemotherapeutic agents currently in use clinically have not succeeded in fulfilling expectations despite the considerable cost of their development. Therefore there is a constant demand to develop new, effective, and affordable anticancer drugs 4. From the dawn of ancient medicine, chemical compounds derived from plants have been used to treat human diseases. Natural products have received increasing attention over the past 30 years for their potential as novel cancer preventive and therapeutic agents.

The increasing costs of conventional treatments (chemotherapy and radiation) and the lack of effective drugs to cure solid tumours encouraged people in different countries to depend more on folk medicine which is rooted in medicinal plants use. Such plants have an almost unlimited capacity to produce substances that attract researchers in the quest for new and novel chemotherapeutics. Of over 2069 anti-cancer clinical trials recorded by the National Cancer Institute as being in progress as of July 2004, over 160 are drug combinations including these agents against a range of cancers.

8.1 Cancer:

Cancer is a general term applied of series of malignant diseases that may affect different parts of body. These diseases are

characterized by a rapid and uncontrolled formation of abnormal cells, which may mass together to form a growth or tumour, or proliferate throughout the body, initiating abnormal growth at other sites. If the process is not arrested, it may progress until it causes the death of the organism. The main forms of treatment for advance stage cancer in humans are surgery, radiation and drugs (cancer chemotherapeutic agents). Cancer chemo-therapeutic agents can often provide temporary relief of symptoms, prolongation of life, and occasionally cures 8. Many hundreds of chemical variants of known class of cancer chemotherapeutic agents have been synthesized but have a more side effects. A successful anticancer drug should kill or incapacitate cancer cells without causing excessive damage to normal cells. This ideal is difficult, or perhaps impossible, to attain and is why cancer patients frequently suffer unpleasant side effects when under-going treatment.

Synthesis of modifications of known drug continues as an important aspect of research. However, a waste amount of synthetic work has given relatively small improvements over the prototype drugs. There is a continued need for new prototype-new templates to use in the design of potential chemotherapeutic agents: natural products are providing such templates. Recent studies of tumour-inhibiting compound of plant origin have yielded an impressive array of novel structures. Many of these structures are extremely complex, and it is most unlikely that such compounds would have been synthesized in empirical approaches

to new drugs.

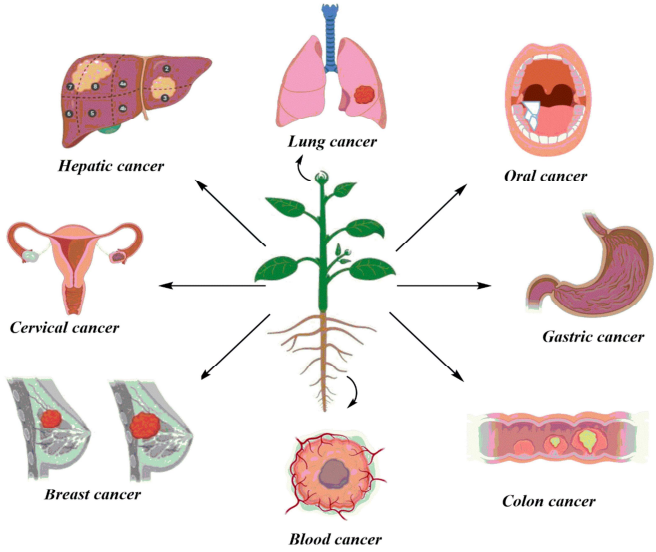


Fig 4: Anticancer activities by using herbal medicine

8.2 Ayurvedic Concept of Cancer

Charaka and Sushruta Samhita both described the equivalent of cancer as "granthi" and "arbuda" 12. "Granthi" and "Arbuda" can be inflammatory or devoid of inflammation, based on the doshas involved 13. Three doshas "Vata, Pitta and Kapha" in body are responsible for disease and the balanced coordination of these doshas in body, mind and consciousness is the Ayurvedic definition of health . Tridoshicarbudas are usually malignant because all three major body humors lose mutual coordination, resulting in a morbid condition.

Neoplasm can be classified in Ayurveda depends upon various clinical symptoms in relation to tridoshas.

Group I:

Diseases that can be named as clear malignancies, including arbuda and granthi, such as mamsarbuda (sarcomas) and raktarbuda (leukaemia), mukharbuda (oral cancer), and asadhya vrana (incurable or malignant ulcers).

