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KITCHEN PHARMACY- I

SPICES

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PREFACE

The present book, “Kitchen Pharmacy–I: Spices”, has been prepared as a Skill Enhancement Course (SEC) text for undergraduate students to bridge the gap between traditional knowledge and modern scientific understanding of spices and condiments. It focuses on the status of spice production in India and the world, their phytochemistry, economic importance, and wide-ranging medicinal uses, with special reference to commonly used household spices such as ginger, turmeric, onion, garlic, mint, coriander, cinnamon, clove, saffron, chilli, black pepper, cumin and others found in our kitchens. By integrating basic concepts, up-to-date data on production and export, and simple practical exercises, this book aims to help students appreciate spices not only as flavouring agents but also as valuable sources of bioactive compounds.

The text has been organized in a systematic manner, beginning with basic information and classification of spices and condiments, followed by detailed accounts of their phytochemistry, properties, uses, and cultivation, as well as selected experiments on preservation and extraction of essential oils and active principles. At every stage, an effort has been made to present the subject in clear and concise language, supported by examples relevant to the Indian context so that students can easily relate theory to their day-to-day life and local market experience. It is hoped that this book will serve as a useful resource for students of Botany and allied Life Sciences, teachers handling Skill Enhancement Courses, and all readers interested in learning how common kitchen ingredients can act as a simple, accessible “pharmacy” for common ailments.

Any suggestions for improvement, corrections, or additions from teachers, students, and readers will be gratefully received and duly considered in future revisions of this work.

- Authors

Dr. Prashant J. Gadge and Dr. Mustafa M. Dandu

ACKNOWLEDGEMENT

The completion of this book, “Kitchen Pharmacy–I: Spices”, has been possible only with the support and encouragement of many individuals and institutions. First and foremost, we express my sincere gratitude to the Management and Principal of Nirmal Krida and Samaj Prabodhan Trust’s Arts, Science and Commerce College, Badnapur, for providing a conducive academic environment and constant encouragement for innovative course design and material development. We are deeply thankful to my respected teachers and mentors from the Department of Botany, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, whose guidance in the areas of phytochemistry, economic botany, and medicinal plants laid the foundation for my interest in spices and their applications.

We are gratefully acknowledging our colleagues in the Department of Botany for their cooperation, constructive suggestions, and help in organizing, typing, and refining the manuscript, as well as the non-teaching staff for their timely assistance in obtaining references and arranging laboratory facilities for the practical components. My heartfelt thanks are due to my students, whose curiosity, questions, and feedback in the classroom and laboratory motivated me to present the subject in a simple and practice-oriented manner, and who inspired the very idea of “Kitchen Pharmacy” as a meaningful Skill Enhancement Course. We also wish to thank the authors, researchers, government agencies, and organizations whose publications, reports, and online resources on spices, their production, trade, and medicinal properties have been consulted and duly acknowledged in the text.

Finally, we are deeply indebted to my family members for their patience, encouragement, and moral support throughout the period of preparation of this book. Without their understanding and constant motivation, this work would not have reached its present form.

- Authors

Dr. Prashant J. Gadge and Dr. Mustafa M. Dandu

Theory Course: SEC 1

KITCHEN PHARMACY-I: SPICES

Course type: Skill Enhancement Course

Credit: 1; Hours: 15 clock hours; 1 hour/week

Marks: 50

Learning Objectives:

- To know the status of Spices and condiments production in world and particularly to Indian scenario.
- To Learn spices commonly used in various culinary and food products.
- To study the biochemical and phytoconstituents of various spices.
- To use the spices as medicine in common ailments

Course Outcome

- On the successful completion of the course, student will be able to-
- Learn skills regarding identification of various spices and condiments used in our region.
- To learn the techniques for estimation of phytochemicals of different spices and condiments.
- Use the Spices as medicine in the common ailments

Unit I: Basic information and differences between Spices and Condiments. India's share in Spices production. Export of Spices to Foreign countries, revenue generation of spices in global market.

Unit II: Phytochemistry. Economic importance. Medicinal properties and uses of Following Spices:

- a) Rhizome Spices: Zinger, Turmeric.
- b) Bulb Spices: Onion, Garlic.
- c) Leafy Spices: Mint, Coriander, Bay leaf.
- d) Bark Spices: Cinnamon.
- e) Flower Spices: Cloves, Saffron.
- f) Fruit Spices: Chilli, Coriander, Black pepper, Star anise, Cumin. Fennel, Caraway, Bishops weed.
- g) Seed Spices: Cardamom, Nutmeg.
- h) Gum/Resin Spices: Asafoetida

UNIT I

BASIC INFORMATION, DIFFERENCE BETWEEN SPICES AND CONDIMENT, INDIA SHARE PRODUCTION, EXPORT AND REVENUE GENERATED

Since from many years, it is referred to a group of spices as "The Kitchen Pharmacy" because they are considered medicinal in Ayurveda. These spices include turmeric, ginger, cinnamon, cumin, fenugreek, clove, fennel, coriander, allspice, curry leaf, and saffron.

