# HERBS FOR DISEASE PREVENTION AND TREATMENT

Editors:
**Velmurugan Devadasan**
**Atanu Bhattacharjee**
**Raman Pachaiappan**
**Gayathri Dasararaju**

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# Herbs for Disease Prevention and Treatment

Edited by

**Velmurugan Devadasan**
*Department of Biotechnology, School of Bioengineering*
*Faculty of Engineering and Technology, SRM Institute*
*of Science and Technology, Kattankulathur-603203*
*Chengalpet Dt., Tamil Nadu, India*

**Atanu Bhattacharjee**
*Department of Biotechnology and Bioinformatics*
*North Eastern Hill University*
*Shillong-793022, India*

**Raman Pachaiappan**
*Department of Biotechnology, School of Bioengineering*
*Faculty of Engineering and Technology, SRM Institute*
*of Science and Technology, Kattankulathur-603203*
*Chengalpet Dt., Tamil Nadu, India*

&

**Gayathri Dasararaju**
*Department of Biophysics and Crystallography*
*University of Madras, Guindy Campus*
*Chennai-600025, Tamil Nadu, India*

## Herbs for Disease Prevention and Treatment

Editors: Velmurugan Devadasan, Atanu Bhattacharjee, Raman Pachaiappan & Gayathri Dasararaju

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# FOREWORD

The author of this book has more than 40 years of research experience in the field of crystallography of small molecules, particularly the structure and functional studies of phytochemicals. He has published more than 600 research articles. His contributions to drug discovery using plant products are significant. This book provides valuable information on the potential therapeutic applications of plant products and gives evidence of the nutritional values of phytochemicals. It gives details on the function of herbalism in the context of its history and significance. The diversified geographical terrains sustaining several indigenous species of plants of medicinal importance are also described. The usage of herbal practices and several techniques are highlighted. The role of nutraceuticals in improving wellness, reducing the rate of aging, averting chronic diseases, and prolonging life, as well as keeping the body in good shape, has been discussed in detail. The importance of dietary supplements to boost health has been discussed in detail. Although better diet quality is imperative to fix various problems, people who are at risk for deficiencies may benefit from dietary supplements and/or food fortification to assist them in fulfilling their nutritional needs. The need for the key minerals as well as fat-soluble and water-soluble vitamins that are vital for human health and well-being has been established. The contamination of aflatoxin in animal diet manifests harmful effects on animal health and productivity. The use of phytochemicals against diseases such as cancer and inflammation has been shown. The importance of plant products that are widely used to treat women's reproductive health, such as polycystic ovary, dysmenorrhea, endometriosis, anovulation, early menopause, painful menstruation, abnormal menstrual cycles, and recurring abortions and also cholera, tuberculosis, leprosy, dysentery, and vector-borne illnesses like malaria and hookworm infection has been described. The utility of phytocompounds for controlling the spread of SARS-CoV2 has also been presented in this book. Overall, this book provides highly useful information for the health benefits of all.

**Prof. T.P. Singh**
SERB Distinguished Fellow
Department of Biophysics
All India Institute of Medical Sciences
Ansari Nagar, New Delhi 110029, India

# PREFACE

Herbals/natural products have been used by humankind for more than 5,000 years. At present, about 60% of people prefer herbals at the global level for treating common ailments as they believe that even if any side effects arise, they would not be as severe as in allopathy medicine. Traditional medicine, folk medicine, naturopathy, Tibetan medicine, traditional Chinese medicine, Indian traditional medicine, *etc*. use herbs or certain plants for preventing or curing human ailments.

This book deals with the control of various diseases using plants. Most of the herbs considered have proven to be not harmful to health, and they either control or cure the diseases. In silico methods have been used in many chapters in docking calculations to confirm the binding of the phytoconstituents at the binding site of the disease-related macromolecular targets. This work was carried out to understand the principle behind the cure. In practice, mostly the whole parts of the herb or certain parts are used for the treatment, and synergism plays a major role in the activity of these herbs.

Chapter 1 deals with the bioactive compounds from marine macroalgae for the management of diabetes mellitus. Chapter 2 deals with the treatment of diseases using herbs as supplements. Herbal nutraceuticals for disease prevention and management are dealt with in Chapter 3. The use of herbs as dietary medicine is described in Chapter 4. In Chapter 5, the evaluation of the anti-aflatoxicosis potential of *Solanum americanum* Mill, an important traditional medicinal plant, is discussed. The use of herbs in the traditional healthcare system of North East India is discussed in Chapter 6 - with regard to its history, contemporary use, and future aspects. Chapter 7 deals with the identification of phytochemicals using GC-MS/LC-MSMS techniques and also docking techniques against COVID-19 targets. Chapter 8 deals with three herbs used in traditional health care system of North-Eastern India to treat conditions like arthritis and rheumatism. Detection of fatty acid modifications from plant edible oils after repetitive use and deep frying of plant and animal-based food items is discussed in Chapter 9. The last chapter, namely, Chapter 10 deals with plants intertwined with humans in treating kidney diseases.

This book thus covers, in general, many common diseases and deals with the ways of overcoming these ailments with natural products/herbs. I hope that this book will serve as a sourcebook for scientists and students of pharmacy, pharmacology, Siddha, and Ayurveda courses.

**Velmurugan Devadasan**
Department of Biotechnology, School of Bioengineering
Faculty of Engineering and Technology, SRM Institute
of Science and Technology, Kattankulathur-603203
Chengalpet Dt., Tamil Nadu, India

**Atanu Bhattacharjee**
Department of Biotechnology and Bioinformatics
North Eastern Hill University
Shillong-793022, India

**Raman Pachaiappan**
Department of Biotechnology, School of Bioengineering
Faculty of Engineering and Technology, SRM Institute
of Science and Technology, Kattankulathur-603203
Chengalpet Dt., Tamil Nadu, India

&

**Gayathri Dasararaju**
Department of Biophysics and Crystallography
University of Madras, Guindy Campus
Chennai-600025, Tamil Nadu, India

# List of Contributors


| | |
|---|---|
| **Anantha Krishnan Dhanabalan** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India |
| **Angneh Ngoruh** | Department of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-793022, India |
| **Atanu Bhattacharjee** | Department of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-793022, India |
| **Archana Saikia** | Molecular Endocrinology and Reproductive Biology Research Laboratory, Department of Zoology, Rajiv Gandhi University, Rono Hills, Itanagar-791112, Arunachal Pradesh, India |
| **Harykrishnan Suresh** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India |
| **Hirendra Nath Sarma** | Molecular Endocrinology and Reproductive Biology Research Laboratory, Department of Zoology, Rajiv Gandhi University, Rono Hills, Itanagar-791112, Arunachal Pradesh, India |
| **Janani Prabaharan** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India |
| **Jayaprakash Chinnappan** | Anthropology and Health Informatics Lab, Department of Bioinformatics, Bharathiar University, Coimbatore-641046, India |
| **Kareem Altaff** | Department of Marine Biotechnology, AMET University, Chennai-603112, India |
| **K. Abinaya** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur-603203, Chengalpet Dt., Tamil Nadu, India |
| **M. Syed Ali** | PG and Research Department of Biotechnology, Mohamed Sathak College of Arts and Science, Sholinganallur, Chennai-600119, Tamil Nadu, India |
| **N. Yogananth** | PG and Research Department of Biotechnology, Mohamed Sathak College of Arts and Science, Sholinganallur, Chennai-600119, Tamil Nadu, India |
| **Nagasathiya Krishnan** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur-603203, Chengalpet Dt., Tamil Nadu, India |
| **Raman Pachaiappan** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India |
| **Prosperwell Ingty** | Department of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-793022, India |
| **Pinki Kumari Singh** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur-603203, Chengalpet Dt., Tamil Nadu, India |

| | |
|---|---|
| **R. Selvi** | Research and Evaluation, Bharathiar University, Coimbatore, Tamil Nadu, India |
| **R. Muthezhilan** | Department of Marine Biotechnology, AMET University, Chennai-603112, India |
| **Rik Ganguly** | Department of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-793022, India |
| **Shashi Kumar Yadav** | Department of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-793022, India |
| **Sonam Doima** | Molecular Endocrinology and Reproductive Biology Research Laboratory, Department of Zoology, Rajiv Gandhi University, Rono Hills, Itanagar-791112, Arunachal Pradesh, India |
| **S. Nagarjun** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur – 603 203, Chengalpet Dt., Tamil Nadu, India |
| **S. Thulasiram** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur – 603 203, Chengalpet Dt., Tamil Nadu, India |
| **Subash C.B. Gopinath** | Institute of Nano Electronic Engineering, Universiti Malaysia Perlis (UniMAP), Kangar 01000, Perlis, Malaysia<br>Faculty of Chemical Engineering & Technology, Universiti Malaysia Perlis (UniMAP), Arau 02600, Pauh Campus, Perlis, Malaysia<br>Micro System Technology, Centre of Excellence, Universiti Malaysia Perlis (UniMAP), Arau 02600, Pauh Campus, Perlis, Malaysia |
| **Shankari Gopalakrishnan** | Anthropology and Health Informatics Lab, Department of Bioinformatics, Bharathiar University, Coimbatore-641046, India |
| **Trinankur Mitra** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur – 603 203, Chengalpet Dt., Tamil Nadu, India |
| **Vijayaraj Radha** | Department of Marine Biotechnology, AMET University, Chennai-603112, India |
| **Vinduja Vasudevan** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India |
| **Velmurugan Devadasan** | Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India |

# CHAPTER 1

# Bioactive Molecules from Marine Macroalgae for the Management of Diabetes Mellitus with Reference to their Inhibitory Activity: An Overview

**Vijayaraj Radha**[1] and **Kareem Altaff**[1,*]

[1] *Department of Marine Biotechnology, AMET University, Chennai-603112, India*

**Abstract:** Diabetes mellitus is a global health issue related to insulin that is associated with a high rate of morbidity and mortality. Synthetic hypoglycemic medications can be used to treat diabetes; however, long-term use of these medications has several negative effects. As a result, there is a paradigm change in favor of using natural agents that may be antidiabetic. The marine environment is a rich source of both biological and chemical diversity, which is being investigated to identify novel compounds with potential for use in the pharmaceutical, cosmetic, and nutritional supplement industries. Marine organisms, especially marine macroalgae, comprise numerous significant novel secondary metabolites possessing strong pharmacological characteristics that have been identified. Sources of marine macroalgae include various bioactive compounds exhibiting various health-promoting properties. Hence, the present chapter aimed to discuss the different antidiabetic mechanisms of bioactive compounds from marine macroalgae and also talked about the variety of marine macroalgal bioactive substances that could help avoid or manage type 2 diabetes by focusing on several pharmacologically significant pathways, such as preventing the activity of enzymes like lipase, α-glucosidase, α-amylase, aldose reductase, protein tyrosine phosphatase 1B, and dipeptidyl-peptidase-4.