Group II:

Diseases that are not cancers but can be considered probable malignancies, such as ulcers and growths. Examples of these are mamsaja oshtharoga (growth of lips), asadhya galganda (incurable thyroid tumour), tridosaja gulmas, and asadhya udara roga, (abdominal tumours like carcinomas of the stomach and liver or lymphomas).

Group III:

Diseases in which there is a possibility of malignancy, such as visarpa, asadhya kamala (incurable jaundice), asadhya pradara (intreatable sinusitis)

Types of Cancers:

1) Cancers of Blood and Lymphatic Systems:

1. Hodgkin's disease
2. Leukemia's
3. Lymphomas
4. Multiple myeloma
5. Waldenstrom's disease

2) Skin Cancers:

1. Malignant Melanoma

3) Cancers of Digestive Systems:

2. Esophageal cancer
3. Stomach cancer
4. Cancer of pancreas

5. Liver cancer
6. Colon and Rectal cancer
7. Anal cancer

4) Cancers of Urinary system:
1. Kidney cancer
2. Bladder cancer
3. Testis cancer
4. Prostate cancer

5) Cancers in Women:
1. Breast cancer
2. Ovarian cancer
3. Gynecological cancer
4. Choriocarcinoma

6) Miscellaneous Cancers:
1. Brain cancer
2. Bone cancer
3. Characinoid cancer
4. Nasopharyngeal cancer
5. Retroperitoneal sarcomas
6. Soft tissue cancer
7. Thyroid cancer

8.4 Causes of Cancer:

Modern medicine attributes most cases of cancer to changes in DNA that reduce or eliminate the normal controls over cellular growth, maturation, and programmed cell death. These changes are more likely to occur in people with certain genetic backgrounds (as illustrated by the finding of genes associated with some cases of cancer and familial prevalence of certain cancers) and in persons infected by chronic viruses (e.g., viral hepatitis may lead to liver cancer; HIV may lead to lymphoma). The ultimate cause, regardless of genetic propensity or viruses that may influence

the risk of the cancer, is often exposure to carcinogenic chemicals (including those found in nature) and / or to radiation (including natural cosmic and earthly radiation), coupled with a failure of the immune system to eliminate the cancer cells at an early stage in their multiplication. The immunological weakness might arise years after the exposure to chemicals or radiation. Other factors such as tobacco smoking, alcohol consumption, excess use of caffeine and other drugs, sunshine, infections from such oncogenic virus, like cervical papilloma viruses, adenoviruses Karposis sarcoma (HSV) or exposure to asbestos. These obviously are implicated as causal agents of mammalian cancers.

However a large population of people is often exposed to these agents. Consequently cancer cells continue to divide even in situations in which normal cells will usually wait for a special chemical transduction signal. The tumour cells would ignore such stop signals that are sent out by adjacent tissues. A Cancer cell also has the character of immortality even in vitro whereas normal cells stop dividing after 50-70 generations and undergoes a programmed cell death (Apoptosis). Cancer cells continue to grow invading nearby tissues and metastasizing to distant parts of the body. Metastasis is the most lethal aspect of carcinogenesis.

Environmental factors which, from a scientist's standpoint, include smoking, diet, and infectious diseases as well as chemicals and radiation in our homes and workplace along with trace levels of pollutants in food, drinking water and in air. Other factors which are more likely to affect are tobacco use, unhealthy diet, not

enough physical activity, however the degree of risk from pollutants depends on the concentration, intensity and exposure. The cancer risk becomes highly increased where workers are exposed to ionizing radiation, carcinomas chemicals, certain metals and some other specific substances even exposed at low levels. Passive tobacco smoke manifold increase the risk in a large population who do not smoke but exposed to exhaled smoke of smokers .

The Mechanism on Cancer Therapy:

1. Inhibiting cancer cell proliferation directly by stimulating macrophage phagocytosis, enhancing natural killer cell activity.
2. Promoting apoptosis of cancer cells by increasing production of interferon, interleukin-2 immunoglobulin and complement in blood serum.
3. Enforcing the necrosis of tumour and inhibiting its translocation and spread by blocking the blood source of tumour tissue.
4. Enhancing the number of leukocytes and platelets by stimulating the hemopoietic function.
5. Promoting the reverse transformation from tumour cells into normal cells.
6. Promoting metabolism and preventing carcinogenesis of normal cells.
7. Stimulating appetite, improving quality of sleep, relieving pain, thus benefiting patient's health.

