SCIENCE OF SPICES & CULINARY HERBS

LATEST LABORATORY, PRE-CLINICAL, AND CLINICAL STUDIES

Editors:
Atta-ur-Rahman
M. Iqbal Choudhary
Sammer Yousuf

Bentham Books

Science of Spices and Culinary Herbs

Latest Laboratory, Pre-clinical, and Clinical Studies

(*Volume 5*)

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Volume # 5

Editors: Prof. Atta-ur-Rahman, Prof. M. Iqbal Choudhary & Dr. Sammer Yousuf

ISSN (Online): 2590-0781

ISSN (Print): 2590-0773

ISBN (Online): 978-981-4998-15-4

ISBN (Print): 978-981-4998-16-1

ISBN (Paperback): 978-981-4998-17-8

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CONTENTS

PREFACE

Spices and culinary herbs have been used as food and medicine since antiquity. Their use in traditional medicines is well documented. The field of research on spices, as health promoting and disease preventing materials, received a new impetus with the scientific work on turmeric as a source of anti-inflammatory, anti-arthritic, anticancer and antioxidant compounds. Since then tremendous studies have been conducted to decipher the science behind the therapeutic and nutritional properties of spices and culinary herbs. The world literature on phytochemistry, pharmacology, preclinical and clinical trials on health foods and spices is fast growing, creating the need for comprehensive reviews with critical analysis of the available data. The 5th volume of the book series **"*Science of Spices & Culinary Herbs*"** is a compilation of several such reviews, contributed by leading experts in the field.

The review by Shah *et al* is focused on the recent literature on ethnomedicinal uses, unique chemistry and a range of pharmacological properties of the versatile spice clove, *Syzygium aromaticum*. Clove is famous for its essential oils, and it is widely used and tested for its antifungal, nematicidal, antitumor, anti-inflammatory, anesthetic, pain relieving and insecticidal properties, to name a few. Age old Black Cumin (*Nigella sativa*) seeds have attracted major scientific interest in recent years due to its novel secondary metabolites, such as thymoquinone, nigellidine, and nigellicine, and for their therapeutic properties. Akaberi *et al* have reviewed the results of various clinical trials on black cumin seeds and its oil for treatment of infertility, cancer, asthma, non-alcoholic fatty liver diseases and rheumatoid arthritis, as well as for the chemistry, and pharmacology of this important spice. Dar *et al* have contributed a review on pharmacological and clinical studies on Mint or Indian "Podina", *Mentha arvensis* in the context of its nutritional, ethnomedicinal, phytochemical, and biological properties, such as antimicrobial, anti-oxidant, antifertility, TNF-alpha inhibition, and neuroprotective, etc. They have also presented results of clinical studies on the efficacy of *Mentha* extract preventing chemotherapy induced nausea and vomiting, and in the management of somatic and psychological symptoms of premenstrual syndrome. Rabinarayan Acharya has contributed a review on the use of *Zingiber officinale* (Ginger) as an essential constituent of Ayurvedic medicines in India. The author has provided a critical review of nutritional and phytochemical properties, as well as clinical evaluation of Ginger extract, and its phytoconstituents for the treatment of post-operative nausea and vomiting, excessive menstural bleeding and dysmenorrhea, diabetes, rheumatic disorders, etc. The article of Tosya and Bolek focuses on nutritional importance, chemical constituents and mechanisms of action of one of the most important spices, cinnamon (*Cinnamomum verum*) bark. They have also discussed the use of cinnamon as a food ingredient, and the changes it causes in the structures of various foods. Sumac (*Rhus coriar*) is a common spice, also known for health benefits. Ceyda S. Kilic present a review on primary and secondary metabolites of Sumac, its reported antioxidants and its anticancer properties.

We would like to express our thanks to all the authors of the above cited review articles for their excellent contributions in this dynamic and exciting field of biomedical and pharmaceutical research. The efforts of the efficient team of Bentham Science Publishers, particularly Mrs. Fariya Zulfiqar (Manager Publications), and Mr. Mahmood Alam (Editorial Director) for the timely production of the 5th volume deserve our appreciation.

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CHAPTER 1

Clove: The Spice of Polyvalent Merit

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Abstract: *Syzygium aromaticum* (Family Myrtaceae), commonly acknowledged as clove, is one of the most valuable spices in the world trade market with global distribution, though Indonesia has maintained its top position as a producer. Clove has sustained its value in the past, dating back to 1700 BC, as is evident from clove found in a ceramic vessel in Syria and modern society. It is well integrated into culinary and non-culinary practices. Apart from culinary use, its distinctive chemical style has demonstrated incredible potential for cosmetic, medicinal, nutrition, and agricultural applications. The ORAC (Oxygen Radical Absorption Capacity) of the clove is above 10 million, making it the most potent antioxidant source ever found in a natural system. Clove imparts a vast range of activities due to various chemical compounds, for example, phenolics, monoterpenes, sesquiterpenes, and other hydrocarbon compounds. The significant phytoconstituents present in clove oil are primarily eugenol (70-85%), trailed by eugenol acetate (14-15%), and β-caryophyllene (5–12%). Their derivatives result in an extensive gamut of biological activity as antifungal, herbicidal, nematicidal, antitumor, anti-inflammatory, antioxidant, antiviral, antimicrobial, antidiabetic, antithrombotic, anaesthetic, pain-relieving, and insect repellent properties. Clove also finds its exceptional locus among various traditional medicinal practices.