**Keywords:** Bioactive compounds, Diabetes mellitus, Marine macroalgae, Marine drugs, Pathways.

## INTRODUCTION

### Diabetes Mellitus

Diabetes is one of the major global metabolic disorders characterized by chronic hyperglycemia and insulin resistance [1]. The impact of *diabetes* m*ellitus* is deter-

* **Corresponding author Kareem Altaff:** Department of Marine Biotechnology, AMET University, Chennai-603112, India; Tel: +91- 9444108110, Fax: 91-44-27472804 / 2747 2904; E-mail: deankaltaff@gmail.com

**Velmurugan Devadasan, Atanu Bhattacharjee, Raman Pachaiappan and Gayathri Dasararaju (Eds.)**

mined by the degree of fat accumulation, enlarged visceral adiposity, and abdominal waist-to-hip ratio. Besides body fat distribution, abnormal glucose homeostasis occurs, leading to an irregular transportation and storage of glucose in the peripheral tissues, such as skeletal muscle, adipocytes, and hepatocytes [2 - 4]. The identification of molecular target drugs involved in the regulation of glucose and lipid metabolism can be crucial in the management of the metabolic syndrome.

Diabetes mellitus is the fastest-growing pandemic associated with metabolic syndrome [5]. The International Diabetes Federation estimates that 415 million people worldwide presently have diabetes, which is projected to increase to 642 million by 2040. In India, around 69.2 million adults are assessed as afflicted with diabetes, and by 2040, over 100 million people are projected to be affected by diabetes. Type 2 Diabetes mellitus (T2DM) is a polygenic disorder of carbohydrate and lipid metabolism, accounting for 90-95% of the diabetic population [6]. Type 1 Diabetes mellitus (T1DM) typically affects children and about 5% – 10% of the overall diabetic population [7].

T2DM is characterized by an improper secretion and action of insulin leading to modulations in the insulin signaling cascade causing an elevated blood glucose level and an impaired insulin resistance with disturbed carbohydrate and fat metabolism [8]. The etiologies of T2DM are complex and include genetic predisposition, consumption of a high-fat diet, sedentary lifestyle, and aging. This leads to other associated metabolic complications such as obesity, cardiovascular disease (CVD), stroke, liver steatosis, and microvascular complications such as renal failure (nephropathy), foot ulcer, and blindness [9].

## MECHANISMS OF CARBOHYDRATES HYDROLYZING ENZYMES

Reducing the conversion of dietary complex carbohydrates into glucose and reducing the passage of glucose across the intestinal wall into the bloodstream are the two key components of treating Type 2 diabetes. Postprandial blood glucose levels can be decreased by inhibiting enzymes that hydrolyze carbohydrates. Amylase and glucosidase are the two main carbohydrate hydrolyzing enzymes in charge of breaking down dietary polysaccharides. Pancreatic amylase catalyzes the initial stage of dietary starch digestion by breaking down the starch into a combination of tiny oligosaccharides. Following this process, glucosidase continues to break down oligosaccharides into glucose. After that, the gut wall allows this glucose to pass into the blood, raising postprandial blood glucose levels (Fig. **1**).

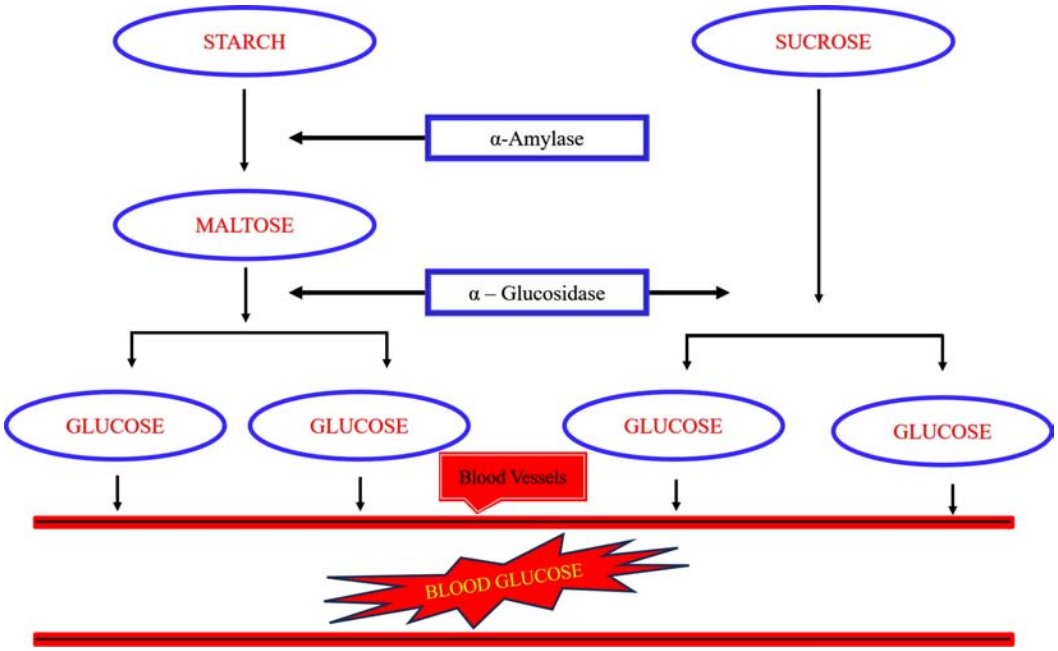


**Fig. (1).** Mechanisms of carbohydrates hydrolyzing enzymes.

## MECHANISMS OF COMMERCIALLY AVAILABLE ANTIDIABETIC DRUGS

Although an effective treatment is focused on the reduction of blood glucose levels, the therapeutic approach is mostly targeted toward improvement in insulin secretion and action [10]. Currently, there are several agents for therapeutic use that mostly target the transportation and metabolism of glucose (biguanidine and thiazolidinediones), insulin secretion and insulin action (sulfonylureas, meglitinides, GLP1 Mimetics and DPP4 inhibitors) and inhibitors (α-glucosidases) of glucose absorption [11].

Metformin, a biguanidine class of drug, is used as a first-line treatment for increasing insulin sensitivity and its glucose-lowering potential [12]. It has also been claimed to reduce fatty acid-mediated insulin resistance by activating the enzyme 5' AMP-activated protein kinase (AMPK) in the liver and inhibiting the enzyme acetyl CoA carboxylase as a result [13]. The usage of this drug exhibits adverse effects such as intestinal discomfort, renal failure and lactic acidosis [14].

Thiazolidinediones (TZDs) are a glitazone class of drugs targeting insulin action chiefly in skeletal muscle and adipocytes [15]. TZDs, including rosiglitazone and pioglitazone, reduce insulin resistance through the activation of peroxisome proliferator-activated receptor Û (PPARÛ) and AMPK. The long-term usage of

CHAPTER 2

# Disease Treatment Using Health Supplements from Herbs

**Vinduja Vasudevan[1], Raman Pachaiappan[1,*], Anantha Krishnan Dhanabalan[1]** and **Velmurugan Devadasan[1]**

[1] *Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India*

**Abstract:** Recently, there has been a surge of investment in various dietary supplements as these offer varied health advantages and are alternatives to the existing treatment. Dietary supplements are frequently used and have the capacity to boost health if given to individuals who need them. Micronutrient inadequacies and nutritional deficiencies are common conditions that have a negative influence on global well-being. Although better diet quality is imperative to fix these problems, people who are at risk for deficiencies may benefit from dietary supplements and/or food fortification to assist them in fulfilling their nutritional needs. The goal of this review is to evaluate the key minerals as well as the fat-soluble vitamins and water-soluble vitamins that are vital for human health and well-being.

**Keywords:** Dietary medicine, Health supplements, Herbs, Minerals, Vitamins.

## INTRODUCTION

Minerals and vitamins are indispensable micronutrients. Humans are unable to produce essential nutrients, at least not sufficiently, thus they must be received through diet. The management of tissues, the development and health of bones and teeth, the activity of cofactors as well as coenzymes in various enzyme systems, the regulation and synchronization of most bodily functions, and many other biochemical and physiological processes are just a few of the many health advantages of micronutrients (vitamins and minerals). In order to regulate numerous physiological functions and preserve health, micronutrients are especially required throughout lifetime by humans and other creatures in varying levels. All living things, including humans, depend on minerals as critical nutri-

* **Corresponding author Raman Pachaiappan:** Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India; Tel: +91 94 8643 3614, Fax: +91-044–27452343; +91-44-22121155;
E-mail: pachaiar@srmist.edu.in

ents to perform the processes necessary for survival and good health. Micronutrient deficiency can result from restricted access to or adaptability to a healthy, well-balanced diet in poor nations, with permanent health effects impacting morbidity and death. Hence, the incorporation of minerals and vitamins into the diet as dietary supplements is critical to counteract the problem of micronutrient deficiency.

## Vitamins

Vitamins are essential micronutrients vital for the growth and development of the human body. Ingested through food, vitamins are divided into water-soluble and fat-soluble categories. Surplus water-soluble vitamins ingested through food are eliminated from the body. Fat-soluble vitamins are retained in the liver and adipose tissue.

## Fat-soluble Vitamins

The vitamins that are fat-soluble are A, D, E, and K. According to their molecular structure, every fat-soluble vitamin is subdivided into other classes. Vitamin A has two distinct classifications. The retinoids are one type. The additional vitamin A variants are carotenoids. Carotenoids, including β-carotene, are compounds from plants that are processed into vitamin A. Tocopherols and tocotrienols, each comprising four subgroups, are the two classifications of vitamin E. Vitamin K is categorized as both a phylloquinone and a menaquinone. Vitamin D is categorized as vitamin D2 ergosterol as well as vitamin D3 cholecalciferol. Once ingested, the absorption and metabolism of fat-soluble vitamins entail a series of intricate processes. Absorption of fat-soluble vitamins requires a number of metabolic reactions and the occurrence of fat in the intestines. Each vitamin that is fat-soluble possesses a distinct structure and should be carried into the bloodstream by lipoproteins. They are then transferred to the liver as well as other adipose tissue, where they are utilized and stored. Deficiencies in fat-soluble vitamins can affect numerous physiological systems, including the immune system. Vitamins A, D, E and K have important functions in the immunological system, and deficiency can negatively affect general health as well as overall quality of life [1].