8.5 Oncogenes and Tumor Suppressor Genes:

Two sets of genes are controlling cancer development. Oncogenes are the first set of genes and are involved in different cell activities including cell division. However, over expression of these genes transforms a normal cell into a cancer cell. On the other hand, the second set of genes (tumor suppressor genes) inhibits cancer cell formation by different mechanisms.

Tumour suppressor genes are under expressed in cancer cells while, oncogenes are over expressed. Summarizes the main oncogenes and tumour suppressor genes and their role in cancer development. Oncogenes and their products represent good targets for Cancer therapy. Other targets include enzymes involved in cell division like topoisomerases that unwind the DNA during replication. The diversity of plant derived natural products can provide therapeutic products attacking different targets in cancer cells.

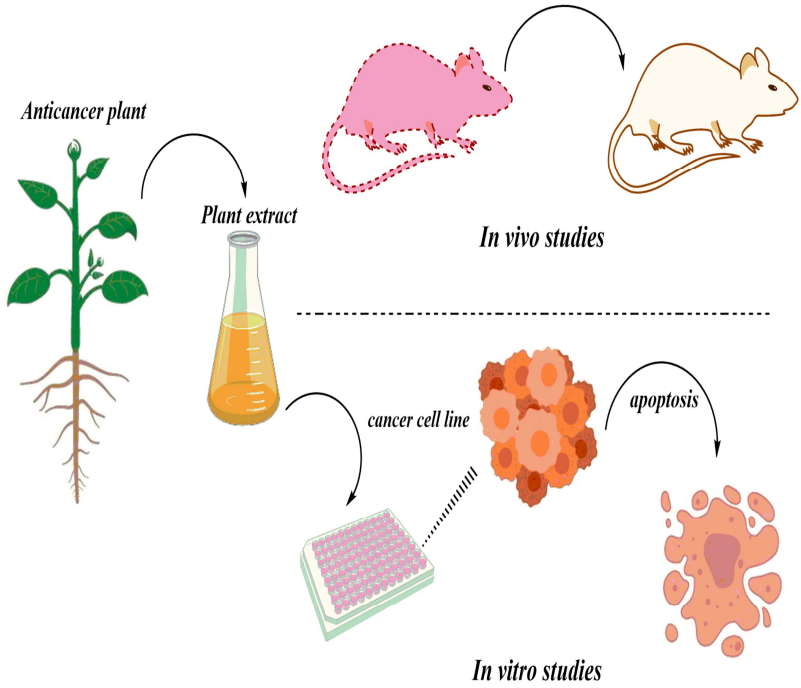


Fig. 5: *Invitro* and *invivo* anticancer studies

9. HERBAL MEDICINE ACT AS AN ANTIOXIDANT

The plants and their products are found throughout human history as herbal supplements as botanicals, nutraceuticals, and drugs. In whole population of the world, about 60– 80% of the population still relies on conventional medicine for the healing of familiar diseases. Folklore medicine are as a source of primary health care and the chief reason for the use of folk medicine is the accessibility, affordability and cultural beliefs. Plants have been found of great importance due to their medicinal and nutritional properties with a primary source of bioactive compounds.

Natural antioxidants are commonly derived from plant sources, and the efficacy is determined by plant species, variety, extraction and/or processing methods, and the growing environment. The mode of action for these substances will vary depending upon the source material, the presence of synergists and antagonists, and of course the food matrix applied to. It is necessary to study the medicinal plants with folklore position in a number of intensified ways to encourage the utilization of herbal medicine and to find out their potential as a source of new medicines.

Today herbal medicine signifies one of the most essential fields of folk medicine and the utilization of herbal medications have been growing popularity for various therapeutic conditions.Total phenolics, antioxidant, antitumor, and enzyme inhibitory activity of Indian medicinal and aromatic plants

extracted with different extraction methods. There is growing tendency in comparing the phytochemical constituents isolated from plants and their pharmacological actions. Because of the effective pharmacological activities, economic viability and low toxicity, the therapeutic properties of plants have been examined in the light of recent systematic developments throughout the world. Plants contain a variety of bioactive compounds with antioxidant capabilities including flavonoids, phenolics, sterols, alkaloids, carotenoids and glucosinolates.