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Atta-ur-Rahman, M. Iqbal Choudhary & Sammer Yousuf (Eds.)

Along these lines, it is wise to say that clove itself has magnanimous pride among natural products. That is why we thought of covering its phytochemistry, phytopharmacology, and traditional values in detail. This chapter aims to present a comprehensive review of traditional and ethnomedicinal uses of clove in traditional medicine. We will then discuss the pharmacological activities reported for clove.

Keywords: Antioxidant, Clove, Eugenol, Pharmacological properties, Phytochemistry, Traditional medicine.

INTRODUCTION

Syzygium aromaticum (Clove) is a dried, aromatic, and unopened flower bud obtained from a tree belonging to the Myrtaceae family, a taxon of dicotyledon plants [1]. *Syzygium* is the largest genus of the Myrtaceae family, comprising about 1200 to 1800 species of flowering plants. Various synonyms used for the clove are *Caryophyllus aromaticus, Caryophyllus silvestris, Eugenia caryophyllus, Jambosa caryophyllus,* and *Myrtus caryophyllus* [2]. Clove is known by different vernacular names in different languages. It is known as qaranful (Arabic), Karamfil (Bulgarian), Ding Xiang (Chinese), Jeonghyang (Korean), Kruidnagel (Danish), Garifalo (Greek), Gvosdika (Russian), Clavo (Spanish), Mikhaki (Georgian), Nelke (German), Szegfu (Hungarian), Cengkeh (Indonesian), Choji (Japanese), Krustnaglinas (Latvian), Laung (Urdu/Punjabi/Hindi) Lawang (Nepalese), Carvo de India (Portuguese), Mikhak (Persian), Carenfil (Turkish), Garn ploo (Thai), Dhing Huong (Vietnamese), and Kala (Pashto) [3]. Clove is found in tropical and subtropical areas of Asia, Africa, Madagascar, and throughout Pacific and Oceanic regions [1, 2]. Clove is the most essential and second valuable spice in world trade and is widely cultivated in North Maluku Islands in Indonesia. Major cultivator countries of clove are Pemba, Zanzibar, Indonesia, Madagascar, and some wild clove varieties found in Bacan, Ternate, Motir, Tidore, Makian, and Western parts of Irian Jaya [4].

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S. aromaticum is an evergreen tree that grows up to a height of 8-12 m; branches are semi-erect, greyish in color, and dense. Leaves are large oblong to elliptic, simple obovate opposite, glabrous, and possess plenty of oil glands on the lower surface. The tree begins flowering in about seven years and continues flowering for 80 years or more [4]. Flowers are small, crimson in color, and hermaphrodite (bisexual) borne at the terminal ends of short branches arranged in clusters. Each peduncle carries 3 to 4 stalked flowers, and inflorescence length remains between 4 to 5 cm (Fig. **1**). Young flower buds are pale in color and slowly change to green and further to bright red when buds are ready for harvesting. These are 1-2 cm long with a thick cylindrical ovary consisting of four fleshy sepals. Buds are

divided into an elongated stem and a globose bulbous head, which stimulates the nail. Fruit matures nine months after flowering, and the red ovary gradually turns to reddish-purple. The fruit nearly contains one or two seeds known as the mother of clove. The cultivated trees are rarely allowed to reach the fruit stage. These are harvested when they develop dark red ellipsoid berry. Harvesting should be done when buds have 1.5–2 cm length, long calyx terminating in four closed petals (forming a tiny ball in the core) and spreading sepals [3, 5, 6]. Clove growth requires well-drained, loamy, and organic matter-rich soils. Constant temperature above 10 ºC is crucial, while the optimum temperature is around 20 to 30 ºC. Clove tree requires heavy sunlight with high atmospheric temperature (25 to 35 °C), well-distributed rainfall 150 to 300 cm, and high humidity above 70% [7]. This species cannot tolerate soggy conditions [3]. *S. aromaticum* (L.) tree is habitually grown at 200 m altitude above sea level in coastal areas. Clove buds are collected before flowering during the maturation phase. The collection is done either manually or chemically using a natural phyto-hormone that releases ethylene in the vegetal tissue, producing precocious maturation [9].

Fig. (1). *S. aromaticum* aerial parts.

