Phytochemistry

Volume 2

Pharmacognosy, Nanomedicine, and Contemporary Issues

Editors

Chukwuebuka Egbuna • Shashank Kumar
Jonathan Chinenye Ifemeje • Jaya Vikas Kurhekar

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PHYTOCHEMISTRY

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Edited by

Chukwuebuka Egbuna

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ABBREVIATIONS

2PFM	2-photon fluorescence microscopy
5-OHMeUra	5-hydroxymethyl uracil
8-OH-G	8-Hydroxy-guanine
AAS	Atomic Absorption Spectroscopy
ABTS	2,2-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid
ACH	Acetylcholine
ACSM	Alternative Chinese System of Medicine
ADH	Alcohol dehydrogenase
AFM	Atomic force microscopy
AGEs	Advanced glycation end products
ALPs	Alkaline phosphatases
ALT	Alanine aminotransferase
AOSs	Active oxygen species
AR	Aldose reductase
ARE	Antioxidant response element
AST	Aspartate aminotransferase
BAM	Brewster angle microscope
BDE	Bond dissociation enthalpy
BHT	Butylated hydroxytoluene
CAT	Catalase
CFT	Critical flocculation temperature
CG	(-)- Catechin gallate
CKD	Chronic kidney disease
CLSM	Confocal laser scanning microscopy
CNS	Central nervous system
COMT	Catechol-O-methyltransferase
CRC	Colorectal cancer
CSF	Cerebrospinal fluid
CTGF	Connective tissue growth factor
CTM	Chinese Traditional Medicine
CUPRAC	Cupric reducing antioxidant capacity
CV %	Coefficient of variation

CVD	Cardiovascular disease
DAD	Diode array detector
DAG	Diacylglycerol
DCM-M	Dichloromethane: methanol
DLS	Dynamic light scattering
DMA	Dimethylacetamide
DM	Diabetes mellitus
DMSO	Dimethyl sulfoxide
DNA	Deoxyribonucleic acid
DN	Diabetic nephropathy
DNP	Dinitrophenylhydrazone
DOX	Doxorubicin
EC	Epicatechin
ECG	Epicatechin gallate
ECM	Extracellular matrix
ED	Erectile dysfunction
EDS	energy-dispersive spectroscopy
EDX	energy-dispersive X-ray spectroscopy
EGC	Epigallocatechin
EGCG	Epigallocatechin gallate
EGFR	Estimated glomerular filtration rate
EL	Ejaculation latency
ELISA	Enzyme-linked immunosorbent assay
EMT	Epithelial mesenchymal transition
ERK	Extracellular-signal-regulated kinases
ES	Electrical field stimulation
ESRD	End-stage renal disease
EVM	Ethnoveterinary medicine
FDA	Food and Drug Administration
FE-SEM	Field emission scanning electron microscopy
FLD	Fatty liver disease
FL	Fidelity level
FRAP	Ferric reducing antioxidant power
FSH	Follicle-stimulating hormone
FTIR	Fourier transform infrared spectroscopy
GAPs	Good agricultural practices
GBM	Glomerular basement thickening
GC	(-)-Gallocatechin

GCG	(-)-Gallocatechin gallate
GCLC	Glutamate-cysteine ligase catalytic subunit
GCL	Glutamate-cysteine ligase
GCLR	Glutamate-cysteine ligase regulatory subunit
GDH	Glutamate dehydrogenase
GFR	Glomerular filtration rate
GGT	γ-Glutamyltranspeptidase
GI	Gastrointestinal
GK	Glucokinase
GMPs	Good manufacturing practices
GPI	Glycophosphatidylinositol
GPS	Geographical positioning system
GPX	Glutathione peroxidase
GR	Glutathione reductase
GSH	Glutathione
GSH-Px	Glutathione peroxidase
GSR	Glutathione reductase
GST	Glutathione S-transferase
HACCP	Hazard analysis critical control point
HBV	Hepatitis B virus
HCV	Hepatitis C virus
HDL	High-density lipoprotein
HIF-1α	Hypoxia-inducing factor-1α
HK	Hepatic hexokinase
HO-1	Heme oxygenase-1
HORAC	Hydroxyl radical averting capacity
HPLC	High-performance liquid chromatography
HRs	Heart rates
IASM	Indian Alternative Systems of Medicine
ICF	Informant consensus factor
ICP	Inductively coupled plasma
ICSI	Intracytoplasmic sperm injection
IDDM	Insulin-dependent diabetes mellitus
IF	Intromission frequency
IL	Intromission latency
IP6	Inositol hexakisphosphate
IPRs	Intellectual Property Rights
IR	Infrared