9.1 Free radicals

Free radicals are essentials to any biochemical progression and signify a fundamental part of aerobic life and metabolism. It may be defined as any molecular variety with an unpaired electron in an outer atomic orbit which is capable of autonomous survival and the presence of such unpaired electron may result in definite familiar properties shared by most radicals. Most of the radicals are extremely reactive and are unstable and can donate or accept an electron from other neighbouring molecule, for that reason acting as oxidants or reductants. In general, free radicals are very short lived, with half-lives in milli-, micro- or nanoseconds (Cheeseman and Slater, 1993). They may be either reactive oxygen species (ROS) i.e. oxygen derived or reactive nitrogen species (RNS) i.e. nitrogen derived. Oxygen derived molecules include O2- (superoxide), ROO (peroxyl), HO2 (hydroperoxyl), HO (hydroxyl), RO (alkoxyl) as free radical and H2O2 oxygen as non-radical. Nitrogen derived free radical mostly involves NO (nitric oxide),

NO2 (nitrogen dioxide), N2O3 (dinitrogen trioxide) and ONOO (peroxy nitrate) (Devasagayam, and Kesavan, 1996). Most of the diseases are chiefly linked to oxidative stress caused by free radicals.

Free radicals are concerned in the development of a wide range of chaos in humans, such as cell death, cardiovascular diseases, tissue damage, ischemic heart diseases, cancer, atherosclerosis, central nervous system injury, neural disorders, reperfusion injuries of many tissues, inflammation, obesity, gastritis, arthritis, and ageing. The human body showed complicated antioxidant defensive mechanisms in the form of natural enzymatic and non-enzymatic processes which neutralize the detrimental effects of free radicals and other oxidants.

Recently it has been reported that naturally obtained antioxidants from plants defend from noxious and detrimental effects of free radicals and showed broad range of pharmacological consequences such as antimutagenic, antimicrobial, antiallergic, anticarcinogenic, antioxidant free radical scavenging actions and antidiabetic.

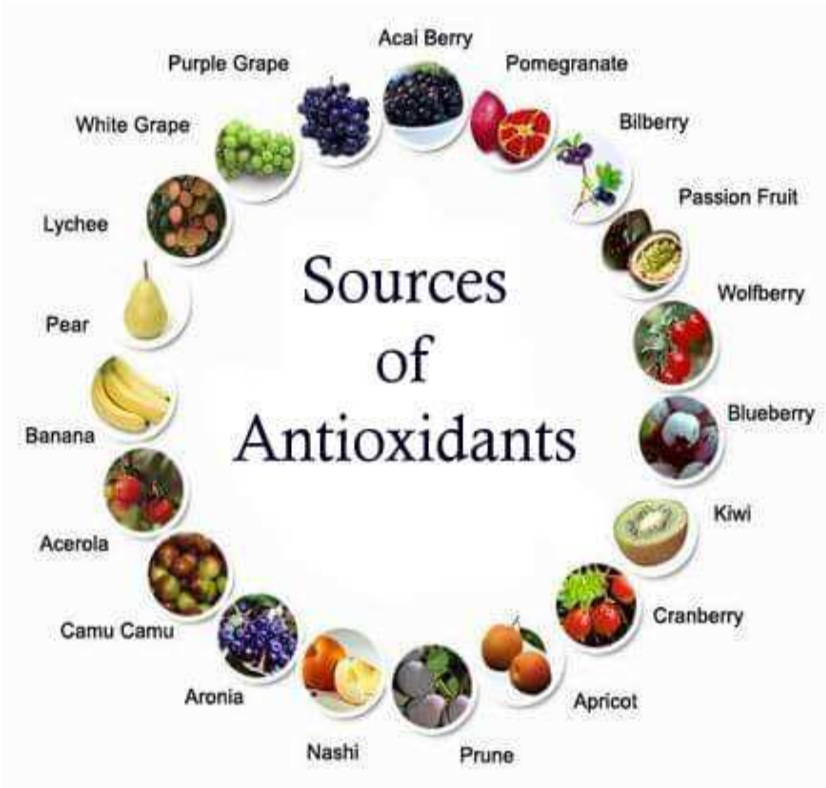


Fig. 6. Sources of Antioxidants

9.2 Antioxidants

Antioxidants are the group of compounds with enormous interest for the biochemists and pharmaceutical industries and are known for their capacity to diminish harm, resulted by some reactive species: oxygen, nitrogen, or even chlorine. It is important for the innovation of the effectiveness of free radicals in a wide range of diseases, which contributes a new way for health care systems. A grand concern was observed in the study executed in

order to achieve the replacement,whether whole or partial, of synthetic antioxidants with natural constituents. On the basis of presence of chemical compounds or oxidative enzymes, the individuals are well protected against free radical damage. Once the antioxidant defence becomes unstable by a sequence of factors physiological functions may deteriorate, as a result various ailments and aging can emerge. Though, in order to reduce the damage caused by oxidation, supply of antioxidants and antioxidants containing foods are required.