Taxonomical classification of *S. aromaticum* (L.) [5]:

Kingdom: Plantae

Subkingdom: Tracheobionta

Superdivision: Spermatophyta

Division: Magnoliophyta

Class: Magnoliopsida

Subclass: Rosidae

Order: Myrtales

Family: Myrtaceae

CHAPTER 2

Black Cumin Seeds: From Ancient Medicine to Current Clinical Trials

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Abstract: Black cumin seeds are the seeds from *Nigella sativa* (Ranunculaceae), an annual flowering plant native to southwest Asia. Traditionally, the seeds or the oil from them have been used for a range of health problems, particularly diabetes, digestive diseases, arthritis, and asthma, as well as a food additive and spice. Laboratory studies have shown that the seeds of *N. sativa* have anti-diabetic, anti-hyperlipidemic, anticonvulsant, anti-microbial, anti-hypertensive, anti-asthmatic and anti-cancer activities. It has also been proven to possess analgesic and wound healing properties. These seeds are also of clinical interest, especially for metabolic disorders, as they have the ability to reduce fat body contents and have beneficial effects on hypertension and diabetes. In addition, many clinical trials are ongoing to investigate the effects of black cumin seeds for the treatment of infertility, cancer, asthma, non-alcoholic fatty liver disease (NAFLD), and arthritis rheumatoid. The mode of action of black cumin seeds is mostly mediated via anti-oxidant, immunomodulatory, cytoprotective and anti-inflammatory mechanisms. The most important bioactive constituents of black cumin seeds are essential oils, including thymoquinone and alkaloids, including pyrazole alkaloids such as nigellidine and nigellicine, and isoquinoline alkaloids such as nigellimine-N-oxide. The aim of the current chapter is to review the chemical, botanical, and pharmacological studies as well as the clinical potential of black cumin seeds.

Keywords: Asthma, Black cumin seeds, Metabolic syndrome, *Nigella sativa*, Ranunculaceae, Thymoquinone.

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Atta-ur-Rahman, M. Iqbal Choudhary & Sammer Yousuf (Eds.)

INTRODUCTION

Nigella sativa is a dicotyledonous flowering plant belonging to the Ranunculaceae family. The black seeds, known as black cumin seeds or black seeds in English, “Siahdaneh” in Persian, and “Habbata Al-Barakah” in Arabic, are embedded inside the plant capsules and have a bitter taste and aromatic odor. The seeds of *N. sativa* have been used traditionally as herbal medicine, additive in bread, cookies, food preservative, or spice in various cultures (Fig. **1**). The seeds or oil have been frequently recommended and prescribed in Ayurvedic, African, Islamic and Chinese medicines as a general tonic and for treating various diseases [1]. Phytochemically, the black cumin seeds possess non-volatile oil [2], essential oil [3], alkaloids [4 - 7], saponins [8, 9], *etc.* Non-volatile oil mainly constitutes tocopherols, fatty acids, including palmitic, oleic, linoleic, and stearic acids. The volatile oil of black cumin seeds constitutes over a hundred components, depending on the region of cultivation and the extraction method. Thymoquinone (30–48%) in combination with its derivatives, such as thymohydroquinone and thymolin, are the major bioactive compounds in the volatile oil [3].

Fig. (1). *Nigella sativa* seeds (A); The flowers of *N. sativa* bearing black seeds (B); The oil obtained from black cumin seeds (C); The seeds have been traditionally used as food additives (D). The photos are from the websites: https://gosumitup.com/health-benefits-of-nigella-seeds-benefits-of-kalonji and https://www.aaj.tv/news/10468476.

Nigella sativa and thymoquinone have shown potential pharmacological effects such as regulation of blood glucose and lipid levels, which are the main components of metabolic disorders, anti-cancer activities through induction of apoptosis, and anti-inflammatory activities. It is also effective against respiratory diseases and auto-immune disorders [10, 11]. The efficacy and safety of *N. sativa* seeds, its essential oil, and its main components have been confirmed through many human clinical studies. For instance, regarding metabolic disorders, the administration of *N. sativa* oil in patients with diabetes could decrease blood glucose and lipid levels [118]. In addition, seed oil of *N. sativa* showed a significant impact on plasma lipid concentrations, decreasing the total cholesterol, TG, and LDL-C levels [12]. In this chapter, we aim to provide a comprehensive review of the phytochemical investigations, pharmacological studies and clinical trials focused on this valuable spice and medicinal herb. Besides, the therapeutic potential of this plant in different systems of traditional medicine, such as Islamic traditional medicine, is discussed.

Nigella sativa in Traditional Medicine

Black cumin seeds have been used for centuries in different systems of traditional medicine, fpr *e.g.* Unani, Ayurveda, Chinese and Islamic medicines as nutritional flavoring agents and natural remedies treating many ailments. In Islamic Traditional Medicine (ITM), black cumin seeds have been applied for a range of diseases. Rāzi quoted Galen: "*Administration of black seeds on the forehead is effective in relieving headaches caused by cold temper. Inhalation of its powder mixture with Irsa oil (lily) is useful in the treatment of early stages of cataracts. Applying a mixture of its powder with vinegar eliminates acne and phlegm swellings. A poultice of a mixture of black cumin seed with old urine eradicates corns and relieves chronic phlegm. Applying a poultice made from black seed powder and water to the navel removes parasitic worms from the gastrointestinal tract. Sipping its decoction with pinewood relieves toothache. Smelling black seed is useful in improving colds and its long-term oral administration is used as an emmenagogue and milk-enhancing agent. Taking it orally with Natron relieves shortness of breath. Oral consumption of one dirham with water is useful in tarantula bites and its smoke is insect repellent*". He also quoted Ibn Māsooyeh: "*Black cumin seeds are hot and dry in the third degree and one of its major properties is to eliminate phlegm and melancholy fevers and eliminate tapeworms*" [13].