ITAM	Immunoreceptor tyrosine-based activation motif
IUCN	International Union for Conservation of Nature
JNK	c-Jun NH (2)-terminal kinase
KCl	Potassium chloride
LDH	Lactate dehydrogenase
LD	Laser diffractometry
LDL	Low-density lipoprotein
LH	Luteinizing hormone
LPIC	Lipid peroxidation inhibition capacity
LPO	Lipid peroxidation
mAb	Monoclonal antibody
MAO-B	Monoamine oxidase-B
MAP	Mean arterial pressure
MAPs	Medicinal and aromatic plants
MDA	Malondialdehyde
MDH	Malate dehydrogenase
MDR1	Multidrug resistance
MF	Mount frequency
MIC	Minimum inhibitory concentration
MIEN1	Migration and invasion enhancer 1
ML	Mount latency
MPTP	Mitochondrial permeability transition pore
MRSA	Methicillin-Resistant Staphylococcus aureus
NAA	Neutron activation analysis
NAFDAC	National Agency for Food, Drugs, Administration and Control
NAFLD	Nonalcoholic fatty liver disease
NA	Nalidixic acid
NCE	New chemical entity
NF-κB	Nuclear factor kappa-B
NHDF	Normal human dermal fibroblasts
NIDDM	Non-insulin dependent diabetes mellitus
NQO1	NAD(P)H: quinone oxidoreductase 1
Nrf2	Nuclear erythroid 2-related factor 2
NS5B	Nonstructural 5B protein
OD	Optical density
OMT	O-methyltransferases
ORAC	Oxygen radical absorption capacity
PAB	Prooxidant-antioxidant balance

PCA	Principal component analysis
PCS	Photon correlation spectroscopy
PDAs	Potable display accessories
PD	Parkinson's disease
PEI	Penile erection index
PEL	Post-ejaculatory latency
PFK	Phosphofructokinase
PFRAP	Potassium ferricyanide reducing power
PI3-K	Phosphoinositide 3-kinase
PKC	Protein kinase C
PLA2	Phospholipase A2
PPAR-α	Peroxisome proliferator-activated receptor α
PUFAs	Polyunsaturated fatty acids
R&D	Research and Development
RAAS	Renin–angiotensin–aldosterone system
RAGE	Receptor for advanced glycation end products
RCI	Relative cultural index
RDA	Recommended dietary allowance
RdRps	RNA-dependent RNA polymerases
RNS	Reactive nitrogen species
RONS	Reactive oxygen and nitrogen species
ROS	Reactive oxygen species
RTA	Ricin toxin A
RTB	Ricin toxin B
SACS	S-allylcysteinesulfoxide
SAR	Structure-activity-relationship
SCFE	Supercritical fluid extraction
SDH	Sorbitol dehydrogenase
SEM	Scanning electron microscopy
SGLT2	Sodium glucose cotransporter 2
SMCS	S-methylcysteinesulfoxide
SNOM	Scanning near-field optical microscopy
SOD	Superoxide dismutase
SREBP1	Sterol regulatory element-binding protein 1
STDs	Sexually transmitted diseases
STZ	Streptozotocin
T1D	Type 1 diabetes
T2D	Type 2 diabetes

TAM	Tumor-associated macrophage
TBARS	Thiobarbituric acid reactive substances
TCA	Trichloroacetic acid
TC	Total cholesterol
TEM	Transmission electron microscopy
TGF-β	Transforming growth factor β
TG	Triglycerides
TMP	Traditional medical practitioner
TM	Traditional medicine
TNF-α	Tumor necrosis factor α
TRAP	Total peroxyl radical trapping antioxidant parameter
TTM	Traditional Tibetan Medicine
USM	Unani System of Medicine
UV	Ultraviolet
VCAM	Vascular cell adhesion protein 1
VEGF	Vascular endothelial growth factor
VLDL	Very low-density lipoprotein
WHO	World Health Organization
XRD	X-ray diffraction

FOREWORD

It is my pleasure to write this foreword and to recommend this book, *Phytochemistry: Volume 2, Pharmacognosy, Nanomedicine, and Contemporary Issues,* to everyone doing research in the field of phytochemistry, pharmacognosy, or related areas. The book's scope is great and one that has incorporated recent developments in the field. The chapters were written by key specialists in the field from diverse academic backgrounds. The volume covers virtually all areas of phytochemistry and pharmacognosy, namely ethnomedicine, ethnobotany, complementary and alternative systems of medicine, ethnoveterinary medicine, herbal medicine, nanomedicine, and so forth.

I commend Chukwuebuka Egbuna for initiating this idea and for his resilient effort in bringing this book to completion. Also, I commend his co-editors and chapter contributors for their excellent work. I am delighted to have known when the book project started and when it was completed.

I am sure the book will receive appreciation from the scientific community. I am also convinced that the book will attract great interest to the industry, especially the pharmaceutical industry.