### *Vitamin A*

It is a yellow antioxidant vitamin that is fat-soluble. Vitamin A exists in various forms, such as retinoic acid, retinoids, retinal, and retinol, which are derived from animal sources. There are other provitamin A molecules derived from plants, such as the carotenoids lycopene, lutein, and β-carotene. Black-eyed peas, red peppers, spinach, mangoes, carrots, cheese, butter, green leafy vegetables, cantaloupe, kale,

milk, and sweet potatoes are all sources of vitamin A. Vitamin A contributes to eyesight, the growth and development of embryonic cells, the immune system, and the maintenance of epithelial cells. It is also a potent antioxidant that adds to numerous health benefits. Hepatic stellate cells retain up to 80% of vitamin A as retinyl palmitate in the liver that is stored in lipid droplets and ready to fuel the body. Vitamin A influences the immune system. It participates in innate and cell-mediated immunity as well as the antibody response. The innate immune system consists of barriers like the skin, the cellular lining of the digestive tract as well as the respiratory tract, and secretions, including tears. The immune system's humoral antibody reaction consists of antibodies and antigens to safeguard the body from numerous diseases. Vitamin A plays a role in how the antibodies in the body react to infections. Retinoic acid aids in the production of natural killer cells that have anticancer and antiviral properties. Retinoic acid also stimulates the phagocytic action of macrophages and the production of inflammatory mediators like interleukin (IL)-1 and other cytokines. It also facilitates the formation of B and T cells. Due to its effect on immune function, vitamin A has been shown to influence the reaction and defense in the body against the measles virus [1]. Vitamin A is primarily used to treat dermatological diseases and lesions (due to downregulation of keratin production and release of mucous), xerophthalmia, cold, warts, corns and calluses (skin infections), acne, and psoriasis as well as prolonged follicular hyperkeratosis of arms, night blindness and breast cancer [1].

### *Vitamin D*

Vitamin D is generally referred to as “sunshine vitamin”. Vitamin D can be produced in the skin through exposure to sunshine. Vitamin D7 is also regarded as a prohormone. Vitamin D3, also referred to as D7-dehydrocholesterol, as well as vitamin D2, also defined as ergosterol, are subcategories of vitamin D. Ergocalciferol, often known as vitamin D2, is acquired from food sources through food fortification. Vitamin D3 plays a role in the intestinal uptake of phosphorus and calcium, which is ultimately used to influence bone mineralization. Vitamin D is liable for calcium and phosphorus control and distribution in the body. Vitamin D is related to bone growth and skeletal development. Vitamin D is obtained from the diet and UV light from the sun. It undergoes a distinct physiological process that can influence other cells and tissues. Vitamin D's primary role is to aid in the serum phosphorus and calcium concentrations necessary for bone and cell formation. Vitamin D promotes the formation of osteoblasts and osteoclasts in bone tissue. Vitamin D is found in bone and aids osteoclastogenesis in the body. Vitamin D regulates the formation of osteocalcin. Vitamin D also occurs in the parathyroid glands and plays a function in the release of parathyroid hormone. Vitamin D is vital for the uptake of calcium and phosphorus in the digestive tract, which is then distributed and utilized in the

# CHAPTER 3

# Herbal Nutraceuticals for Disease Prevention and Management

**Raman Pachaiappan[1], Vinduja Vasudevan[1], Janani Prabaharan[1], Anantha Krishnan Dhanabalan[1]** and **Velmurugan Devadasan[1,*]**

[1] *Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India*

**Abstract:** In recent years, there has been a surge of interest in nutraceuticals, which offer health advantages and are alternatives to the existing treatment. Nutraceuticals can be extracted, incorporated as dietary supplements, and added to foods. Nutrients, herbs, and dietary supplements are the primary components of nutraceuticals that make them useful for preserving health, combating various diseases, and enhancing the quality of life. The booming expansion, research advancements, marketing fervor, quality control, and regulation will have a significant impact on their success or failure. The intention of this review is to evaluate the principal nutraceuticals that have an important function in the mitigation and cure of infectious as well as non-infectious illnesses.

**Keywords:** Disease prevention, Food supplements, Functional foods, Herbs, Nutraceuticals.

## INTRODUCTION

Nutraceuticals are naturally occurring biologically active chemical substances with health-promoting and disease-preventing benefits. Nutraceuticals exist in a mixture of products originating from (a) the food industry, (b) the herbal as well as dietary supplement market, (c) the pharmaceutical industry, and (d) the recently integrated pharmaceutical/ agribusiness/ nutrition consortiums. Nutraceuticals may include isolated nutrients, herbal products, dietary supplements, and diets, as well as genetically modified "designer" foods and processed foods like cereals, soups, and beverages. They provide significant potential for researchers and industry professionals to capitalize on their value. The nutraceutical sector has

[*] **Corresponding author Velmurugan Devadasan:** Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India; Tel: +91 98410 75847; Fax: +91-044-27452343, +91-44-22121155;
E-mails: shirai2011@gmail.com, velmurud@srmist.edu.in

utilized a broad spectrum of phytochemicals encompassing polyphenols, isoflavanoids, phytosterols, limonoids and terpenoids *via* therapeutic activity on humans as anti-inflammatory, anti-allergic, antioxidants, neuroprotective, antibacterial, antifungal, anti-cancer, *etc*. Through this review, we will be providing an evaluation of several nutraceuticals that can be employed in disease prevention and management.

## Infectious Diseases

### *Antimicrobial Activity*

In the recent decade, the antibacterial efficacy of compounds isolated from natural sources has received extensive exploration. One of the most well-known biological properties of coriander leaves and seeds, as well as their extracts and essential oils, is antimicrobial activity. Several bacteria and yeast species were inhibited by the essential oil and aqueous extract of coriander leaves. The essential oil had a strong inhibitory impact against gram-positive as well as gram-negative bacteria [1].

Regarding the antibacterial properties of alkaloids, studies that have been conducted over the years have demonstrated that most of these compounds may be successful in treating numerous bacterial infections. Sanguinarine is an alkaloid that expresses antimicrobial properties. Long recognized for its antimicrobial and anti-inflammatory characteristics, sanguinarine is a benzophenanthridine alkaloid obtained from the rhizomes of *Sanguinaria canadensis*. *In vitro* studies have demonstrated that sanguinarine inhibits bacterial adhesion to the teeth's surface, thereby expressing an anti-plaque effect. This alkaloid exhibits an antimicrobial effect by suppressing bacterial cytokinesis and interfering with the production of bacterial FtsZ Z-rings. Several research studies investigated tomatidine, a steroid alkaloid derived from tomato plants, as an alternate virulence attenuator agent for *S. aureus* as well as for *S. aureus* small-colony variant phenotypes, which may be important in the development of chronic infections. In addition to possessing anti-virulence efficacy against normal *S. aureus* strains, tomatidine also exhibits synergistic effects with aminoglycoside antibiotics, as demonstrated by these investigations. In addition, tomatidine's antimicrobial action against the growth of *S. aureus* in the presence of *Pseudomonas aeruginosa* has been studied. In cystic fibrosis illnesses, these two viruses frequently coexist, and the implications of these co-infections have previously been documented. When *S. aureus* is cultivated in the presence of *P. aeruginosa*, tomatidine has a potent bactericidal effect. Additionally, a number of alkaloids prevent the production of biofilms. 6-gingerol, an oil extracted from fresh ginger, inhibits the synthesis of virulence factors, including rhamnolipid,

pyocyanin, and elastase, hence reducing biofilm formation in *P. aeruginosa* [2]. Allicin (diallyl-thiosulfinate) is derived from crushed garlic by the conversion of alliin to allicin by the enzyme alliinase. Allicin has revealed antibacterial action against *Burkholderia cepacia*, *S. epidermidis*, *S. agalactiae*, MRSA, *P. aeruginosa* and dental infections responsible for periodontitis and caries [3].

*Pseudomonas aeruginosa*'s quorum sensing regulated virulence factors can be utilized to address antimicrobial resistance. In a study on*P. aeruginosa,* virulence factor production controlled by N-acylhomoserine lactone, two flavonoids (apigenin and acacetin), as well as three isoflavonoids (genistein, daidzein, biochanin A) was examined (AHL). In the investigation, biofilm formation, rhamnolipid, pyoverdin, pyocyanin, and exo-polysaccharide synthesis were studied as virulence factors. The flavone acacetin was shown to have the highest inhibitory activity against all bacterial virulence factors, based on the findings of the research. In addition, treatment of the compounds triggered a remarkable decline in the expression of virulence genes, indicating that these substances are strong anti-quorum sensing targets [4]. In another study by Chandran *et al.* [5], a 14kDa protein was isolated from *Ferula asafoetida* (asafoetida) root exudate using chromatographic techniques. This protein was shown to exhibit an antiviral effect against *Pseudomonas aeruginosa*.

A study revealed the bioactive compounds present in black cumin seed oil (*Karumjeerakam kuzhi thailam*). The study showed the antibacterial effects of this oil against *Staphylococcus aureus* and *Pseudomonas aeruginosa* at 10µg/mL concentration. GC-MS analysis showed the presence of various antibacterial compounds such as maculosin, hygrine and N-[2-[4-[2- (hydroxyamino) etylamino] butylamino] ethyl] hydroxylamine [6]. Molecular docking studies have been undertaken by us to check the binding of tomatidine, sanguinarine, allicin, 6-gingerol, biochanin A, apigenin, genistin and daidzein against *Staphylococcus aureus* FtsZ target of bacterial related infections [7, 8]. Table **1** shows the docking score, energy, and hydrogen bond interactions. Fig. (**1**) shows Ligplot interactions [9]. The interactions common with that of the co-crystal are shown in bold letters. The results of the interactions are depicted below.