Ibn Sinā (Avicenna) considers black seed as a pungent spice with anti-phlegm and anti-flatulence properties that eliminate warts, moles, scars, and leprosy. He also believed that whenever roasted black seed is left in a bag and placed on the forehead, it is effective in treating colds. If the powder is soaked in vinegar

CHAPTER 3

Mentha arvensis (L.): an Insight on the Pharmacological and Phytochemical Profile

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Abstract: *Mentha arvensis* Linn. commonly called Podina, is a traditional herb of the family Lamiaceae distributed all over the world. First grown in Europe in ancient times, cultivation spread to Japan in the nineteenth century, then to China and other Asian countries ethnomedical records. Preliminary studies from the animal model have provided valuable scientific evidence for its use and the novel bioactive compounds. The chapter summarizes the selected scientific evidence on the pharmacological properties and phytochemistry of *Mentha arvensis* (L.) over the past 47 years from 1972 to 2020 available on several Non-English journals and English/Non-English, while identifying potential areas of further development of this herb as an economic adjunct. The evidence suggests that the extracts and compounds from *Mentha arvensis* (L.) possess antimicrobial action against several gram-positive and gram-negative bacteria, antioxidant, antifertility, TNF-alpha inhibition, radioprotective, anti-ulcer, neuroleptic, nephroprotective, sedative-hypnotic, anticancer, antiemetic, analgesic, anti-allergic, anti-inflammatory and other cardiovascular protective activities. The various scientific evidence suggests that there is strong pharmacological potential in developing *Mentha arvensis* (L.) as a drug to be used in the treatment of various disorders from antimicrobial to anticancer therapy.

Keywords: Bioactive compounds, Ethnopharmacology, *Mentha Arvensis*, Novel Herbal Drugs, Podina, Phytochemistry.

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Atta-ur-Rahman, M. Iqbal Choudhary & Sammer Yousuf (Eds.)

INTRODUCTION

Medicinal plants have been used in healthcare since time immemorial. Natural products from plants, animals, and minerals are the basis for treating human diseases [1]. Medicinal plants are presently in demand, and their acceptance is increasing progressively. Studies have been carried out globally to verify their efficacy, and some of the findings have led to the production of plant-based medicines. The global market value of medicinal plant products exceeds $100 billion per annum [2]. Medicinal herbs have constantly acted as an overall indicator of ecosystem health. Human beings have undoubtedly considered medicinal plants since ancient times [3]. The majority of the world population has used traditional medicine for thousands of years [4]. The World Health Organization reported that an estimated 80% of the population in developing countries depend on traditionally used medicinal plants for their primary health care [5]. Even the current conventional medicine uses plant-derived phytochemicals as therapeutic agents. Therefore, there is a compelling need for detailed scientific validation of all traditional medicinal plant drugs to establish their efficacy and safety in light of modern science [6]. The plant is shown in Fig. (**1**) below.

Fig. (1). *Mentha arvensis* L.

Scientific Classification

Taxonomy

Mentha arvensis L. is a branched herb that grows to a height of 60 cm [7, 8]. The plant possesses suckers and a cylindrical stem with 2.5-5 cm long simple and opposing leaves [7, 8]. Leaves are short petioles or sessile oblong-ovate or lanceolate, obtusely or acutely serrate cuneate at the base, sparsely hairy or almost glabrous; flower lilac, arranged in verticillasters arranged on axils of leaves [7, 8]. The lower surface of the leaves have stomata of diacytic type and striated cuticle

clothing trichomes (3-8 celled) [7, 8]. Glandular trichomes have two types viz. unicellular base with small single cell head and multicellular head, which are the main feature of this family [9].

Vernacular/Common Names

Mentha arvensis L. is distributed all over the world and has been given different cultural names in the countries where it is mostly used [10]. Various vernacular names of *Mentha arvensis* L. are below mentioned below in Table **1** [10].

Table 1. Several vernacular names of *Mentha arvensis* L. in different languages.

Name of Language	Vernacular Names
Sanskrit	*Puthea*
Japanese	*Midorihakka*
German	*Minze*
Chinese	*Po-ho*
Hindi	*Pudina, podina*
English	*Corn mint*
Unani	*Pudinah*
Arabian	*Putnaj*
Bengali	*Pudina*
Nepalese	*Nawaghya*
Tamil	*Puthina*
Sinhalese	*Odutalan*
Kashmiri	*Pudenah*

Distribution and Spread of Usage

In ancient times *Mentha arvensis* L. was first grown in Europe [11]. But in the nineteenth century, its cultivation was started by Japan [11]. Medicinal use of *Mentha arvensis* L. was first documented by China and Japan [11] and later introduced in India by the name Pudina [11]. *Mentha arvensis* L. is currently widely cultivated in temperate regions of Europe, western and central Asia, and also east of the Himalayas [11].