9.3 Classification of antioxidants:

Antioxidants can be classified into three types:

1. Primary or natural antioxidants:- The antioxidants which are involved in chain breaking process, which when reacted with lipid radicals to convert them into more stable components. Antioxidants involved in this group are mostly phenolic in configuration. The absence of these antioxidants may influence the metabolism of macromolecules including carbohydrates, as they are the cofactors of antioxidant enzymes.

2. Secondary or synthetic antioxidants:- These antioxidants are pheniloc compounds that achieve the role in free radical capturing and stopped the chain reactions. Examples of this group include Butylated hydroxyl anisole (BHA), Butylated hydroxytoluene (BHT), Tertiary butyl hydroquinone (TBHQ), Propyl gallate (PG) and metal chelating agent (EDTA) and Nordihydro guaretic acid (NDGA).

3. Tertiary antioxidants:- These antioxidants are involved in the

repair of biomolecules smashed by free radicals e.g., methionine sulfoxide reductase and DNA repair enzymes.

Antioxidants can also be categorised into two groups (in figure 2), these are

1. Enzymatic antioxidants:-These are the antioxidants which are involved directly or indirectly in the defence of body against reactive oxygen species(ROS). Superoxide dismutase (SOD), Catalase, glutathione reductase, glutathione peroxidise etc. are the examples of Enzymatic antioxidants.

2. Non-enzymatic antioxidants:-These antioxidants are acquired from dietary sources, which can be differentiated into several classes including polyphenols, vitamins, carotenoids, organosulfural compounds, and minerals. Among them, polyphenols i.e. phenolic acids and flavonoids, is the largest class of antioxidants.

On the basis of line of defence mechanism, antioxidants are classified into three types:

a. Superoxide dismutase (SOD), glutathione reductase (GR), catalase (CAT), and minerals like Se, Cu, Zn etc. which may be included in the first line defence antioxidants.

b. Glutathione (GSH), flavonoids, albumin, vitamin C, vitamin E, carotenoids etc. are included in the second line antioxidants and

c. The third line antioxidants involves a complex group of damaged DNA repair enzymes like transferases, methionine sulphoxide reductase etc, damaged proteins, oxidized lipids and

peroxides etc.

9.4 Mechanism of action of antioxidants

Two standard mechanisms of action have been anticipated for antioxidants. The first is a chain- breaking mechanism through which the primary antioxidant contributes an electron to the free radical present in the system. The removal of ROS/ reactive nitrogen species initiators (secondary antioxidants) by quenching chain-initiating catalyst is involved in the second mechanism. Other mechanisms of antioxidants are effective on biological systems like metal ion chelation, electron donation, co-antioxidants or by gene expression regulation (Lobo et al., 2010).

9.5 Role of Antioxidants in human body

In order to protect the cells and organs of the body against free radicals (ROS), a highly combined and complicated system has been evolved in human body, which involve a diversity of components, originated both endogenously and exogenously that function interactively and synergistically to reduce the effect of free radicals. These are

1. Antioxidants from nutrients such as carotenoids, ascorbic acid (vitamin C), tocopherols and tocotrienols (Vitamin E), and other low molecular weight compounds including glutathione and lipoid acid.
2. Enzymatic antioxidants, which catalyze free radical quenching reactions including glutathione peroxidase, superoxide dismutase, and glutathione reductase.
3. Proteins that bind metals that seizes free iron and copper

ions that are capable of catalyzing oxidative reactions, such as lactoferrin, ferritin, albumin, and ceruloplasmin.

4. A number of other antioxidant phytonutrients present in a wide variety of plant foods.

9.6 Antioxidants from dietary food

Regular utilization of fruits and vegetables is documented to diminish the risk of chronic ailments. Populace obtain supplements of antioxidant directly from fresh fruits and vegetables, as they contain a huge quantity of flavonoids and antioxidant complements which can take part in the defence mechanisms against different cardiovascular ailments including different types of cancers and many health problems (Hamid et al., 2010).