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PREFACE

The roadmap to the discovery of new and effective drugs with fewer side effects is one that is very expensive and that which spans a period of 10–12 years from discovery to clinical trials. It is projected that the global drug discovery informatics market of US $1.67 billion will reach US $2.84 billion in 2022 and much higher by 2050 at the compound annual growth rate of 11.2%. The practices leading to the discovery of new drugs cut across several horizons, starting from the indigenous knowledge about the peoples' medicinal plants, *in vitro* research about the phytochemical compositions of the plants, and the *in silico* and *in vivo* studies, including both preclinical and clinical trials. The discovery of drugs encompasses several disciplines, namely ethnomedicine, ethnopharmacology, pharmacognosy, ethnobotany, complementary medicine, and alternative medicine. Several other fields, such as biotechnology, microbiology, zoology, chemistry, plant biochemistry, and marine biochemistry, to mention a few, are involved.

Over the last 50 years, there has been a lot of progress in the discovery of drugs or lead compounds. This volume, *Phytochemistry, Volume 2: Pharmacognosy, Nanomedicine, and Contemporary Issues,* presents a complete coverage, with chapters demonstrating recent advances on the potentials of medicinal plants for the treatment and management of diseases. Since phytomolecules have different mechanisms of action and the fact that their number appears astonishingly high in plants, there is a need for a well-structured book to systematically aid in providing easy understanding for researchers, students, and other users from related areas. This book is comprised of 25 chapters that are grouped into four parts: ethnomedicine and pharmacognosy, medicinal potentials of phytochemicals, nanoparticle biosynthesis and applications, and phytochemicals as friends and foes. The chapters provides information on the recent advances in the discovery of therapeutic drugs from plants. The authors have provided figures, pictures, tables, pathways, and illustrations to aid easy understanding where applicable.

Chapter 1 by Egbuna et al. in Part I of this book presents background information on pharmacognosy, the scope, and the prehistoric uses of medicinal plants. Chapter 2 by Kumar and Sharma discusses the various complementary and alternative systems of medicines. Chapter 3 by Nwafor and Inya-Agha documents the indigenous people's medicinal plants and their

ethnobotanical uses. Chapter 4 by Oyedepo presents an overview of herbal medicine and quality control with emphasis on Nigerian medicinal plants. Lakshminarayana and Rao in Chapter 5 documents the Indian ethnoveterinary medicinal plants, their uses, and modes of administration.

In Chapter 6 in Part II, Egbuna discusses antioxidants and phytochemicals. Chapter 7 by Sulaiman et al. is an overview of the roles of phytochemicals in the prevention and treatment of various diseases. Gupta and Pandey in Chapter 8 emphasizes the roles phytochemicals as oxidative stress mitigators. In Chapter 9, Kurhekar presents antimicrobial medicinal plants. The chapter is a combination of review and research on plants that are effective against different strains of microorganisms. Chapter 10 by Tijjani and Egbuna is a systematic study of medicinal plants with antivenom activities. The authors conducted a survey and reached a conclusion on the most reoccurring antivenom plant families, the most used plant parts, and preferred extraction solvents. Ujah in Chapter 11 discusses the medicinal potentials of green tea, *Camellia sinensis.* Chapter 12 by Haider et al. illustrates the antioxidant potentials of cinnamon. Swagata et al. in Chapter 13 details the potentials of phytochemicals as hope for the treatment of hepatic and neuronal disorders. Chapter 14 by Parmar and Variya details the medicinal roles of phytochemicals in the treatment of male infertility. Upadhyay et al. documents medicinal plants and phytochemicals effective against cancer. Chapter 16 by Kushwaha et al. presents an *in silico* study on the potentials of methylated flavonoids as a novel inhibitor of metastasis in the cancer cell. The findings are positive and one that can serve as a lead for the discovery of anticancer drugs. Aslam et al in Chapter 17 provides an overview of diabetes and detail the medicinal plants with active components that are effective in the treatment and management of diabetes mellitus. Shukla et al. in Chapter 18 discusses the roles of phytomolecules in the treatment of diabetic nephropathy with emphasis on medicinal plants. Mishra et al. in Chapter 19 documents phytochemicals and plant sources that can be beneficial for the treatment and management of autoimmune diseases.

Part III details the biosynthesis of nanoparticles and their biomedical applications. In Chapter 20, Pothabathula et al. details the green biosynthesis of metallic nanoparticles. Hii et al. in Chapter 21 presents the cytotoxicity and biomedical applications of metal oxide nanoparticles synthesized from plants. Chapter 22 by Shah et al. details the 'green synthetic approaches and precursors for Carbon Dot Nanoparticles.'

Part IV demonstrates the ability of phytochemicals as friends and how they can be foes as well. Chapter 23 by Egbuna et al. is a review of toxic plants and phytochemicals. Mtewa in Chapter 24 discusses phytochemicals

as prooxidants. Chapter 25 by Egbuna is an overview of phytochemical as antinutrient.