Traditional Uses

Traditionally *Mentha arvensis* L. is widely used as a contraceptive [12], carminative, antispasmodic, anti-peptic ulcer healing agent to prevent indigestion,

CHAPTER 4

Zingiber officinale: The Golden Spice, As Portrayed in Ayurveda

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Abstract: *Zingiber officinale* Rosc. (*Zingiberaceae*) - Ginger, an essential raw spice and natural medicine, plays an important role in the kitchen (a food spice) and has medicinal uses worldwide for health benefits. It is an ancient recipe of Indian systems of medicine such as Ayurveda, Unani, Siddha, and Homoeopathy. Ginger is one of the important drugs of the Ayurvedic System of Medicine, known as the universal medicine (*Viswabhesaja*), and found in almost all classical formulations of Ayurveda for the treatment of different diseases, and the majority of Ayurvedic prescription drugs contain ginger as one of the ingredients. The present paper highlights the use of *Zingiber officinale* in the Ayurveda system of medicine in India. In Ayurveda, *Zingiber officinale* is used both in fresh (Ardraka) and dry (*Shunthi*) forms. Description of the drug appears in almost all pharmacopeia of Ayurveda known as *Nighantu* (lexicons), *Samhita* (treaties), *Chikitsagrantha* (Compendia), and *Rasa grantha* (Pharmacopeia), *etc.* Dry ginger is one of the ingredients of *Trikatu* (group of three pungent spices), a famous Ayurvedic formulation for the treatment of digestive and other disorders.

In Ayurveda, fresh ginger alone or along with other drugs is used in fever, coryza, and bronchial asthma, cough, disorders due to change of place, inadequate digestion, diarrhea, anorexia, piles, oedema, abdominal disorders, fainting, urticaria, earache, and rheumatoid arthritis, *etc.*

Dry ginger alone or with other medicines is used for fever, diarrhea, loss of appetite, indigestion, malabsorption syndrome, piles, hyperacidity, abdominal pain, heart diseases, abdominal lump, diseases of abdomen, oedema, hiccough and bronchial asthma, cough, alcoholism, rheumatoid arthritis, filarial, diseases of the mouth, diseases of the ear, eye diseases, diseases of the head, for purifying breast milk, jaundice and scorpion poisoning, *etc.*

Recent research works have shown that the drug has nutritional value and has been clinically evaluated and found to be effective in the treatment of postoperative nausea and vomiting, excessive menstrual bleeding and dysmenorrhea, cancer, diabetics, and

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Atta-ur-Rahman, M. Iqbal Choudhary & Sammer Yousuf (Eds.)

rheumatic disorders, *etc.* The rhizome is rich in volatile oils (known as ginger essential oils), containing active compounds such as [6]-gingerol (a phenylpropanoid, pungent compound found in fresh ginger), [6]-shogaols (a dehydrated form of gingerols formed when ginger is dried or cooked, responsible for the pungency of dry ginger), zingiberol, Zingiberone, and α-Zingiberene. The plant has a number of chemicals responsible for its medicinal uses, including antiarthritis, anti-inflammatory, antidiabetic, antibacterial, anticancer, antifungal properties, *etc.*

Keywords: *Ardrak*, Dry Ginger, Fresh Ginger, Green Ginger, Shunthi, Spice, Trikatu, *Zingiber officinale*.

INTRODUCTION

Zingiber officinale, or Ginger, was well-known by the ancients and was widely used by the Greeks and Romans, who regarded it as an Arabian commodity because it arrived from the Red Sea, along with other spices from India. It was a common item of import from the East to Europe between the eleventh and thirteenth centuries A.D., and possibly for a long time before that. Ginger, pepper, garlic, galangal, cubebs, and other spices were taxed as spices. It was often mentioned in the eleventh century. It was also mentioned in Anglo-Saxon domestic works on medicine, and Welsh physicians used it in the thirteenth and fourteenth centuries when it was second to pepper in popularity. Around 1280-90, Marco Polo witnessed it in China and India [1].

Ginger is a popular food spice all over the world. It has been an essential ingredient in Ayurvedic, Chinese, Tibb-Unani, and Siddha medicines for centuries [2]. The deception of ginger is known by many names in Ayurvedic literature, including Mahaushadha (great remedy), Visva (pervade), Visvabheshaja (panacea), Sringavera (antlered), and Katubhadra (the good acrid). In contrast to Ardraka (fresh ginger), its dry form is known as Sunthi and Nagara. It is defined as acrid and digestive in Ayurvedic lexicons and is used to treat cold humours, costiveness, nausea, asthma, cough, colic, palpitation of the heart, tympanitis, swellings, piles, and other ailments. Trikatu (three acrids), one of the frequently used drugs in Ayurveda, contains an equal quantity of dry ginger (Sunthi), black pepper (Maricha), and long pepper (Pilppali) [3].