**Table 1. Results of induced-fit docking studies on *Staphylococcus aureus* FtsZ [PDB id: 3VOB].**

| Compounds | Docking Score (kcal/mol) | Glide Energy (kcal/mol) | Hydrogen Bond Interaction | Distance (Å) |
|---|---|---|---|---|
| Sanguinarine | -10.90 | -51.97 | --- | --- |
| Allicin | -3.21 | -28.60 | (LEU209) N-H…O1 | 2.76 |
| Tomatidine | -8.32 | +51.29 | N1-H…OG1 (THR265) | 3.15 |

# CHAPTER 4

# Herbs as Dietary Medicine

**Velmurugan Devadasan[1], Vinduja Vasudevan[1], Harykrishnan Suresh[1], Anantha Krishnan Dhanabalan[1]** and **Raman Pachaiappan[1,*]**

[1] *Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India*

**Abstract:** Nutraceuticals can be utilized to improve wellness, reduce the rate of aging, avert chronic diseases, prolong life, andkeep the body in good shape. Because of their excellent nutritive, safety, as well as potential health benefits, nutraceuticals have lately received considerable interest. Supplementing the diet can help fulfill the increased nutritional requirements of one's highly demanding lifestyle or health condition. Stress, health problems, and a vigorous lifestyle can all lead to an increased demand for very precise minerals or vitamins in the body. This article provides insight into various plant compounds that have therapeutic properties and that can be used as health supplements with nutraceutical activities.

**Keywords:** Herbs, Health, Dietary medicine, Primary metabolites, Secondary metabolites.

## INTRODUCTION

Dietary medicines/supplements and nutraceuticals are non-pharmaceutical substances that are similar but not quite the same. Nutraceuticals are supplements that possess health advantages aside from their nutritive value. A nutraceutical differs from a dietary supplement in that it should not only enrich the diet but at the same time prevent the occurrence of a disease and also aid in disease management [1]. Plant nutraceuticals are currently gaining global recognition for their possible use as therapies for the long-term therapy and control of inflammatory diseases, neurological disorders, and severe chronic diseases, particularly cancer [2]. Phytochemicals are active plant compounds that protect plants from diseases and injury and are found in several areas of the plant, including the stems, seeds, roots, flowers, and fruits. A vast spectrum of bioactive

* **Corresponding author Raman Pachaiappan:** Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur–603 203, Chengalpet Dt., Tamil Nadu, India; Tel: +91 94 8643 3614;
Fax: +91-044-27452343, +91-44-22121155; E-mail: pachaiar@srmist.edu.in

**Velmurugan Devadasan, Atanu Bhattacharjee, Raman Pachaiappan and Gayathri Dasararaju (Eds.)**

chemicals can be found in plant nutraceuticals, which interact with multiple targets in various organs to elicit their impact at a systemic level. However, the anti-oxidant, hypocholesterolemic, anti-inflammatory, anti-proliferative, and anti-microbial properties are the most important. The bioactive phytochemicals can be derived from various plants and foods, and they have the ability to modulate metabolic activities, resulting in positive outcomes. The occurrence of bioactive compounds normally existing in food or produced de novo via metabolic processes has been associated with these beneficial effects [3]. Traditional medicines, such as herbal dietary supplements, have made a comeback in 21st-century medicine. Despite this, they also constitute molecules that are alien to humans (xenobiotics) and have the same pharmacological issues as artificial therapeutic medications. Hence, it is critical for all stakeholders, including the medical community, investigative scientists, authorities in charge of regulatory affairs, and the general public to comprehend the unique qualities of botanicals, as well as their likelihood of succeeding in disease prevention and treatment [4].

## PRIMARY METABOLITES

Plants contain a vast spectrum of organic molecules, which are classified as primary or secondary metabolites based on their direct involvement in the growth and development of the host. The main metabolites, which are found in all plants, play a critical role in metabolism. All plants include organic acids, phytosterols, nucleotides, acyl lipids, and amino acids, and these substances are directly engaged in their metabolism, making them primary metabolites. These compounds have a wide spectrum of structural features and are often variably distributed throughout specific taxonomic categories among the plant kingdom [5].

### Vitamins

Vitamins are crucial for human health because of their antioxidant properties and can be used as nutraceuticals. Vitamin shortages are common in smokers and individuals with special dietary habits, and these nutraceutical supplements can help in these instances. Vitamin shortage is caused by a lack of food intake, the body's inability to absorb nutrients, and inefficient utilization. Seaweeds contain significant concentrations of B complex vitamins (B1, B2, B12), anti-oxidant vitamins (i.e., vitamins C and E), provitamins A and E, as well as carotenoids [6]. They aid in the decrease in the number of deaths from cerebrovascular illnesses and have a beneficial effect on lung and cervical malignancies. Vegan diets are typically deficient in vitamin B12, which is abundant in red algae (*Porphyra* sp.). It was also reported that patients who eat vitamin C-rich diets have a lower risk of acquiring stomach cancer than those who consume a conventional diet [7].

According to research, Shilajit and B-complex vitamins work together to help avoid Alzheimer's disease. For the therapy of dry and itchy eye symptoms, oral supplementation with nutraceuticals containing antioxidants, minerals, vitamins and omega-3 fatty acids is effective [8]. As a result, vitamins have a lot of potential and can be incorporated into diet as a health supplement [9]. Vitamin C is a powerful antioxidant that enables the connective tissues to stay healthy by promoting collagen formation. Vitamin C has been recommended as an immune-boosting substance against flu by the nutraceutical sector. Several investigations have shown that it can help avoid pneumonia and sepsis. Researchers discovered that vitamin C pretreatment decreased cold and flu symptoms at very high dosages and improved symptoms when administered as treatment in prospective-controlled research. According to recent research, vitamin C can be used as a prophylactic treatment for COVID-19 in low doses and as an adjuvant therapeutic treatment in higher amounts. Vitamin D, widely referred to as the sunshine vitamin, is found in a variety of vegetarian and non-vegetarian foods as well as supplements. Vitamin D is a vitamin, a hormone, and an immunomodulator all in one. Vitamin D supplementation has been proven in many investigations to lower the chance of disease, alleviate symptoms, and prevent death from influenza and COVID-19, among other respiratory diseases, through various pathways. Vitamin D boosts innate immunity in the respiratory system, lowering COVID-19 transmission rates. Vitamin E, also known as tocopherol, is a fat-soluble antioxidant with a high antioxidant capacity. Vitamin K triggers the Gla protein in the extracellular matrix, which aids in shielding the pulmonary as well as vascular fibers from damage [10].

## Carbohydrates

Carbohydrates have a positive impact on human physiology and metabolism. They aid in the mitigation of a variety of chronic diseases, including cancer, heart disease, diabetes, obesity, as well as gastrointestinal disorders. Starchy carbohydrates are an important energy source and help to keep the digestive system in good condition. Research on the utilization of bioactive carbohydrates in functional foods is still in its inception.

Complex non-starch carbohydrate consumption (particularly polysaccharides) has been associated with a lower risk of diseases such as cancer, heart disease, and diabetes, according to research. Inulin (fructans), fructose, and some other oligosaccharides, for instance, promote the growth of health-promoting bacteria such as *Bifidobacteria*, which can restrict the growth of potentially hazardous anaerobic gut microbes while also acting as immunomodulators [11]. According to new research, eating a balanced diet of carbohydrates and proteins has a positive influence on the gut bacteria count, which possesses numerous health

# CHAPTER 5

# Evaluation of Anti-aflatoxicosis Potential of *Solanum americanum* Mill. – An Important Traditional Medicinal Plant

**N. Yogananth[1], R. Selvi[2], M. Syed Ali[1], Velmurugan Devadasan[3], Anantha Krishnan Dhanabalan[3,*]** and **R. Muthezhilan[4,*]**

[1] *PG and Research Department of Biotechnology, Mohamed Sathak College of Arts and Science, Sholinganallur, Chennai-600119, Tamil Nadu, India*

[2] *Research and Evaluation, Bharathiar University, Coimbatore, Tamil Nadu, India*

[3] *Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur-603203, Chengalpet Dt., Tamil Nadu, India*

[4] *Department of Marine Biotechnology, AMET University, Chennai-603112, India*

**Abstract:** The contamination of aflatoxin (AF) in animal diets manifests harmful effects on animal health and productivity. The effect of ethanolic leaf extracts of *Solanum americanum* in rat diet against aflatoxicosis has been discussed. All hematological and biochemical parameters of AF-alone treated rats were significantly changed when compared to normal diet-treated ones. The obtained results indicated that the administration of the leaf extract of *S. americanum* to aflatoxicated rats improved the hematological and biochemical parameters toward their respective normal value. Molecular docking studies have been undertaken for the phytoconstituents reported for this plant against two cancers and inflammation-related protein targets. The results of this study indicated that *S. americanum* has the possibility of serving as an easily obtainable natural antiaflatoxigenic source for food supplements or the pharmaceutical sector.

**Keywords:** Aflatoxin, Antiaflatoxigenic, Molecular docking, Rat diet, *Solanum americanum*.

## INTRODUCTION

Aflatoxicosis is a poisoning that results from ingestion of aflatoxin. Aflatoxin is a well-known contaminant of foods especially in the staple diets of many develo-

* **Corresponding R. Muthezhilan:** Department of Marine Biotechnology, AMET University, Chennai-603112, India; Tel: +91-9443873501, Fax No: 91-44-27472804/27472904, E-mail: mycomuthu@gmail.com

ping countries. The toxin is produced by *Aspergillus flavus* and *A. parasiticus*, which are inevitable food contaminants. The United States Food and Drug Administration (FDA) considers it to be an unavoidable contaminant of food during production, harvest, storage, and food processing. Food storage facilities in subtropical and tropical areas of the world are insufficient, which allows fungi to attack cereals, nuts, oil seeds, milk, and spices. Aflatoxin contamination has an economic impact on all stages of food production, including the raising of livestock and crops, food processing, and food distribution [1]. Animals exposed to chronic amounts of these substances through their food and easily contaminated agricultural products may be the primary factor in profit or loss [2, 3].

Along with biological impacts, aflatoxin also has biochemical effects. Aflatoxin toxicity can influence proteins, lipids, nucleic acids, and carbohydrates in biochemistry, but they can have negative biological effects such as cancer, teratogenicity, and hepatotoxicity [4.5]. Among other diseases, aflatoxins are particularly carcinogenic in humans, and eating contaminated food can result in liver cancer. Incidents of aflatoxins in livestock can also result in economic losses due to increased susceptibility to disease and decreases in productivity. Eventually, humans and animals that consume aflatoxins-contaminated feed develop a variety of health problems, such as growth retardation, hematological disorders, nephrotoxicity, genotoxicity, and immunotoxicity [6, 7].