This book will to be an invaluable resource for all in the field and related disciplines, and I recommend it to everyone. I extend my heartfelt thanks to the chapter contributors for their great contributions, patience, and cooperation during the editorial process. My sincere thanks goes to the volunteer reviewers and to my co-editors. I will remain grateful to my family for their support and patience during the editorial process of this book. To the management of Apple Academic Press, I extend a special thanks for demonstrating an ability to support authors despite the workload and particularly for a very fast response to emails. To the readers, I appreciate you all and would welcome reviews about the book with an open heart. Thank you.

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PART I
Ethnomedicine and Pharmacognosy

CHAPTER 1

PHARMACOGNOSY AND PREHISTORIC USES OF MEDICINAL PLANTS

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ABSTRACT

Pharmacognosy is arguably the oldest modern science which involves the study of drugs in its crude form. The crude drugs could be from a plant, animal, or microbial origin. The term pharmacognosy was coined from two Greek words: "*pharmakon*" meaning drug or medicine, and "*gnosis*" meaning knowledge. Seydler, the German botanist, was the first to use the term "pharmacognosy" but Schmidt, the Australian doctor was credited for begetting the word. Stress areas of pharmacognosy encompasses botany, ethnobotany, ethnomedicine, ethnoveterinary, marine pharmacognosy, zoopharmacognosy, microbiology, herbal medicine, chemistry, biotechnology, phytochemistry, pharmacology, pharmaceutics, clinical pharmacy, and pharmacy practice. Most significantly, plants have been a subject of discussion in pharmacognosy owing to its

prolific sources for new bioactive compounds. Plants since antiquity have been utilized for the treatment of diseases and prehistoric evidence from the works of great scientists of all time attests. This chapter provides a foundation for this volume. The definition, scope and prehistoric use of medicinal plants were detailed.

1.1 INTRODUCTION

Pharmacognosy is an essential branch of pharmacy which involves the study of medicinal drugs derived from plants or other natural sources. It incorporates the logical investigation of the auxiliary, physical, biochemical, and natural properties of drugs and looks for new actives from plants, animals, and mineral sources. It also investigates a number of medicinal and commercial items, for example, vitamins, compounds, pesticides, allergens and additionally the history, circulation, development, accumulation, readiness, distinguishing proof, assessment, protection, and trade of therapeutic plants. An Austrian doctor J. A. Schmidt (1759–1809) begat the term "pharmacognosy" in his composition "*Lehrbuch der Materia Medica*," distributed in 1811, although C. A. Seydler utilized the term in his book on crude medications "*Analectica Pharmacognostica*" in 1815. Pharmacognosy is the convergence of the two Greek words "*pharmakon*" (medication) and "*gnosis*" (information).

Pharmacognosy has advanced from one being an expressive plant subject to one having a more substance center grasping an expansive range of orders including organic science, phytochemistry, pharmacology, zoology, ethnobotany, sea life science, microbiology, biotechnology, herbal medicine, science, pharmaceutics, clinical drug store, drug store rehearse, and so forth, which makes it today to be an interdisciplinary science (Alamgir, 2017). Pharmacognosy is presently enduring significant change owing to the extensive variety of different procedures, and the current advance in extraction, chromatography, hyphenated systems, screening of common item, biotechnology, and so forth.

Plants produce chemical compounds as part of their normal metabolic activities. These phytochemicals are either primary metabolites such as sugars and fats or secondary metabolites which are produced from primary metabolites. For example, some secondary metabolites are toxins used to deter predation and others are pheromones used to attract insects for pollination. Plant preparations are said to be medicinal or herbal when they are used to promote health beyond basic nutrition. Doubtlessly, plants are prolific

sources of new bioactive chemicals such as atropine, ephedrine, morphine, caffeine, salicylic acid, digoxin, taxol, galantamine, vincristine, colchicine, and so forth. (Orhan, 2014).

Nonetheless, periwinkle (*Catharanthus roseus*) and its anticancer specialists, vinblastine and vincristine; St. John's Wort (*Stramonium*) and its synthetic constituents tropane alkaloids, hyoscine, and hyoscyamine; Indian snakeroot (*Rauvolfia* root) and its alkaloids, ajmalicine, reserpine, and rescinnamine; natural products, for example, papaya (*Carica papaya*), kiwifruit (*Actinidia deliciosa* and different species), pineapple (*Ananas comosus*), figs (*Ficus carica*) and their proteases catalyst blend; thyroid organ and its separated hormone, thyroxin; pancreas and its peptide hormone, insulin, and so forth, are similarly critical as topics of pharmacognosy (Eisenberg et al., 2011). The plant kingdom still holds many species of plants containing substances of medicinal value which are yet untapped. Some actives discovered by great scientists were presented in Table 1.1.