Nowadays, ginger is one of the most commonly used home remedies all over the world. Ginger rhizomes are used as a spice in food and beverages. The World Health Organization (WHO) monograph on ginger compiles data on anti-inflammatory, analgesic, anti-emetic, anti-diabetes properties, and cancer preventive activities available from different sources, including the pharmacopeias of China, Japan, British, African Japanese, Europe and, German commission [4]. Section 409 of the Food and Drug Administration (FDA) has

specified in the act about the safety of the intended use of its essential oils, oleoresins (solvent-free), and natural extractives (including distillates) [5].

Ginger is commonly used in the preparation of pickles, confections, and as a restorative or medicinal herb. It is produced in numerous economies, such as India, China, Indonesia, Brazil, and other countries which have humid and tropical conditions. It comes in a variety of forms, including crude ginger, dry ginger, faded dry ginger, ginger powder, ginger oil, ginger oleoresin, ginger treats, ginger lager, brined ginger, ginger wine, ginger squash, ginger pieces, and so forth. Ginger is widely used in convenience food and snacks, culinary, bakery items, sauces and soups, alcoholic and non-alcoholic drinks, confectionery, and chocolate. The opportunities in this sector are expected to develop at a CAGR of 6.50 percent between 2017 and 2022, reaching an approximate value of US$4.18 billion by the end of 2022 [6].

BIOLOGICAL SOURCE

Ginger is the dried rhizome [7] and fresh rhizome [8] of *Zingiber officinale* Roscoe, a monocot of the family *Zingiberaceae*.

Synonyms

The botanical synonyms [9] are *Amomum zingiber* L., *Curcumia longifolia* Wall., *Zingiber cholmondeleyi* (F.M.Bailey) K.Schum., *Zingiber majus* Rumph., *Zingiber missionis* Wall., and *Zingiber zingiber* (L.) H. Karst.

HABITAT AND DISTRIBUTION

Habitat: It grows in a wild state.

Global distribution: It is mainly cultivated in China, India, Nepal, Thailand, Nigeria, Indonesia, Bangladesh, Philippines, Republic of Korea, and Sri Lanka [10].

Regional distribution: It is widely cultivated in India, mainly in Assam, Kerala, Odisha, Gujarat, Sikkim, Mizoram, and Arunachal Pradesh [10].

VERNACULAR NAMES

Ginger is known by various names in different parts of the world [9]. Some of them are Bulgaria: Dzhindzhifil; Cambodia: Chnay; Khnhei; Khnheiphlung; Chinese: Jiang; Croatia: Dumber; Ecuador: Agiringuire; sachaajo; English: Common ginger, garden ginger true ginger; French Polynesia: Rea moru, rea tinito,re'a-ma'ohi,re'amoruru; French: Gingembre,gingembre chinos; Germany:

CHAPTER 5

Effects of Cinnamon on Health and its Potential as a Functional Food Ingredient

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Abstract: Cinnamon has been used as a spice in many societies for a long time, as well as for medical use. Botanical source, climatic conditions, and harvesting and production techniques alter the cinnamon's quality and chemical components. However, the geographical origin of the cinnamon and the conditions under which it is processed affect the chemical composition. Essential oils derived from the bark, leaf, and root bark of *Cinnamomum verum* vary significantly in chemical composition. Cinnamon and its extract are known to have many positive effects on health, regardless of the type. In traditional medicine, cinnamon barks are used in many kinds of treatment methods of diseases, such as gastrointestinal system disorders, type 2 *diabetes mellitus,* lungs infections, cardiovascular diseases, cancer, and neurological disorders. For several decades, cinnamon has been used for its potential antioxidant, antimicrobial, anti-cancer, anti-inflammatory attributes. It is effective in controlling blood sugar and lipid levels. In this study, components, structures, nutrients of cinnamon were reviewed. Various food enrichment studies with cinnamon were reviewed, and the changes cinnamon caused in the composition of foods were examined.

Keywords: Anti-Inflammatory, Anticancer, Antimicrobial, Antioxidant, Antidiabetic Effect, Cinnamon, Enrichment.

INTRODUCTION

Besides its medical use, cinnamon has been used as a spice in many societies for a long time [1, 2]. *Cinnamomum zeylanicum* or *Cinnamomun verum* originated from Sri Lanka and India. *Cinnamomum tamala* comes from the southern hillsides of the Himalayas. *Cinnamomum burmannii,* which is Indonesian cinnamon, originally grows in Sumatra's west. *Cinnamomum pauciflorum* is grown in the southwest of China, northeast India, and the hillside of Assam and Khassia [3].