Studies reveal that a diet with rich antioxidants has an affirmative impact on health on a large scale. Wide variety of plants and plant parts have been demonstrated to contain a large amount of antioxidants such as strawberries, Blueberries, grapes, spinach, plums, broccoli flowers, alfalfa sprouts and many more, and they are also integrated into many dietary ingredient. Citrus fruits like lemons, oranges etc. also contain a high quantity of natural antioxidants, most significantly vitamin C.

Moreover there are some new and distinctive antioxidants like derivatives of flavonoids and p- coumaric acid that have been discovered in spinach. NAO- a spinach-derived natural antioxidant that contains derivatives of flavonoids and p-coumaric acid has a

beneficial biological activity in the prevention of prostrate cancer. Recently it has been revised that fruits like araticudomato, pindo palm and jackfruit are good sources of vitamin C, vitamin A and other phenolic compounds, analysis on these fruits is being carried out to create the genetic, chemical or biological variations so as to enhance the antioxidant potential of the same.

9.7 Antioxidant from plants

The use of synthetic and natural food antioxidants regularly in medicine and foods particularly those having fats and oils to shield the food from oxidation. Butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) are the synthetic and natural food antioxidants which have been used extensively in cosmetic, food and therapeutic industries. But, owing to their instability at high temperatures, high volatility, synthetic antioxidant's carcinogenic behaviour, users inclinations led to shift in the consideration of producers or manufacturers from man-made to natural antioxidants.

In consideration of growing risk issues of humans to various lethal diseases, there has been a universal trend in the direction of the use of natural substances present in dietary and medicinal plants as curative antioxidants. A variety of medicinal plants have been reported to reveal antioxidant activity, including Allium sativum, Zingiber officinale, Crocus sativus, Dodonaea viscose, Barleria noctiflora, Anacardium occidentale, Datura fastuosa, Caesalpinia bonducella and many more as in table below.Numerous antioxidants identified as active oxygen

scavengers or free radicals, obtained naturally from the plant sources are used in food, cosmetic and remedial purposes proved to be brilliant alternatives for man-made antioxidants because of their inexpensiveness, and have no any harmful effect on human body(Brown, and Rice-Evans, 1998). In order to defy the detrimental effects of reactive oxygen species, plants have a powerfully built enzymatic and non-enzymatic scavenging pathway.

Enzymes included are catalase (CAT), superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione reductase (GR), glutathione S-transferase (GST), dehydroascorbate reductase (DHAR), monodehydroascorbate reductase (MDHAR), peroxidases (POX) and glutathione peroxidase (GPX). Non enzymatic compounds include glutathione (GSH), carotenoids , tocopherols and ascorbate (AsA). There are unambiguous, well synchronized ROS generating and scavenging systems present in different organelles of the plant cells. Lesser levels of ROS comparatively act as signalling essences that arouses abiotic stress tolerance by altering the expression of resistant genes. In plants, elevated levels of antioxidants have been accounted to demonstrate better resistance to different types of environmental stresses.

Table: 9.1: Some medicinal plants having potential of Antioxidant activity

S. N	**Name of plants**	**Commo n Name**	**Family**	**Plant part used**
1.	*Allium sativum*	Garlic	Alliaceae	Bulb
2.	*Artemisia campestris*	'T'gouft	Asteraceae	Aerial part
3.	*Zingiber officinale,*	Ginger	Zingiberaceae	Rhizome
4.	*Crocus sativus L*	Saffron	Iridaceae	Tepals
5.	*Dodonaea viscose*	Hopbush	Sapindaceae	Flower
6.	*Barleria noctiflora*	Blooing	Acanthaceae	Aerial part
7.	*Anacardium occidentale*	Cashew	Anacardiaceae	Leaves
8.	*Datura fastuosa*	Kecubung	Solanaceae	Seeds
9.	*Caesalpinia bonducella*	Nata Karanja	Caesalpiniaceae	Leaves
10.	*Vernonia cinerea*	Dandotapala	Compositae	Leaves
11.	*Platycodon grandifloru*	Balloon Flower	Campanulaceae	Roots
12.	*Ficus beecheyana*	Erect Fig	Moraceae	Roots
13.	*Costus pictus*	Spirll	Costaceae	Leaves
14.	*Stevia rebaudiana*	Sweetleaf	Asteraceae	Leaves
15.	*Coscinium fenestratum*	Tree turmeric	Menispermaceae	Stem and leave
16.	*Hemidesmus indicus*	Ananthamul	Apocynaceae	Stem
17.	*Plumbago zeylanica*	Chitra	Plumbaginaceae	Root
18.	*Bacopa monnieri*	Brahmi	Scrophulariaceae	Leaves