1.2 SCOPE OF PHARMACOGNOSY

The advancement of pharmacognosy additionally prompts improvement of organic science, scientific categorization, plant biotechnology, plant hereditary qualities, plant pathology, pharmaceutics, pharmacology, phytochemistry, and different branches of science. The major stress areas of pharmacognosy encompass botany, ethnobotany, ethnomedicine, ethnoveterinary, marine pharmacognosy, zoopharmacognosy, microbiology, herbal medicine, chemistry, biotechnology, phytochemistry, pharmacology, pharmaceutics, clinical pharmacy, and pharmacy practice (Table 1.2).

1.3 PREHISTORIC USES OF MEDICINAL PLANTS

1.3.1 MESOPOTAMIAN CIVILIZATION (3000 BC TO 539 BC)

Some of the major Mesopotamian civilizations include the Sumerian, Assyrian, Akkadian, and Babylonian civilizations. The Sumerians (3000–2400 BC) who inhabited in the lower Mesopotamia a region between the rivers of Tigris and Euphrates (now what is the present-day Iraq and Kuwait) were regarded as the first to have developed the World's first civilization around 4000 BC (Alamgir, 2017). They are the pioneers in using plant-based drugs, wound washing, plasters, and bandaging. The early Babylonians

TABLE 1.1 Some Phytochemicals and their Discoverers.

Secondary metabolites	Medicinal plants	Name of the scientist	Therapeutics potentials
Alkaloids – morphine Over 12,000 alkaloids are now found	*Papaver somniferum* (opium poppy)	German chemist Friedrich Sertürner (1804).	Anticancer, antimalarial, anti-asthma, vasodilatory, and so forth.
Flavonoids Over 4000 flavonoids now found	Paprika and citrus peel are found in almost all plants	The Nobel Prize winner, Dr. Albert Szent-Gyorgyi, and coworkers (1936). Identified flavonoids as vitamin P. Also discovered Vitamin C.	Antioxidant, anti-inflammatory, anti-allergic, antiviral, and anticarcinogenic
Glycosides – amygdalin	Rhubarb, cascara, and so forth.	French chemists Pierre Robiquet and Antoine Boutron-Charlard (1830)	Laxative and detoxification
Cardiac glycosides	Digitalis (Foxglove plants) and other plants	William Withering (1785)	Dropsy and congestive heart failure
Saponins –ginsenoside	Panax species	Garriques (1854)	Antitumor and antimutagenic
Terpenes	Conifers and many plants	Leopold Ružička (I953) – Discovery of isoprene unit linkages	Antimicrobial and antifungal
Tannins – gallic acid	Gallnuts, sumac, and tea leaves	French Chemist Henri Braconnot (1831)	Antibacterial, binds with proteins and antioxidant
Benzoic acid	Plant gums	Nostradamus (1556). Justus von Liebig and Friedrich Wöhler elucidated the structure in 1832	Antifungal ability
Shikimic acid	Plants and microorganism	Johan Fredrik Eylman (1885)	Antioxidant, anti-inflammatory, and antinociceptive activity. Listed as group 3 carcinogen.

TABLE 1.2 Branches and Subfields in Pharmacognosy.

Fields/Subfields	Definition
Botany	Also called plant science(s), plant biology, or phytology. It is a branch of biology that deals with the study of plant life.
Ethnobotany	Study of a region's plants and their practical uses through the traditional knowledge of a local culture and people. See Chapter 3.
Ethnomedicine	Deals with a wide range of healthcare systems/structures, practices, beliefs, and therapeutic techniques that arise from indigenous cultural development. Ethnopharmacology inclusive.
Ethnopharmacology	Study of the pharmacological qualities of traditional medicinal substances
Chemistry	Study of the structure, properties, composition, mechanisms, and reactions of organic compounds.
Phytochemistry	Study of plant-derived chemicals, particularly the secondary metabolites. Also, see volume 1 and 3 of this book for comprehensive details.
Pharmacology	Branch of biology concerned with the study of drug action.
Pharmacy	Science and technique of preparing and dispensing drugs.
Pharmaceutics	A discipline of pharmacy that deals with the process of turning a new chemical entity (NCE) or old drugs into a medication to be used safely and effectively by patients.
Marine Pharmacognosy	Study of chemicals derived from marine organisms. See volume 3 of this book for detailed information.
Microbiology	Study of microorganisms which encompasses virology, mycology, parasitology, and so forth. See Chapter 9 of this volume for more information.
Herbal medicine	Also called botanical medicine or phytomedicine, refers to using a plant's seeds, berries, roots, leaves, bark, or flowers for medicinal purposes. See Chapter 4 of this volume for detailed information.
Ethnoveterinary medicines	Concerned with traditional knowledge for primary healthcare treatment of domestic animals to order to keep them productive and healthy. See Chapter 5 of this volume for detailed information.
Biotechnology	A technology based on biology that deals with the use of living systems and organisms to develop or make products for example, the synthesis of natural bioactive molecules using biotechnology. See volume 3 of this book for more information.
Zoopharmacognosy	The science of animal self-medication.
Medical anthropology	Involves the study of human health and disease, healthcare systems, and biocultural adaptation.