Botanical source, climatic conditions, and harvesting techniques alter the quality

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Atta-ur-Rahman, M. Iqbal Choudhary & Sammer Yousuf (Eds.)

and chemical components of cinnamon [4]. Moreover, the geographical origin of the cinnamon and the conditions under which it is processed affect the chemical composition [5]. However, cinnamaldehyde, cinnamate, cinnamic acid, gum, mannitol, coumarins, and essential oils are the main components of cinnamon [6]. The specific flavor and aroma of cinnamon come from its aromatic essential oils [2]. Essential oils derived from the bark, leaf, and root bark of *Cinnamomum verum* vary significantly in chemical composition (Table **1**), suggesting that they also vary in their pharmacological effects. These oils, which are from three different parts of the cinnamon plant given in Fig. (**1**), have the same monoterpene hydrocarbon sequence in different percentages. Each of these oils contains a different main ingredient, such as higher content of cinnamaldehyde is present in bark oil, eugenol in leaf oil, and camphor in root bark oil [1, 6]. Bark oil of cinnamon consists of cinnamaldehyde (80–90%), which is responsible for its sweet taste [5]. This specific taste and smell are due to the oxygen absorption of cinnamaldehyde. When cinnamon gets older, its oxygen absorption increases, making it darker in color and improving resinous compounds. The structures of compounds of cinnamon are given in Fig. (**2**) [7].

Leaves **Fruits** **Barks and powder**

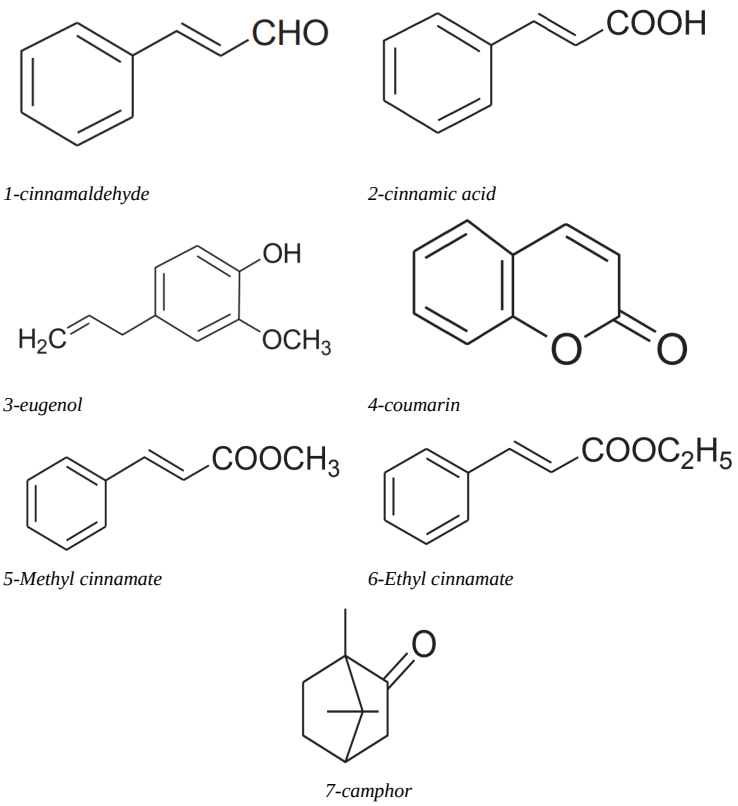
Fig. (1). Part of *C. verum* plants.

Table 1. The distribution of the composition of the *C.verum* according to its different parts.

Part of the Plant	Compound	%
Leaves	Cinnamldehyde	1.00-5.00
	Eugenol	70.00-95.00
Bark	Cinnamldehyde	65.00-80.00
	Eugenol	5.00-10.00
Root Bark	Camphor	60.00
Fruit	*Trans*-Cinnamyl acetate	42.00-54.00
	Caryophyllene	9.00-14.00

(Table 1) cont.....

Part of the Plant	Compound	%
C.verum Buds	Tepene hydrocarbons	78.00
	α-Bergamotene	27.38
	α-Copaene	23.05
	Oxygenated terpenoids	9.00
C.verum Flowers	E-Cinnamyl acetate	41.98
	Trans-α- Bergamotene	7.97
	Caryophyllene oxide	7.20



1-cinnamaldehyde *2-cinnamic acid*

3-eugenol *4-coumarin*

5-Methyl cinnamate *6-Ethyl cinnamate*

7-camphor

Fig. (2). Structures of compounds of cinnamon.

Nutritional Composition of Cinnamon

The nutritional composition of cinnamon is given in Table **2**. Cinnamon has a high content of carbohydrates. Fat and protein content are relatively lower compared to the carbohydrate content. Besides, it has rich dietary fiber content. Cinnamon bark oil contains chromium (0.4 mg/g), zinc (2.6 mg/g), iron (7.0

CHAPTER 6

Sumac: A Spice with Many Health Benefits

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Abstract: *Rhus coriaria* is a plant which has been known and used for a long time all throughout the world as a dyestuff and condiment, and in addition to these well-known uses, it has various biological activities and thus is being used traditionally in different countries due to various important primary and secondary metabolites that it contains. Besides its traditional uses, there are studies on the antioxidant, antinociceptive, antimicrobial, antifungal, antilipidemic, anti-inflammatory, antidiabetic, and anticancer activities of the plant; it is also known to have positive effects on the cardiovascular system and is used as a wound healer. Over time, an extensive amount of studies have been performed on the plant, and more studies are quite likely on the way in respect of a computational study performed on its effectiveness against COVID-19.