Pharmacy in a Kitchen is a program that provides recipes, inspiration, and lifestyle suggestions to help people eat in a way that nourishes their bodies. The program was created by a registered pharmacist and cancer survivor who is certified in plant-based nutrition.

1. Basic Information of Spices and Condiments

Spices and condiments are both essential cooking ingredients that we must consume on a daily basis. We must include them in our meals to improve their flavor, color, presentation with nutritional value. India accounts for 75% of global spice production, and the global spice market is expanding. Indian spices are renowned for their exceptional aroma, flavor, and pungency, which no other country can match. After cheese, the condiment trade is the second largest market in specialty foods. Almost every country used spices in ancient times, and the spice trade developed throughout South Asia and the Middle East around 2000 BCE, primarily with cinnamon and pepper. In India, the major spices produced are pepper, cardamom, ginger, turmeric and chillies. Black pepper is one of the most important Indian spices, and is known as the **‘King of Spices’** or black gold of India. Next comes cardamom also called the **‘Queen of Spices’**, through which India earns a lot of foreign exchange. Some other important spices grown in India include anise seed, caraway, celery, coriander, cumin, dill, fennel, fenugreek, garlic, onion, saffron and vanilla. In India, spices are grown mainly in states of Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Orissa, Rajasthan and Bihar.

1. According to the International Organization for Standardization (ISO) report, there are about 109 spices grown in different parts of the world.
2. India grows more than 60 spices. The term ‘Spices and Condiments’ are natural plant products.
3. Spices are natural plant products used to improve the flavor, aroma, taste and color of food products.
4. Indian spices are renowned for their excellent aroma, flavor and pungency, not easily matched by any other country.

Definition of Spices:

“Spices are derived from other parts of plants, such as seeds, roots, bark, or fruits”. The word “spice” is derived from the Latin word species that means specific kind, and later, goods or merchandise. Spices are vegetable products or mixtures free from extraneous matter used for

flavoring, seasoning and imparting aroma in foods. Spices have medicinal uses also because of their carminative stimulating and digestive properties.

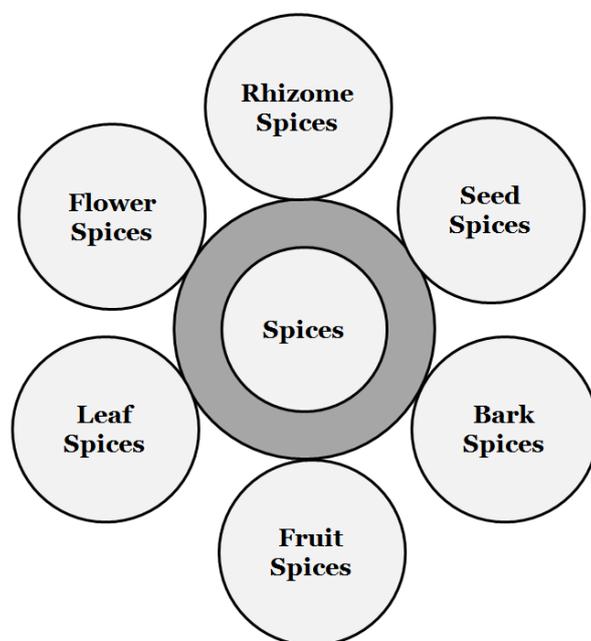
Definition of Condiments:

“Condiments are sauces or preparations added to food to enhance its flavor, often used at the table or during cooking”. Condiments on the other hand are spices that are usually added to food after cooking. A condiment is a spice, sauce or a spice mixture which is mainly added to food dishes to give a specific flavor or to supplement a dish. When the aromatic vegetable product comes from a temperate plant, it is considered as a culinary herb (non-woody), as in case of bay leaves, coriander, fennel, mustard, etc. Food items like pickles, sauces and mustards are considered to be condiments.



Various spices used in kitchen

Classification of Spices and Condiments



Types of Spices

There are about 35 spices and condiments which can be broadly classified into 6 groups, based upon the parts of the plants are following.

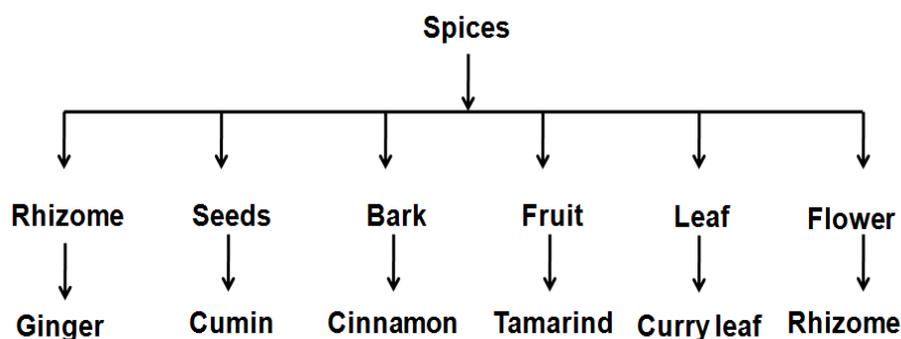
1. **Rhizomes and root spices**— Ginger, Turmeric, onion and Garlic.
2. **Seed spices** — Nutmeg, Coriander, Fennel, Cumin, Fenugreek, Dill, Aniseed, Celery and Bishop-weed.
3. **Bark spices** —Cinnamon
4. **Fruit spices**—Cardamom, Black Pepper, Vanilla, Allspice, Cassia, Tamarind, etc.
5. **Leaf spices** —Bay leaf, Curry leaf, etc.
6. **Flower spices**—Clove, Saffron, Asafoetida, etc.