19.	*Aloe vera*	star cactu	Asphodelaceae	Leaves
20.	*Citrus aurantifolia*	key lime	Rutaceae	Leaves
21.	*Cannabis sativa L.*	Hemp/mariju ana	Cannabaceae	Seed
22.	*Mentha Pulegium*	Pennyroyal	Lamiaceae	Leaves
23.	*Ageratum conyzoide. L*	chick weed	Asteraceae	Leaves
24.	*Salvia hypargeia*	Turkish Mountai n Sage	Lamiaceae	Aerial parts
25.	*Cotinus coggygria*	Smoketree	Anacardiaceae	Leaves
26.	*Rosa damascene*	Damask rose	Rosaceae	Flowers
27.	*Ocimum basillicum*	Basil	Lamiaceae	Leaves
28.	*Ocimum sanctum*	Tulsi	Lamiaceae	Leaves
29.	*Alpina calcarata*	cardamom ginger	Zingiberaceae	Leaves
30.	*Jatropa curcas*	Barbados nut	Euphorbiaceae	Fruits
31.	*Anthemis arvensis*	corn chamomile	Asteraceae	Leaves
32.	*Arnebia benthamii*	Gaozaban	Boraginaceae	Whole plant
33.	*Polygonum minus*	Kesum	Polygonaceae	Leaves, stem
34.	*Curcuma longa*	Turmeric	Zingiberaceae	Rhizome
35.	*Reaumuria vermiculata*	Molleih	Tamaricaceae	Aerial part
36.	*Lantana camara*	Lantana	Verbenaceae	Leaves

10. SOME ON MEDICINAL PLANTS ACTING AGAINST FISH DISEASES

To preserve and protect the environment as well as human health as a best alternative, different parts of *Azadirachta indica* (Neem) tree have been studied by Chitmanat et al. (2005). Neem leaves containing nimbin, azadirachtin and meliantroil have been reported to possess a variety of properties, including insecticidal and antiviral from ancient times. Indian almond (*Terminalia catappa*) and garlic (*Allium sativum*) have been said as an alternative to chemicals to treat fish ectoparasites, Trichodina sp. infections in tilapia (*O. niloticus*) fingerlings. Both Indian almond and garlic had low acute toxicity to tilapia fingerlings, treating the trichodiniasis caused by Trichodina. The authors further cited that the Indian almond, commonly used as herb in Taiwan, prevents the fish diseases. It is claimed to be a wound healing substance for Siamese fighting fish hurt after matches in Thailand as well. The immunostimulant effects of the dietary intake of 3 plants (viz., *Viscum album, Urtica dioica* and *Zingiber officinale*)-extracts on rainbow trout (*Oncorhynchus mykiss*) have also been narrated by the authors.

Christybapita et al. (2007) observed the immunostimulatory effect of aqueous extract (AqE) of *Eclipta alba* (Bhangra) leaf (oral administration as feed supplement) in tilapia fish, Oreochromis mossambicus. It was noted that the *E. alba* extract enhances non-specific immune responses and disease resistance of *O. mossambicus* against *A. hydrophila* infection. According to Winkaler et al. (2007), *A. indica* extract can be used

successfully in aquaculture to control fish predators. Castro et al. (2008) screened the methanolic extracts of 46 Brazilian plants and found only 31 to have the antibacterial activities against fish pathogenic bacteria, viz., Streptococcus agalactiae, *Flavobacterium columnare* and *A. hydrophila*. Yin et al. (2008) added the extracts of 2 Chinese herbs (viz., *Lonicera japonica* and *Ganoderma lucidum*) in diets of tilapia fish (*O. niloticus*) and found that these herbs act as immunostimulants and appear to improve the immune status and disease resistance. Both herbs when used alone or in combination increased the survival of fish after challenge with *A. hydrophila*. On the basis of several studies, Yin et al. (2008) reported that oral administration of ginger (*Z. officinale*) extract increases the phagocytic capability of cells in rainbow trout (fish), while the extracts of 4 Chinese herbs (*Rheum officinale, Andrographis paniculata, Isatis indigotica and Lonicera japonica*) increased the phagocytosis of white blood cells of carp.