Numerous studies have been carried out to avoid harmful effects caused by aflatoxin. Controlling of aflatoxin by using atoxigenic strains of A. flavus and Bacillus thuringiensis, and heating with pressure, chemicals and microbes or probiotics such as various Lactobacillus species toxin binders such as clay and hydrated sodium calcium are reported [8 - 13]. It is not advised that certain adsorbents be added to the diet without thorough testing, despite the fact that they have been proven to reduce nutrient utilization [14] and mineral absorption in animals [15]. In recent years, researchers have been interested in natural scavengers for their ability to reduce aflatoxin toxicity as consumers become more sensitive to residual pollution and the toxic effects of these products.

*Solanum americanum* Mill., generally known as black nightshade, is a dicot weed of the Solanaceae family. It has long been used historically to treat a wide range of illnesses, including pain, inflammation, and fever. As an antitumorigenic, antioxidant, diuretic, and antipyretic agent, as well as an anti-inflammatory, hepatoprotective, antibacterial, and antiulcer agent, this plant is also employed in Oriental systems of medicine [16]. This plant's leaves include minerals like calcium, iron, and phosphorus, as well as carbohydrates, protein, and fat. Alkaloids, steroid alkaloids and steroids, glycoprotein, flavonoids, tannins, saponins, glycosides, proteins, sugars, coumarins, and phytosterol are just a few

of the secondary metabolites found in the plant. Riboflavin, nicotinic acid, vitamin C, beta-carotene, citric acid, protein, fat, steroid alkaloids glycol, solasonine, and solamargine acid are all abundant in the leaves. These data motivated the need for a study to assess the impact of *Solanum americanum* ethanolic leaf extracts on aflatoxins and establish the optimum dose to reduce aflatoxicosis.

## MATERIALS AND METHODS

### Sample Collection

The leaf parts of *Solanum americanum* were collected from 3-5 months old healthy plants growing at Jawadhu Hills region, Chengam, Tiruvannamalai Dt, Tamil Nadu, India. The authorities verified and taxonomically recognized the plant by Dr. C. Murugan, scientist-D and head of Botanical Survey of India, Southern Regional Centre, Coimbatore, Tamil Nadu, and India. The plant parts were thoroughly washed with running tap water and air-dried at room temperature for a week. After drying, the leaf was powdered and extracted by using a soxhlet apparatus at 470°C. Ethanol was used as a solvent.

### Experimental Procedure

Aflatoxin was produced from *A. flavus* culture through the rice fermentation method [17]. Tap water (25 mL) was added to the rice (50 g) in the 250 mL Erlenmeyer flasks, and the mixture was shaken often while it stood for two hours. After cooling down and autoclaving for 15 minutes at 121°C, A. flavus spores were added to the flasks. The glass flasks were kept at room temperature (25±1°C) in a dark, moist atmosphere while being shaken briskly by hand at least six to ten times a day to prevent clumping. The fungus growth was observed in the rice medium (green color) after 10 days of incubation, and contaminated rice was treated in a steam bath for 10 mins to arrest further growth of fungus and aflatoxin production. Then, the rice was dried overnight at 60°C in a hot air oven. The moldy rice was homogenized and quantified by using Modified Romer's method.

The moldy rice powder at 6-ppm concentration was mixed with the commercial rat feed ad libitum and fed to the rats for 3 weeks to induce carcinogenicity, followed by a progression period of 3 weeks with a normal diet. Silymarin (25mg/kg b.wt.) was used as a standard hepatoprotective drug for comparison. Initial LD50 studies carried out were used to ascertain the highest dose (75 mg/kg) that did not cause the rats to perish. Twenty five and 50 mg/kg b.wt of *S. americanum* was suspended in physiological saline and administrated orally. The experimental rats were divided into 06 groups as follows:

CHAPTER 6

# Herbal Medicine: History, Contemporary Use and the Future

**Rik Ganguly[1], Prosperwell Ingty[1], Shashi Kumar Yadav[1], Angneh Ngoruh[1], Velmurugan Devadasan[2]** and **Atanu Bhattacharjee[1,*]**

[1] *Department of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-793022, India*

[2] *Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur – 603 203, Chengalpet Dt., Tamil Nadu, India*

**Abstract:** The plant kingdom is as diverse as the animal kingdom. There are several species that are yet to be discovered or whose therapeutic properties are undiscovered. Many of the species may have become extinct before they were discovered. This work investigates the function of herbalism in the context of its history and significance. The diversified geographical terrain sustaining several indigenous species of plants of medicinal importance is described. The usage of herbal practices and several techniques are highlighted. The toxicity of plant-based medicines and the progress of several clinical trials are also discussed.

**Keywords:** Berbalism, Indigenous, Therapeutics, Topographical, Toxicity.

## INTRODUCTION

The original date when humans began utilizing botanicals for therapeutic reasons is unclear. For thousands of years, humans have utilized plants to treat a wide range of illnesses [1]. Herbalism's history was intertwined with the history of medicine in ancient days until the advent of the germ theory of disease in the nineteenth century. The use of herbal remedies was first mentioned in writing in about 2800 B.C. in China [2]. The oldest written evidence for the use of medicinal plants in herbal preparation was discovered on a Sumerian clay slab, which was found in Nagpur, India about 5000 years back, and included 12 drug-preparation formulas mentioning over 250 different plants, among which were alkaloid-rich plants, such as poppy, henbane, and mandrake [3]. Plant products have been exploited for medicinal purposes since far before known history, at least as far

* **Corresponding author Atanu Bhattacharjee:** Department of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-793022, India; Tel: +91 9436703339, Fax: +91-364-2551634, E-mail: atanubioinfo@gmail.com

**Velmurugan Devadasan, Atanu Bhattacharjee, Raman Pachaiappan and Gayathri Dasararaju (Eds.)**

back as the Palaeolithic era, about 60,000 years ago [4]. India has a rich culture of therapeutic herbs and spices, over 2000 species, and a broad geographical region with great potential for Ayurvedic, Unani, and Siddha traditional medicines, but only a fraction has been chemically and pharmacologically studied for their potential medical worth [5]. Ayurveda refers to the use of medicinal herbs and is an important part of Indian culture. The Vedas, the Indian holy scriptures, suggest therapy using herbs, which are widespread in the nation [6].

## Sacred Knowledge of Babylonian Medicine and Treatments

Babylon was the capital city of the ancient Babylonian Empire, which was one of two independent empires in the Mesopotamian region in antiquity. Cuneiform tablets are the primary source of information on ancient medical procedures in this region (Shown in Fig. **1A**). [7]. The Babylonian term for the physician, asu, has originated from the Sumerian a-zu or ia'-zu, meaning 'the one who knows water (or oil)'; presumably relating to divination by water with the help of the water God Ea [Enki] [8]. Before 1000 BCE, medicine in the ancient Near East was a well-developed profession by the time the Old Babylonian and Old Assyrian periods arrived (c. 2100-1500 BCE). It became more streamlined by the time of the Bronze Age collapse (c. 1200 BCE) and the subsequent rise of the Neo-Assyrian Empire [9]. The Uruanna: matakal (meaning 'the plant whose home is heaven is the plant matakal') is one of the best-documented cuneiform medicinal texts. It comprises over 1300 plant-derived pharmacological names that, when combined with variations and synonyms, define approximately 340 distinct plants. The incantations engraved in the old cuneiform excavated reveal the fact that they believed in the use of spells with the massage that can heal the patients (Shown in Fig. **1C**) [10]. Plants (herbs, trees and shrubs, spices, grasses, algae, fragrant plants, and fungus) dominated the repertoires of Babylonian healers; many were also common diets (onion, garlic, pomegranate, fig and date) [11]. The Babylonians were not only good with herbal knowledge, but they were also well-known for their anatomical understanding as well. Diviners studied how the sheep's colon curled to make prophecies for their patrons (particularly kings) (Shown in Fig. **1B**) [12]. The Babylonian practice of healing was mostly through herbs with a spiritualistic approach [13].

## *Egyptian Medical Papyri, Herbs and Complementary Medicine*

Egypt has always been the land of mystery and magic, but most importantly, it has also given the world enlightenment about the usage of herbs [14]. The pharaohs place great value on health and well-being [15]. In ancient Egypt, both physicians and magicians engaged in the field of medicine. From a holistic standpoint, they saw health and illness as an ongoing battle between good and evil

[16]. Ancient texts like the Papyrus Ebers explain and disprove some of the mythology surrounding ancient herbal usage in Egypt [17]. Opium, cannabis, myrrh, frankincense, fennel, cassia, senna, thyme, henna, juniper, aloe, linseed, and castor oil are among the plant remedies described in the Ebers Papyrus [18]. Other papyri include the Edwin Smith Papyrus, which was written around 1500 BCE but is thought to be a copy from the Old Kingdom (3000-2500 BCE) and contains information on the oldest known surgical treatise on trauma [19]. Ramesseum medical papyri was written in the 18$^{th}$ century BC in hieroglyphic and hieratic language, explaining medicine, gynecology, ophthalmology, rheumatology and paediatrics [20]. The Hearst Papyrus was written in the 18$^{th}$ Dynasty of Egypt during the reign of Tuthmosis III, although it is thought to have been written earlier, during the Middle Kingdom, circa 2000 BC, in hieratic language, and mentions urology, medicine, and bites [21]. London Medical Papyrus was composed in hieratic language in the 19$^{th}$ dynasty (1300 BC or 1629-1628 BC), defining treatments for skin ailments, eye complaints, hemorrhage, miscarriage, and burns [22]. Brugsch Papyrus was written in the 19$^{th}$ dynasty dated 1350 - 1200 BC in hieratic language, exhibiting medicinal applications stated before in Ebers Papyrus [23]. Carlsberg papyrus was written during the 19$^{th}$ and 20$^{th}$ dynasties, largely in Hieratic and Greek, containing information about obstetrics and gynecology, medicine, pediatrics, and ophthalmology [24]. Chester Beatty Medical Papyrus, which dates back to the Ramesside Era around 1200 BC, used hieratic language to define mostly headache and anorectal disorders [25]. The Brooklyn Papyrus is a collection of papyri from the end of the 30$^{th}$ dynasty, circa 450 BC, or the beginning of the Ptolemaic Period. However, it is written in the Middle Kingdom style, suggesting that it might have originated from Egypt's Thirteenth dynasty. It only deals with snake and scorpion stings and the formula to drive out the venom of such creatures [26]. Erman Papyrus, from the beginning of the New Kingdom (16$^{th}$ century BC), defines medicine, magic, and anatomy [27]. Leiden Papyrus from the 18$^{th}$-19$^{th}$ dynasties depicted medical and magical knowledge [28]. Papyrus Oxyrhynchus 2547, written in the third century, contains a definition of the Hippocratic Oath, as shown in Fig. (**2**) [29].