Keywords: Anacardiaceae, Antioxidant, Anticancer, Composition, Dye, Ethnobotany, Foodstuff, *Rhus coriaria* L., Sumac, Spice.

INTRODUCTION

Rhus coriaria L., is a small deciduous shrub or a small tree of the family Anacardiaceae. Young branches of the plant are brownish tomentose, leaves are pinnately compound with 9-15, broadly lanceolate to elliptic, serrate to deeply serrate leaflets, sparsely pilose above and beneath. Flowers are in spikes or dense panicles having five greenish-white petals. Fruit is a reddish or purple-colored drupe having brown seeds [1 - 3]. The general appearance of the plant is given in Fig. (**1**).

The plant naturally grows in the temperate and tropical regions, mainly in the countries having a coast on the Mediterranean Sea. It grows in South Europe, North Africa, Iran and Afghanistan [4, 5], and Anatolia is considered to be the gene center.

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Atta-ur-Rahman, M. Iqbal Choudhary & Sammer Yousuf (Eds.)

Fig. (1). General appearance of *R. coriaria* (Photo by G. Yılmaz).

This plant and the spice obtained from the plant are both known by the name Sumac, and this word is considered to come from the word "summaq" [6] or "sumaga", which means red/dark red in Arabic [7]. Dark red colored fruits of the plant Fig. (**2**) are collected, dried and powdered to obtain a crimson-colored sour spice that is highly appreciated in the Middle Eastern cuisine [8]. *R. coriaria* is used as a spice, sprinkled over kebabs and salads [9] and especially on onions in Turkey, and gives these dishes a sour taste [10]; it is also eaten as an appetizer [11].

However, it is known with the name "sommaccheti" in Sicily (originating from its local name "Sommacco") and is considered to be a noxious weed since fruits are toxic when consumed fresh, though used for culinary purposes after drying. The plant is largely used in tanneries due to its tannin-rich bark and leaves [12], and therefore, known by the name "tanner's sumac" [13].

Fig. (2). *R. coriaria* fruits (Photo by G. Yılmaz).

In addition to its culinary usage, different colored dyes are obtained from different parts of the plant in Turkey; for *e.g.,* a black dye is obtained from the leaves and

twigs, and a yellow colored dye is obtained from the bark and used to dye wool or cotton [14]. Moreover, the dye obtained from the plant is known to be effective against decaying of wood [15].

In addition to these aforementioned uses, this is actually a medicinal plant having various biological activities, and thus, it has been used in different countries for different purposes throughout the world.

TRADITIONAL USES

The plant grows naturally in many countries, and is therefore used for different purposes to treat and/or to prevent some ailments. Some of these traditional uses are listed below as country-based.

Traditional Uses in Turkey

Since this plant grows naturally in Turkey, it is used extensively and for various purposes in the country. For example, the leaves of the plant are used against diseases of the mouth and throat in Turkey [16]. Mature fruits of the plant are grounded, kept in water for a period of time and then used as a gargle in the treatment of oral wounds [17, 18]; sour extracts prepared from the berries are used for this purpose as well [19] and *R. coriaria* inflorescences are used against throat inflammation in the form of a paste [20]. Berries are known to be diuretic and they are also used against bowel complaints, as an antiseptic, and for reducing fever [11]. The plant is reported to be used against tooth abscess in Turkey [21]. *R. coriaria* fruits are considered to be effective against diabetes and are used to give flavor to dishes in Muğla, Balıkesir [22] and Gaziantep provinces of Turkey [23]. It is also reported to be used for gastric bleeding traditionally [24]. Fresh leaves are boiled with water, filtered and the filtrate is used in stomach pain and also used for the treatment of wounds in animals. In addition, leaves are known to be antiseptic, antimicrobial, hemostatic and febrifuge and are used against diarrhea especially in children [17, 25, 26]. Fruits are either eaten or seeds are used as infusion internally, and leaves are used as a decoction and also as maceration internally for this purpose [27]. Moreover, some alternative treatments involving the application of *R. coriaria* juice are implemented in atopic dermatitis, a chronic inflammatory dermatological disease that is characterized by dryness and itching of the skin which can not be healed completely [28]. The plant is also reported to be used in eczema [29]. Decoction and infusion of the leaves and the decoction of the fruits are used as pain killer [30]. The plant was also reported to be effective against diabetes; flower and leaf decoctions of the plant are used against diabetes as 1 tea glass per day [31], and similarly, fruits and

SUBJECT INDEX

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

U

V

W

X

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