Turker et al. (2009) reported that the alcoholic and aqueous extracts of *Nuphar lutea, Nymphaea alba, Stachys annua, Genista lydia, Vinca minor, Fragaria vesca, Filipendula ulmaria* and *Helichrysum plicatum* herbs of Bold have antibacterial activity against *A. hydrophila*, *Yersinia ruckeri, Lactococcus garvieae, Str. agalactae* and *Enterococcus faecalis* bacteria isolated from fish. This observation provides the aquaculturists with a promising management tool for control or treatment of fish diseases. Nya and Austin (2009) observed the control of *A. hydrophila* infection after feeding with *A. sativum* (0.5 and 1 g/100 g of feed for 14 days) to rainbow trout

(fish), *O. mykiss* (Walbaum).

Ahilan et al. (2010) observed that the addition of *Phyllanthus niruri* and Aloe vera (Aloe) as herbal additives can positively enhance the growth performance of goldfish, *Carassius auratus* as well as its resistance to A. hydrophila infections. The authors further reported that the herbal additives in diets often provide cooperative action to various physiological functions. The synergistic effect of herbs has been reported in other fishes, including Japanese flounder and *Clarias gariepinus*. The growth increase in Labeo rohita fish fed with herbal supplemented diet was due to improved food utilization and high protein synthesis. The benefit of herbal growth promoters as an additive in the carp feed has also been found. Furthermore, the medicinal plants, viz., ginger, nettle and mistletoe as an adjuvant therapy in rainbow trout through feed enhanced phagocytosis and cellular and humoral defense mechanisms against pathogens. The traditional Chinese medicines in yellow croaker elevated the non specific defense mechanism and increased the disease resistance of fish against bacterial pathogens. The disease resistant of Catla catla fish was produced through immersion treatment of 3 herbs, viz., A. sativum, A. indica and Curcuma longa (Haldi rhizome, turmeric) in spawn. A. vera has been found to a disease suppressing agent and showed antibacterial effect in juvenile rock fish. Harikrishnan et al. (2010) reported that mixed herbal Medicinal Plants Useful in Fish Diseases 3 extracts supplementation diets restored the altered haematological parameters and triggered the innate immune system

of goldfish (C. auratus) against A. hydrophila infection.

Ravikumar et al. (2010) observed that the chloroform extract of Datura metal plant has wide range of antimicrobial activity against many fish pathogens, which collected from the Kanyakumari coast can be used as a putative antimicrobial drug in the aquaculture maintenance. The chloroform extract of *D. metel* can be effectively used as a potential antimicrobial agent to overcome the problem of mass mortality of ornamental fish in aquarium so as to enable to enhance the market revenue throughout the world. These authors also told the antimicrobial activity of 5 Chinese herb extracts against 13 bacterial and 2 viral fish pathogens. Sharma et al. (2010) observed the stimulatory effect of dietary doses of *Withania somnifera* (Ashwagandha) root on immunity and disease resistance against *A. hydrophila* infection in Indian major carp, *L. rohita* fingerlings. Abdul Kader Mydeen and Haniffa (2011) cited that *A. indica* leaf AqE could effectively control the *A. hydrophila* infection in common carp (a fresh-water fish usually bred in ponds), *Cyprinus carpio*. Further, *Enterobacter* sp. and Escherichia coli bacteria, isolated from marine fish (*Amphiprion sebae*) showed 15 mm zone of inhibition against neem extract. The antimicrobial activity of AqE of 3 medicinal plants, viz., *A indica* (leaf), *Solanum torvum* (Sundakai fruit coat) and *C. longa* (rhizome) against the in vitro growth of *A. hydrophila*, isolated from infected fresh-water fish, Channa striatus was noticed by Abdul Kader Mydeen and Haniffa (2011). Kolkovski and Kolkovski (2011) reported that some herbal extracts are very effective against gills

and skin flukes like *Benedenia seriolae*. Nargis et al. (2011) seen the immunostimulant effects of the dietary intake of *A. sativum* and *Vitex negundo* extracts on fingerlings of *L. rohita* fish. Ravikumar et al. (2011) studied that among 15 coastal medicinal plants/ parts of plants, A. indica, *Cinnamomum verum* and *Eupatorium odoratum* exhibited excellent antibacterial activity against 10 bacterial pathogens from diseased ornamental fishes.

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