# CHAPTER 7

# Identification of Phytochemicals Using GC-MS / LC-MS-MS Techniques and Modeling Studies against COVID-19 Targets

**Raman Pachaiappan[1], Vinduja Vasudevan[1], Nagasathiya Krishnan[1], Pinki Kumari Singh[1], K. Abinaya[1], Anantha Krishnan Dhanabalan[1], Atanu Bhattacharjee[2]** and **Velmurugan Devadasan[1,*]**

[1] *Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur-603203, Chengalpet Dt., Tamil Nadu, India*

[2] *Department of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-793022, India*

**Abstract:** The 'Severe Acute Respiratory Syndrome – Corona Virus -2' (SARS-CoV-2), identified first in China on 31st December 2019, immediately became a pandemic health concern. 'Coronavirus Disease–2019' (COVID-19) outbreak wasdeclared a global pandemic by the WHO in March 2020. More than 4,786,203 people died as a result of this illness, and about 233,908,734 people worldwide had been infected as of 1st October 2021. Multi-organ involvement of COVID-19 often leads to death and other complications like cerebrovascular and various thyroid diseases. As SARS-CoV-2 has a level of resemblance with SARS-CoV, the antivirals used earlier have been attempted in the COVID-19 treatment. Proposing new antivirals is a lengthy process for SARS-CoV2, and drug repurposing is also another route to reduce the number of deaths. SARS-CoV-2-infected patients who already have diseases like diabetes, hypertension, *etc*., are at more risk. Using phytocompounds as a control of SARS-CoV2 is also the need of the hour as the side effects of these are expected to be very less compared to the synthetic ones or vaccines. This review covers the above aspects in detail and reports the outcomes for the past few years period. The use of bioinformatics tools is also emphasized in this chapter.

**Keywords:** COVID-19, Drug repurposing, GCMS/LCMS-MS, Molecular docking, Phytochemicals.

* **Corresponding author Velmurugan Devadasan:** Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur-603203, Chengalpet Dt., Tamil Nadu, India; Tel: +91 98410 75847; Fax: +91-044–27452343, +91-44-22121155;
E-mails: shirai2011@gmail.com; velmurud@srmist.edu.in

## INTRODUCTION

As the spread of SARS-CoV-2 in the past two years was severe in most of the countries (which is under control now due to serious precautionary steps and vaccines), people played their part in controlling the spread by social distancing, frequent cleaning of hands and face, *etc*. Unfortunately, some new strains like alpha, beta, gamma and delta, and most recently, the Omicron (November, 2021) have come into existence. The risk factor is less for those who had vaccination twice. As SARS-CoV2 mostly resembles the earlier SARS-CoV, vaccines/drugs used earlier can be attempted here too. Many targets for inhibition of SARS-CoV-2 to control COVID-19 have been studied. The mechanism of COVID-19-causing virus is now known. The prime targets that need inhibitors are i. the SARS main protease M pro or the spike protein, ii. Angiotensin-converting enzyme (ACE2), and iii. RNA-dependent RNA polymerase (RdRp).

### Pathophysiology of COVID-19

The RNA viruses with the longest single-strand positive-sense genome are coronaviruses, which can be enclosed, spherical, or pleomorphic [1]. They are part of a vast virus family that is accountable for both the common cold and associated complications such as MERS and severe acute respiratory syndrome. Various coronavirus species were known to cause respiratory sickness prior to the current pandemic [2]. The HKU1, NL63, human coronaviruses 229E, and OC43 coronaviruses often only cause moderate symptoms and only infect the upper respiratory tract [3]. However, the other three coronaviruses, including the coronavirus associated with severe acute respiratory syndrome, the coronavirus associated with middle east respiratory syndrome, and the recently identified severe acute respiratory syndrome coronavirus-2, can enter the lower respiratory tract and cause deadly pneumonia.

Glycoprotein with trimeric spike present on the membrane of viral cells is responsible for coronavirus infection. Coronavirus spike proteins are class I fusion proteins that resemble the other viruses' envelope like the influenza hemagglutinin and the human immunodeficiency virus (HIV). Spike, envelope, nucleocapsid, and membrane proteins are the four types of structural proteins found in the virus. The RNA genome is held together by the nucleocapsid proteins, which also possess the other proteins together to constitute the envelope of the virus [4]. The virus penetrates healthy cells when the angiotensin-converting enzyme-2 receptor on the host cell membrane is in contact with the viral structural spike protein. After docking, the spike protein changes its shape, and the virus is transported via the endosomal pathway. The virus is subsequently released from its coating and translated into viral parts inside the cell. Following the assembly of nucleocapsids

in the host cells' cytoplasm, viral structural proteins are generated and then bud into the endoplasmic reticulum lumen. The virus' structural proteins are then expelled from the infected cell via exocytosis [5]. SARS-CoV-2 spreads largely by droplets in the airway via the fecal-oral route. Normal latency time with infection is four to five days before the first symptom emerges; however, 97.5 percent of symptoms occur in just 11.5 days [6]. Five to six days after the first symptom appears, the viral load peaks. Between 8 and 9 days after the symptoms start, individuals affected with COVID-19 experience severe acute respiratory distress syndrome, which includes robust inflammatory responses, hyaline membrane development, and lung fibrosis [7, 8]. As a result, the degree of disease is essentially determined by the immunological responses of the host cell. Breathing issues, hypoxia, and respiratory system failure characterize the severe acute respiratory syndrome coronavirus-2-caused acute respiratory illness syndrome, which is fatal in 70% of severe COVID-19 patients. When the COVID-19 virus interacts with immune cells, it causes strong inflammatory reactions and a higher chance of multi-organ dysfunction [9]. Interleukin-7, interleukin-2, interleukin-1, interleukin-6, interferon-γ, interferon-1β, induced protein-10 and monocyte chemoattractant protein-1 are considerably enhanced in individuals with COVID-19, leading to multi-organ failure. Increased levels of cytokines and chemokines enhance T lymphocytes and monocytes, two types of white blood cells, from the bloodstream to the area of inflammation [10]. Low lymphocyte level, high T helper cell to T regulatory cell ratio, and elevated neutrophil to lymphocyte ratio, which are present in roughly 80% of patients, may be linked to the inflow of white blood cells to lung tissue and lymphocytes into the respiratory system [6]. Thus, the life cycle of the virus can cause damage and death to cells and tissues, resulting in the severe acute respiratory syndrome coronavirus-2. The replication of COVID-19 in pulmonary epithelial cells has been shown to trigger pyroptosis with vascular leakage in COVID-19 patients [11]. Pyroptosis is a type of inflammatory programmed cell death that is induced by cytopathic viruses and results in an immunological response [12]. Aside from the damage to lung cells, the cytokine storm generates immunological responses, necessitating a greater effort in the recovery of damaged cells, as well as the inhibition or control of inflammatory reactions.

Transmission of the SARS-CoV-2 coronavirus results in the generation of variations, such as the B.1.617.2 (Delta) variety of concern, which is causing a new wave of infections and is now widespread throughout the world. These mutations reduce the efficacy of vaccine-elicited serum neutralizing antibodies in vitro and give a structural configuration for explaining how they evade the immune system. Several monoclonal antibodies are unable to recognize the B.1.617.1 (Kappa) and B.1.617.2 (Delta) spike glycoproteins due to changes in key antigenic regions, including remodeling of the B.1.617.2 (Delta) N-terminal

# CHAPTER 8

# Herbs in the Traditional Healthcare System of North East India

**Hirendra Nath Sarma**[1,*], **Archana Saikia**[1] and **Sonam Doima**[1]

[1] *Molecular Endocrinology and Reproductive Biology Research Laboratory, Department of Zoology, Rajiv Gandhi University, Rono Hills, Itanagar-791112, Arunachal Pradesh, India*

**Abstract:** The traditional healthcare system of North East India encompasses a rich repository of medicinal herbs that have been utilized for centuries to address various health concerns. Traditional medicine practitioners, with their distinct diagnostic methods, often rely on attentive observation and tactile examination to discern health issues, devoid of modern diagnostic instruments. Remedies are prepared from fresh plant materials collected from nature and prescribed to patients, frequently in composite forms comprising multiple herbs or their parts. In this study, we focus on three notable herbs: *Polygonum hydropiper, Coptis teeta,* and *Lasia spinosa.* They have been traditionally used to alleviate pain, reduce swelling, and treat conditions such as arthritis and rheumatism. Also, they possess antimicrobial, antioxidant and anti-inflammatory activities. These plants hold immense therapeutic potential and exhibit the invaluable wealth of traditional knowledge that continues to inform and enrich contemporary pharmaceutical endeavors.