(2200–1300 BC) learned to manufacture soaps, leather, vinegar, beer, wine, glass extract natural plant aroma, and animal products (Alamgir, 2017). They are much aware of the use of medicinal plants and plant drugs such as balm of Gilead, colocynth, hellebore, licorice, mustard, myrrh, oleander, opium, opopanax, and storax. Documents showing the use of senna, coriander, saffron, cinnamon, garlic and the preparation of liniments for external applications for sprains, bruises on the skin, and elixirs for internal impairment. In this era diagnosis and treatment separated followed by the preparation of medicines which was handled by assistants called apothecaries.

1.3.2 ANCIENT CHINESE

The Chinese Emperor Shen Nung at about 2000–2500 BC explored the hidden treasure of medicinal plants. His document "Pen T-Sao" constitutes about 365 herbal drugs and its procedures of preparations. Most of the drugs he had tried upon himself. Some of the medicinal plants he mainly focused on such as opium, podophyllum, ginseng, rhubarb, cinnamon bark, valerian, and so forth. The Chinese physicians practiced "moxibustion" which means the placement of powdered leaves on an acupuncture point and set alight. These results in yang, that is, the appearance of blisters on that region (see Chapter 2 of this volume). The idea behind this is that they believed that to discard the pain of a disease is by creating a new one. They are not much aware of anatomy at that time. Chinese traditional medication was purely based on Yin and Yang theory. They believed that Yin refers to the dark moist feminine side whereas the Yang refers to the bright dry masculine side (see Chapter 2 of this volume for more information).

1.3.3 EGYPTIAN CIVILIZATION (3000 BC–1200 BC)

Simultaneously, the Egyptian civilization emerged in North-east Africa. Their inscriptions on tombs, ceramics, Cyperus papyrus, and so forth, have provided information on the Egyptians medicines and surgery (Dawson, 1927). The Egyptians culture provided a number of documentation which imparts knowledge on the use of medicinal plants to treat illnesses. For example, the medical document, Papyrus Ebers was also known as Ebers Papyrus (1550 BC) which was named after the German Egyptologist, Georg Ebers is among the oldest and most important medical papyri of ancient Egypt. It was purchased at Luxor (Thebes) in the winter of 1873–74 by Georg

Ebers. The document is full of incantations and foul applications meant to turn away disease-causing demons, and it also includes 877 prescriptions and 700 drugs derived from plants, animals, and minerals. Among those derived from plants are cumin, Ricinus seeds opium, poppy, castor seed, garlic and Arabic gum, and so forth, animal sources are milk, waxes, livers, and excreta. The minerals include salt, copper, carbonate alum, and stibnite. These papyri – the first systematic classification of medicine – gave "recipes" for the treatment of certain diseases and symptoms. For example, the Ebers Papyrus lists 21 ways to treat coughs, and others deal with at least 15 diseases of the abdomen, 29 of the eyes and 18 of the skin. The Egyptians used wines and beers with milk together as a physical boost in their liquid medicines (Court, 2005). They also used honey in solid pills and waxes in ointments. Their medication includes pills, decoctions, teas, gargles, snuffs, infusions, lotions, plasters, inhalations, fumigation, troches, enema, and so forth.

1.3.4 INDIAN HISTORY OF PHARMACOGNOSY

The in-depth knowledge of pharmacology is rooted in Indian historic herbal drugs which has been practiced in India since 5000 years ago. Evidence can be found in the ancient Ayurvedic documentations "Charak Samhita and Sushrutha Samhitha." The earliest herbal medicine used in Ayurvedic system is dated 1200 BC and it consists of about 127 medicinal plants, its formulation, and efficacy upon human health (see Chapter 2 of this volume for more information).

1.3.5 HIPPOCRATES AND GREEK MEDICINES (460–377 BC)

In ancient Greek, medicines were regarded as the second to mathematics. Greek medicines acted on three basic sources such as the temple practice of Asclepius or healing by the god, physiological opinion by the philosophers, and finally, practice of the superintendents of the gymnasia (Court, 2005). The Greek physicians were recognized as spiritual healers. The most renowned Greek Physician, Hippocrates (460–377 BC) credited for being the father of medicine, established the doctrine of medicines and used some 300–400 drugs (Jones, 1923). Hippocrates used the Greek word *carcinos*, meaning crab or crayfish, to refer to malignant tumors. It was Celsus who translated the Greek term into the Latin cancer, also meaning crab. The best known of the Hippocratic writings is the Hippocratic Oath which reads:

> I swear by Apollo the physician, and Aesculapius, and Health, and All-heal, and all the gods and goddesses, that, according to my ability and judgment, I will keep this Oath and this stipulation – to reckon him who taught me this Art equally dear to me as my parents, to share my substance with him, and relieve his necessities if required; to look upon his offspring in the same footing as my own brothers, and to teach them this art, if they shall wish to learn it, without fee or stipulation; and that by precept, lecture, and every other mode of instruction, I will impart a knowledge of the Art to my own sons, and those of my teachers, and to disciples bound by a stipulation and oath according to the law of medicine, but to none others.
>
> I will follow that system of regimen which, according to my ability and judgment, I consider for the benefit of my patients, and abstain from whatever is deleterious and mischievous.
>
> I will give no deadly medicine to anyone if asked, nor suggest any such counsel, and in like manner I will not give to a woman a pessary to produce abortion. With purity and with holiness I will pass my life and practice my Art.
>
> I will not cut persons laboring under the stone, but will leave this to be done by men who are practitioners of this work. Into whatever houses I enter, I will go into them for the benefit of the sick, and will abstain from every voluntary act of mischief and corruption; and, further from the seduction of females or males, of freemen and slaves.
>
> Whatever, in connection with my professional practice or not, in connection with it, I see or hear, in the life of men, which ought not to be spoken of abroad, I will not divulge, as reckoning that all such should be kept secret.
>
> While I continue to keep this Oath unviolated, may it be granted to me to enjoy life and the practice of the art, respected by all men, in all times! But should I trespass and violate this Oath, may the reverse be my lot!

Hippocrates group medicated on four liquid humors – blood, phlegm, bile, and black bile. They believed that diseases cause an excess of any one of these liquid humor. Their treatment leads to the elimination of such liquid humor from the body by using enemas, purgatives, and emetics to cleanse and purify the impaired body. Thus pharmakon became the remedy for ailments.

Hippocrates believed in medical astrology and insisted his students to study astrology, saying, “He who does not understand astrology is not a doctor but a fool.” He believed that each of the astrological signs (along with the Sun, Moon, and planets) is associated with different parts of the human body. He further stated that many plants are referred to in old herbals as being “under the influence of” some planet. This was used as a codification of the plant’s properties and used to create mixtures specific to different diseases.

1.3.6 THEOPHRASTUS (FATHER OF BOTANY) AND ARISTOTLE

Theophrastus (372–287 BC) a Greek native of Eresos in Lesbos is a pupil of Plato successor of Hippocrates later a student of Aristotle became the head of Lyceum assigned as natural Philosopher and medical person (Paulsen, 2010). He established the field of botany and clearly classified plants as trees, shrubs, and herbs. He gained the knowledge of folk medicines and documented it in his two famous documents "*De causis plantarum* and *De historia plantarum*." He mainly focused on the morphology, classification, and natural history of plants.

1.3.7 AULUS CORNELIUS CELSUS (CA 25 BC–AD 45)

Aulus Cornelius Celsus, a Roman encyclopaedist, flourished in the first century AD in Rome. He was a distinguished author of "*De Medicina*" (eight volumes, see below) dealing with agriculture, military, rhetoric, philosophy, and medicine. It is now considered as one of the most important historical sources for the present-day medical knowledge (Court, 2005). It was discovered by Pope Nicholas V in (1397–1455) and was the first medical works to be published (1478) after the innovation of printing press. He recommended wounds be washed and treated with substance now applied as antiseptics, such as vinegar, thyme oil, and so forth. He enunciated plastic surgery of the face using skin from other parts of the body. He was the pioneer who identified the cardinal signs of inflammation, calor (warmth), dolor (pain), tumor (swelling), and robur (redness and hyperemia) (Cefalu, 2000).

Book 1 – The History of Medicine
Book 2 – General Pathology
Book 3 – Specific Diseases
Book 4 – Parts of the Body
Book 5 and 6 – Pharmacology
Book 7 – Surgery
Book 8 – Orthopedics

1.3.8 PLINY THE ELDER (23–79 AD)

Pliny the Elder (born Gaius Plinius Secundus, AD 23–79) was a Roman officer and the author of the book "Historia Naturalist" an encyclopedia of 37

volumes. In it, 16 volumes which are subjected to Pharmacology. This document assigned as a reference to pharmacologists. Apart from pharmacology, it considered astronomy, mathematics, geography, anthropology, ethnography, human physiology, zoology, botany, horticulture, sculpture, painting, and precious stones. Pliny's pharmacopeia was the seedling towards the field of pharmacotherapy (Tellingen, 2007). In his book on pharmacopeia, he had suggested some 20 species of herbs against cardiovascular diseases some are presented in Table 1.3.

TABLE 1.3 Some Medicinal Plants of Pliny's Pharmacopeia.

Common name	Scientific name	Biological actions
Garlic	*Allium sativum*	Antiviral, antibacterial, cardiovascular, and antidiuretic
Sea onion	*Urginea maritima*	Jaundice, asthma, heart diseases, laxative, and expectorant
Laburnum	*Cytisus laburnum*	Anti-smoking
Atropine	*Atropa belladonna*	Jaundice and anticholinergic syndrome
Myrtle	*Myrtus communits*	Antioxidant activity
Laurel	*laurelia*	Antimicrobial and antifungal activity
Indian holly	*Ilex aquifolium*	Emetic and central nervous system stimulant
White lupine	*Lupinus albus*	Emmenagogues and vermifuge
Broom	*Genista sphaerocarpos*	Liver disorder and diuretic
Horehound	*Marrubium vulgare*	Wheezing and cough

1.3.9 PEDANIUS DIOSCORIDES (40–80 AD)

A Greek botanist of the first century AD was the most important botanical writer after Theophrastus and he was the most popular Greek physician and pharmacologist in the Roman era (Bender and Thom, 1965). In his document *De Materia Medica*, he described about 600 plants and their medicinal properties. *De Materia Medica* is the prime historical source of information about the medicines used by the Greeks, Romans, and other cultures of antiquity. Later his document became the precursor of pharmacopeias. When people underwent surgery he used the extracts of mandragora to induce anesthesia. He grouped plants into three categories such as aromatic, culinary, and medicinal.

1.3.10 AVICENNA: THE "PERSIAN GALEN" (980–1037 AD)

Avicenna (980–1037 AD) was one of the eminent physicians and philosophers during the Arabian era and his work had been documented in Canon Avicenna also termed as Canon of medicine which imparts the knowledge of medicine and Pharmacology (Bender and Thom, 1965). Avicenna was a famous physician, philosopher intellectual, and favorite among Persian rulers. His pharmaceutical work was accepted by the west till the 17th century and still dominant. All his writings were in Arabic. Some of his system of pharmacy and remedies are still in business such as camphor, saffron, rhubarb, mastix, and aloe. He introduced the systems in experimentation and understood the physiology of human and diagnosed patients with experimental based medicines (Paulsen, 2010).

1.4 MODERN ERA OF PHARMACOGNOSY

Since initiation in 1811, pharmacognosy has advanced impressively amid the previous two hundred years. Recently, it has increased much significance in light of the inclusive progress of natural items as lead atoms for new medications and additionally, the expanded utilization of correlative restorative items in industrialized countries. At the start of the 21st century, accentuation has been put on (i) examination, (ii) natural testing, and (iii) coordinated effort of pharmacognostical explore. The multidisciplinary qualities of pharmacognosy are ending up increasingly unmistakable the same number of new zones of research and concentrate; for example, molecular pharmacognosy, neuropharmacognosy, and mechanical pharmacognosy are rising in current pharmacognosy with time. In the cutting edge period, the customary herbalism has been authoritatively viewed as a strategy for elective prescription in numerous parts of the world, particularly in some created nations (e.g., USA and UK). The Traditional Chinese Medicine has been used by the Chinese in healing facilities. The World Health Organization assessed that 80% of individuals overall depend on homegrown meds for some piece of their essential human services. In Germany, around 600–700 plant-based drugs are accessible and are endorsed by almost 70% of German doctors. Numerous elective doctors in the 21st-century join herbalism in present-day medication because of the assorted capacities plants have and their low number of symptoms (Alamgir, 2017).

In the 19th century, microscopy was presented in pharmacognosy for the quality control of crude medications, and for a long time, pharmacognosy stayed bound with the magnifying lens based strategies. In the 20th century, the revelation of essential medications from the set of all animals and microorganisms, especially hormones and vitamins, has turned into a vital wellspring of medications. In the end of the 20th century, chromatographic spectrometric techniques were presented in pharmacognostical investigation. In vitro framework bioassay was included at end of the 20th century, and amid this period (1983–1994), countless and antitumor standards from regular sources were found (Cragg et al., 1997; Alamgir, 2017).

1.5 CONCLUSION

Pharmacognosy has advanced throughout the years and is now proper to address the difficulties of medication disclosure and improvement. The pharmacognosy is expansive and incorporates the logical investigation of unrefined medications, therapeutic items (e.g., allergens, vitamins, chemicals, antimicrobials, pesticides, and allergenic concentrates), and excipients (e.g., shading, flavoring, emulsifying and suspending specialists, fasteners, diluents, solidifiers, building or filler operators, sweeteners, disintegrants, analgesic guides, and cements). It manages the examination issues in the zones of phytochemistry, microbial science, biosynthesis, biotransformation, chemotaxonomy, and other organic and compound sciences. It also concentrates on harmful, stimulating, and teratogenic plants crude materials for the generation of oral contraceptives, aphrodisiacs, and so forth, and in addition, flavors, refreshments, and toppings.

KEYWORDS

- **pharmacognosy**
- **medicinal plants**
- ***De Materia Medica***
- **Hippocrates**
- **Dioscorides**

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