**Keywords:** Behu, Geli-geli, Hioactivity, Mishmi Teeta, Phytochemistry.

## INTRODUCTION

The North Eastern Region of India is well known for its rich natural heritage. The region is located in the Eastern Himalayan region and the great Brahmaputra river basin and experiences a varied climate, which gives rich floral diversity. Assam and Arunachal Pradesh are two frontier states of India with this treasure of indigenous knowledge on traditional medicine systems. The inhabitants of these regions preserved a long and enduring custom of using plants and plant-derived products for various essential needs, such as cure and prevention of ailments not only for humans but also for domestic and wild animals. Investigation of natural resources, especially plants and their derivatives, based on the traditional knowle-

* **Corresponding author Hirendra Nath Sarma:** Molecular Endocrinology and Reproductive Biology Research Laboratory, Department of Zoology, Rajiv Gandhi University, Rono Hills, Itanagar-791112, Arunachal Pradesh, India; Tel: +91-9436059038, Fax: 0360-2277889; E-mails: hnsrgu@gmail.com, hirendra.sarma@rgu.ac.in

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dge system (TKS) to identify new pharmacological agents is one of the primary objectives of the current trend of pharmaceutical research. In traditional systems, herbs are used either in single or in composite form [1]. Traditional medicine practitioners have their own diagnostic system for health problems. They are often unaware of the modern medical practice for the diagnosis or the required active compound to treat particular health problems. They diagnose the symptoms of the health problems without using any instruments, instead, they listen attentively to the problems of the patients, feel the organs with their hands, and then come to a correct conclusion. The traditional healer prepares the medicines by collecting fresh plant materials from nature and prescribe the plant materials to the patients. Most commonly, the medicines are composite forms of multiple numbers of herbs or their parts They also prescribe the dose of the medicines in terms of the amount of the medicines as well as the duration of use. At the same time, they prescribe the food to be taken by the patients during the medication period. It has also been observed that certain medicines are prepared by the healers and given to the patients. Thus, innumerable traditional herbal preparations are in the record either in oral literature or written in ancient manuscripts. These cover a wide range of health problems, including women's reproductive health problems like dysmenorrheal, endometriosis, anovulation, early menopause, painful menstruation, abnormal menstrual cycle, recurring abortion, inducing permanent sterility, and polycystic ovary. They also diagnose infectious diseases like cholera, tuberculosis, leprosy, dysentery, vector-borne diseases like malaria, hookworm infection, *etc.*, and prescribe medicines accordingly. Three such plants, namely, *Polygonum hydropiper, Coptis teeta and Lasia spinosa* (Figs. **1-3**), which are widely practiced in traditional medicine among the ethnic communities of Assam and Arunachal Pradesh, are described below.

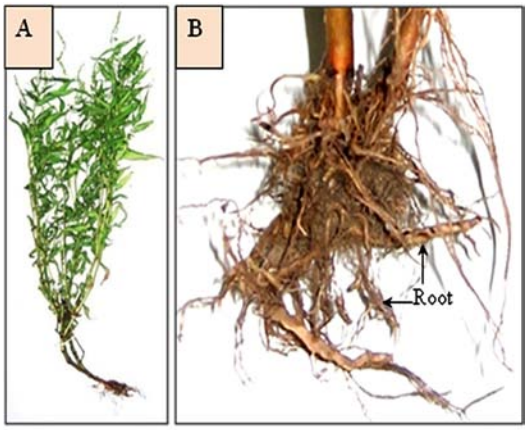


**Fig. (1 (A & B)).** The whole *Polygonum hydropiper* (A) and the roots (B).

**Fig. (2).** The plant of *Coptis teeta* with rhizome.

**Fig. (3).** The plant *Lasia spinose.*

## *Polygonum hydropiper*

*Polygonum hydropiper*, a perennial herb, is commonly known as "Behu" (Assamese vernacular name), and this herb grows in the wild in semi-aquatic or moist conditions (Fig. **1**). The plant may grow up to 1.5m in height or more. Its branches are sparsely hairy and hollow. Its leaves are 10-25 cm long, short-stalked, elliptic or elliptic, lanceolate, thin, and slender with many nerves. Its stalk is 1.3-2.5 cm long, with a scabrous margin, sub-sessile, glabrous stipules, a few, and usually deciduous bristles, mostly under 2.5mm long. The pedicles are mostly

# CHAPTER 9

# Plant Edible Oils - Detection of Disease-Causing Compounds due to Repeated Heating of Oils

**Trinankur Mitra[1], S. Nagarjun[1], S. Thulasiram[1], Pinki Kumari Singh[1], Vinduja Vasudevan[1], Nagasathiya Krishnan[1], Velmurugan Devadasan[1], Subash C.B. Gopinath[2,3,4]** and **Raman Pachaiappan[1,*]**

*[1] Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur – 603 203, Chengalpet Dt., Tamil Nadu, India*

*[2] Institute of Nano Electronic Engineering, Universiti Malaysia Perlis (UniMAP), Kangar 01000, Perlis, Malaysia*

*[3] Faculty of Chemical Engineering & Technology, Universiti Malaysia Perlis (UniMAP), Arau 02600, Pauh Campus, Perlis, Malaysia*

*[4] Micro System Technology, Centre of Excellence, Universiti Malaysia Perlis (UniMAP), Arau 02600, Pauh Campus, Perlis, Malaysia*

**Abstract:** The repetitive frying of food items in the same plant edible oil in order to reduce the cost is a common practice among street food vendors. However, repeated heating and frying can cause spoilage of oil by altering the physicochemical and nutritional qualities of cooking oils. The fried food items in the reused and reheated cooking oil lead to various diseases such as cancer, cardiovascular diseases, diabetes, atherosclerosis, *etc*. The health risks associated with using reused and reheated cooking oil are causing a significant concern in the medical world. The focus of this study was to identify the structurally modified fatty acids and formation of various toxic compounds in the reused and reheated cooking oil samples derived from plant-based and animal-based fast food items for comparative analysis. Fatty acid methyl esters (FAMEs) were analyzed by gas chromatography-mass spectrometry (GC-MS). The major toxic compounds detected from plant-based oil samples were phorbol (2.06%) and campesterol (50.06%). On the other hand, from animal-based oil, hentriacontane (50.8%), trimethylsilyloxytetradecane (70.2%), and estra-1,3,5 (10)-trien-17-β-ol (12.40%) were detected. Also, the amino acid profiling of the oil samples was performed using HPLC. Higher concentrations of the amino acids found were lysine (4.30µg/mL in plant-based oil samples and 5.24µg/mL in animal-based oil samples), phenylalanine (3.03µg/mL in plant-based oil samples and 40.6µg/mL in animal-based oil samples) and aspartic acid (9µg/mL in plant-based oil samples and 10.6µg/mL in

* **Corresponding author Raman Pachaiappan:** Department of Biotechnology, School of Bioengineering, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Kattankulathur – 603 203, Chengalpet Dt., Tamil Nadu, India; Tel: +91 94 8643 3614; Fax: +91-044–27452343, +91-44-22121155; E-mail: pachaiar@srmist.edu.in

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animal-based oil samples). The outcome of this study infers that continuous consumption of food items deeply fried and heated with re-used oils would indirectly lead to complications in humans, and this comparative study reflects the distinction between the types of diets, animal-based and plant-based, and also between unused oil stock and repeatedly used cooking oil stock.

**Keywords:** Amino acids, Animal and plant-based foods, Fatty acids, GC-MS, HPLC, Repeated over-heated oil.

## INTRODUCTION

Plant-derived oils, as the name suggests, are oils that are derived from various parts of the plant, such as seeds, fruits, pulps, and many others. Triglycerides, which are molecules with carbon, hydrogen, and oxygen, make up the majority of their structure, along with glycerol and three fatty acids. Apart from triglycerides, refined plant-derived oils contain a diversity of non-triglyceride minor components that represent important biological properties and contain a high nutritional value. Polyphenols, which are generated from virgin plant-based oils, indirectly protect by boosting the body's natural defense mechanisms and controlling cellular signaling. Complex chemicals like sterols are present in major concentrations in unadulterated cooking oils. They exhibit cholesterol-lowering properties, antioxidant properties, *etc*. Avenasterol, campesterol, stigmasterol, and β-sitosterol are a few of the typical plant sterols (phytosterols) found in the oils. After refining and adulteration of the un-processed oils, lipids form as the major components in the adulterated cooking oils. They are an excellent source of phenolic chemicals, which remove free radicals from the body [1]. The oil produced solely through mechanical means, without any chemical treatment, is known as plant edible virgin oil. The second-most significant virgin oil in Europe is sunflower oil, but due to the high levels of linoleic acid in conventional sunflower seeds, the oil's nutritional status has declined over the past few years. Today, sunflower oil with a high oleic acid content is receiving more attention since its fatty acid composition is more similar to that of rapeseed and olive oils. Another crucial factor is that the high oleic acid content produces good oxidative stability, which makes this oil intriguing for a variety of applications. The leading oil in terms of nutritional value a few years ago was conventional sunflower oil. This was explained by the significant amount of linoleic acid present. The most significant omega-6 fatty acid, linoleic acid, is one of the necessary fatty acids because human systems are unable to produce it. Today, however, it is advised to partially substitute mono-unsaturated fatty acids for omega-6 fatty acids. However, a high linoleic acid intake has significant nutritional drawbacks. Similar effects on HDL and LDL cholesterol were seen in studies using oleic and linoleic acid. Humans more readily oxidize this fatty acid than oleic acid, which increases

the risk of developing atherosclerosis. One of the oils high in vitamin E is sunflower oil, which has a-tocopherol content of 50–150 mg/100 g. Sunflower oil is an attractive source of this vitamin in diets since it contains more than 90% -tocopherol, which has the highest biological activity of tocopherols. Only wheat germ oil has higher levels of α-tocopherol than other commonly used edible oils. In contrast, sunflower oil has a lower level of oxidative stability than other oils like rapeseed oil due to the low number of other tocopherols [2]. The mesocarp of the ripening oil palm fruit is where the palm is extracted. Nearly equal proportions of saturated and unsaturated fatty acids are present in palm oil. Oleic acid is a monounsaturated fatty acid, and palmitic acid is a significant saturated fatty acid. Additionally, it contains vitamin E, particularly tocotrienols and tocopherols. The carotenoids and vitamin E function together as potent natural antioxidants. For many years, people have used palm oil as food and medicine. The oil contains large amounts of beta-carotene, palmitic acid, and vitamin E. Because of the interaction between carotene and tocotrienol, palm oil is remarkably stable when fried [3]. Palm oil is a better source of solid fats than vegetable oils that have been hydrogenated. Because palm oil is solid at normal temperature, oxidation is less likely to occur. Rapeseed or soybean oils, on the other hand, must be hydrogenated for them to solidify or become semi-solid [4]. The adulterated cooking oils are distributed worldwide in huge quantities and are used for cooking as well as frying purposes. Some of the commonly used cooking oils are avocado oil, mustard oil, palm oil, peanut oil, rice bran oil, safflower oil, olive oil, canola oil, coconut oil, semi-refined sesame oil, and semi-refined sunflower oil. These oils are further flavored with aromatic foodstuff like herbs, chilies, garlic, *etc*., to enhance the taste of the food items. Such modifications and adulteration of the cooking oils often affect the original quality and, hence, affect the nutritional value of the oils [5]. To maintain the nutritional factor and enhance the quality of the oil, edible oils are adulterated and refined. Chemical refining of edible oil has been practiced since time immemorial, and several refining methods have been developed and modified accordingly concerning the product requirements. Refining cooking oil is a crucial step in the production of commercially produced cooking oil. The oils are stabilized and made appropriate for human use. Treatments are applied to the oil to remove the harmful elements and turn it from its crude oil form into a stable version. The subject oil is refined using a variety of techniques, including degumming, neutralization, washing and drying, bleaching, *etc* [6]. Commercially produced cooking oils are often heated and fried at a high temperature to enhance the taste and other appetizing properties of the particular food items. Oil pre-heating is a very common and crucial step towards cooking and preparing food. It induces several intricate chemical processes in the frying oil, including oxidation, hydrolysis, thermal polymerization, *etc*. [7]. These reactions often result in harmful and toxic end products such as polyfluoroalkyl

CHAPTER 10

# A Way to Treat Kidney Diseases with Plants in Humans

**Shankari Gopalakrishnan**[1] and **Jayaprakash Chinnappan**[1,*]

[1] *Anthropology and Health Informatics Lab, Department of Bioinformatics, Bharathiar University, Coimbatore-641046, India*

**Abstract:** Traditional medical systems are evolving through technological advancements, with numerous scientific experiments in genomics, proteomics, transcriptomics, and pathway analysis driving discoveries in health-related issues. The primary physiological role of the kidney is the elimination of metabolic waste products and the regulation of homeostasis within the body. Renal dysfunction, characterized by the impairment of these vital functions, precipitates severe complications. Dialysis serves as a therapeutic intervention to ameliorate renal failure by effectively extricating waste products and surplus fluids from the bloodstream. Though dialysis helps in treating renal failure, it cannot cure it completely. Although synthetic drugs are not fully successful, the old medicinal system offers new paths for scientific investigations. The herbs *Aerva lanata* and *Aerva javanica* have a plethora of information about folkloric traditions and traditional characteristics of therapeutically relevant medications. The genes responsible for kidney failure are collected from NCBI and GEO databases. The network is constructed using STRING, and hub genes are identified from Cytoscape. These hub genes show valid interaction with compounds of *A. lanata* and *A. javanica* herbs than the synthetic compounds that are used in treating kidney failure. Further, the gene expression, survival and pathways are analyzed, and experiments are carried out for clinical trials. There are still numerous opportunities for researchers, practitioners, and professionals in this sector to preserve conventional healthcare systems and contribute to their future growth.

**Keywords:** *Aerva lanata*, *Aerva javanica*, Genomics, Kidney failure, Pathways.

## GENERAL INTRODUCTION

There is a growing recognition of the increasing popularity of traditional medical systems in contemporary healthcare practices. Research institutions and governmental agencies are initiating efforts to explore and investigate these systems, anticipating promising outcomes in terms of efficacy and patient satisf-

* **Corresponding author Jayaprakash Chinnappan:** Anthropology and Health Informatics Lab, Department of Bioinformatics, Bharathiar University, Coimbatore-641046, India; Tel: +91-9976967160, Fax: +91-422-2425706, E-mail: mycomuthu@gmail.com

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action. Public health and sanitation, nutritious food, elderly care, and disease cure are all essential needs. Among the current diseases, kidney-related ones are the worst, posing a great challenge to human society. Kidney disease is a dangerous health issue that mitigates with expensivetreatment after causing great physical damage. It may eventually cause loss of life. Many treatments are available for these diseases, but there is no complete cure yet in all medical systems. Ayurveda, Yoga, Naturopathy, Unani, Siddha, and Homeopathy (AYUSH) are all undergoing research in this direction. Therefore, research related to this is an urgent need. Recent developments in bioinformatics can solve this problem.

## ACUTE KIDNEY FAILURE

### General Introduction

Kidney failure, a chronic condition, progresses with the loss of function in one or both kidneys, impairing their ability to effectively filter blood and eliminate waste products through urine excretion. The accumulation of these waste products in the body can lead to adverse health outcomes, including hypertension, cerebrovascular accidents, cardiovascular disease, and potentially fatal outcomes. The Glomerular Filtration Rate (GFR) serves as a measure of kidney function, with a GFR of approximately 100 indicating normal renal function. While kidney dysfunction is most commonly observed among individuals aged 65 and older, it also affects younger populations, including adolescents and children, often due to recurrent urinary tract infections or inherent kidney disorders. The symptoms of declining kidney function manifest vvariably. Still, they may include fatigue, nausea, vomiting, edema, diminished appetite, muscle cramps, increased urinary frequency, dry or pruritic skin, elevated blood pressure, and in severe cases, seizures or coma.

### Stages of Kidney Failure

There are two categories of renal failure:

i. Acute renal failure occurs abruptly (may be due to some injury) and can be treated.
ii. Chronic renal failure can develop over years, and it cannot be treated. It may also lead to end-stage renal disease (ESRD). Dialysis or kidney transplant has to be done for patients having ESRD.

This undergoes 5 stages of struggles.

- *Stage I*: If GFR is between 90-100, it shows kidneys have mild damage but are functioning normally.
- *Stage II*: If GFR is between 60-89, it signifies a degree of kidney impairment, indicating that the kidneys are partially damaged yet still able to function adequately within normal parameters.
- *Stage III*: If GFR is between 30-59, kidneys lose function.
- *Stage IV*: If GFR is between 15-29, it shows a severe loss of the functions of the kidneys.
- *Stage V*: If GFR is below 15, it shows a complete failure of kidney functions.

Drugs currently available in the market for kidney failure are given in Table (**1**):

**Table 1. Drugs Currently Available in the Market for Kidney Failure.**

| **Potassium** | **Velphoro** |
|---|---|
| Belladonna | Fosrenol (lanthanum) |
| Glycyrrhizic acid | Jynarque |
| Calcium levulinate | Retacrit |
| Agkistrodonpiscivorus antivenin | Tarpeyo |
| Astagraf | Feraheme (ferumoxytol) |
| Geraniol | Trifericavnu |
| Magnesium | Mircera |
| Sulisobenzone | Korsuva |
| Polaprezinc | Co-trimoxazole |
| L-tartaric acid | Isoniazid |
| Farxiga | Azathioprine |
| Phoslo (calcium acetate) | Prednisolone |
| Renvela (sevelamer carbonate) | Cyclophosphamide |
| Sensipar (cinacalcet) | Ciclosporin |
| Procrit | Mycophenolate |
| Erythropoiesis stimulating agents | Renagel (sevelamer hydrochloride) |
| Sirolimus | Hectorol (doxercalciferol) |
| Tacrolimus | Phoslyra |
| Intravenous iron | Auryxia |
| Invokana | Kerendia |
| Zemplar (paricalcitol) | Triferic |
| Epogen | Parsabiv |
| Eno caps | Extraneal |

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*As in the anecdote written in a famous textbook of biochemistry, digitalis was the active ingredient in the witch's wonder drug for heart attack; there are probably many herbs with medicinal properties that are still unrecognized in the natural world. India still retains a magnificent natural environment, and many precious endemic species have been preserved. Among them, there are many interesting folk remedies with many herbs that have been handed down in the region. It would be significant and exciting to reconsider and summarize this knowledge.*

Professor Satoshi Murkami, Ph.D.
Dept. Life Science, Tokyo Institute of Technology
Japan

## Velmurugan Devadasan

D. Velmurugan and his research group are pioneers in molecular docking and structure-based drug discovery of various viral diseases including coronavirus, Human Immunodeficiency Virus (HIV), Dengue, Chikungunya Virus and others especially finding target active site, receptor specificity, and structure based relationship between bioactive compounds with targets. He has been intensively working on antiviral compounds from medicinal herbs and catalogued more than 100 medicinal plants by GC-MS analysis. He has worked as a Director, Professor, and Head, of CAS in Crystallography and Biophysics, at the University of Madras. He has also worked in several administrative positions at University of Madras. He has been awarded UGC BSR Faculty Fellowship, UGC Distinguished Fellowship, Lifetime Achievement Award, University Grants Commission Career Award and etc. He has served as a Visiting Professor in USA, German, and Japan Universities and involved in developing various herbal formulations. Currently, he is a Professor of Research, School of Bioengineering, Department of Biotechnology at SRM Institute of Science and Technology heading a research group on Drug development. He has published more than 625 research articles, out of which about 600 are in international journals. An average impact factor of 4.5, H index – 31, total Google scholar citation – 5147

## Atanu Bhattacharjee

Atanu Bhattacharjee obtained his Ph.D. from North-Eastern Hill University, Shillong, and Meghalaya in Botany. He is currently working as an Associate Professor in the Department of Biotechnology and Bioinformatics. He is working on natural products especially North-Eastern grown herbal plants against cardiovascular diseases. He has published more than 75 research articles and obtained several grants from the Government of India. He has more than 15 years of teaching, research, and administrative experience. He was awarded the Department of Biotechnology (DBT) Overseas Associateship by DBT in 2012. He established a research laboratory equipped with high-end analytical instruments with government financial support.

## Raman Pachaiappan

Obtained his Ph.D. in Botany - plant pathology, and worked on purification and characterization of the fungal cell wall hydrolyzing enzymes (PR-2, PR-3, and PR-6) from medicinal plants. This was followed by Erasmus's fellow as his post-doctoral experience in molecular plant pathology, signal transductions, and microbial communications in Europe. For the past 15 years, his focused on multidisciplinary approaches like bacterial pathogenesis, Phytochemistry, plant defense and immunology related-technology, plant food, and nutraceuticals. He has been trained in the area of proteomics and metabolomics from July – 2017 to December 2017 as a Visiting scholar, in Metabolomics, Proteomics, and Mass Spectrometry, Core Facilities, at the University of Utah, Salt Lake City, UT, USA. Overall, Dr. R. Pachaiappan's expertise is finding the phytochemicals by GC-MS, LC-MS/MS, and HPLC. Presently, he is working as an associate professor in Biotechnology at SRM Institute of Science and Technology, Chennai. He has guided 2 Ph. D students. He has published 85 articles on phytochemistry, pathogenesis, and plant defense aspects with a cumulative impact factor of 215. 5, his H-index is 20 and his total citation is 1780.

## Gayathri Dasararaju

Gayathri Dasararaju holds a PhD degree in Crystallography and Biophysics from the University of Madras India with post-doctoral experience from Forschungszentrum Juelich Germany. She is currently working as an Assistant Professor in the Centre of Advanced Study in Crystallography and Biophysics, University of Madras, India. Her research papers in the areas of structural biology, bioinformatics, and natural products research have been published in reputed journals.