There are two types of spices

1. **Whole Spices:** Whole spices are the barks, roots, seeds, leaves or stem of dried plants and ready to release the fascination aromas. These spices hold a special place in Indian cuisine, and it won't be wrong to say that Indian dishes are incomplete without them. Black cardamom, Cinnamon, Cumin seeds, Bay-leaf, Coriander seeds, Black pepper, Mace, green cardamom, Mustard, Fenugreek.
2. **Culinary Herbs:** Culinary Herbs and Spices are edible parts of plants that are traditionally added to foodstuffs for either their natural flavoring, aromatic and/or visual properties. Oregano, Thyme, Basil, Dill, Sage, Coriander, Parsley, Chives, Rosemary, Chervil, Tarragon, Mint.

Properties and Importance of Spices

1. Spices are well known as appetizers.
2. They add a tang (taste) and flavor to otherwise in sipid foods.
3. Some of them also possess anti-oxidant properties.
4. Some of them have preservative qualities (clove and mustard).
5. Some have strong anti-microbial and antibiotic activities. Ex: Turmeric, Nutmeg etc.
6. Several of them possess medicinal properties.
7. Some spices stimulate secretion of digestive enzymes and helps digestion. Ex: ginger.
8. Some spices like garlic when consumed in diet reduces cholesterol levels and may decrease the risk of heart disease.



Difference between Spices and Condiments

| Sr. No. | Spices | Condiments |
|---------|---|--|
| 1. | Spices are aromatic flavorings derived from plants' seeds, fruits, bark, rhizomes, and other parts. | Condiments are substances or preparations that are added to foods after they have been cooked to enhance the flavor and taste. |
| 2. | They are used to season and preserve food, as well as to make medicines, dyes, and perfumes. | Typically used in smaller quantities, condiments can be served alongside food or incorporated into recipes for additional flavor. |
| 3. | Spices are rich in vitamin A, B, and, C, cryptoxanthin, riboflavin, niacin, selenium, magnesium, iron, copper, sodium, potassium, manganese, zinc, folate, and calcium. | Condiments are high in iron, mineral salts, fat, proteins, carbohydrates, calcium, fibre, and phosphorus. |
| 4. | Spices are added during the preparation of a meal | Condiments are added after the Preparation of a meal. |
| 5. | Spices cannot serve as a garnish | Condiments can serve as a garnish or even as ideal meal. |
| 6. | Spices have strong anti-oxidant, anti-microbial and antibiotic activities. | They also have antioxidant properties too. |
| 7. | Eg. Bay leaf, Peppermint, Cumin, Cardamom, Ginger, Coriander, Nutmeg Cinnamon, Saffron, Clove, Black pepper and turmeric etc | Eg. Aioli, Gravy, Anchovy sauce, Caramel, Maple syrup, Cheese, Chimichurri, Chrain, Coleslaw, Dip, sauce, Chutney, Mayonnaise, Piccalilli, Ketchup etc |

Spices Production and Share in Global Market

From various ages, spices have always been a crucial component of India's external trade with foreign countries unlike Arabia, Sumeria, Mesopotamia, China, Egypt and, along with textiles and perfumes.

The giant history of spices includes in its place in each holy book. The Ramayana also in the writings dating back to the Roman Empire in the first century AD. The caravans of camels moved regularly from Calicut, Goa and the Orient. They even transport these spices to distant destinations such as Carthage, Alexandria, and Rome.

Today, Indian spices are available everywhere, but there was a time when people have to risk their existence to gain access to Indian spices. From the Indian point of view, it brought in traders and invaders alike – a century after century.



India is the world's largest spice producer. It is also the largest consumer as well as exporter of spices. The production of different spices has been growing rapidly over the last few years. India's share of the global spice export market is around **20%** in value terms. Production in 2022-23 stood at 11.14 million tonnes compared to 11.12 million tonnes in 2021-22. During 2022-23, the export of spices from India stood at US\$ 3.73 billion from US\$ 3.46 billion in 2021-22. During 2021-22, the single largest spice exported from India was chilli followed by spice oils and oleoresins, mint products, cumin, and turmeric. India produces about 75 of the 109 varieties which are listed by the International Organization for Standardization (ISO). The most produced and exported spices are pepper, cardamom, chilli, ginger, turmeric, coriander, cumin, celery, fennel, fenugreek, garlic, nutmeg & mace, curry powder, spice oils and oleoresins. Out of these spices, chilli, cumin, turmeric, ginger and coriander makeup about 76% of the total production. The largest spices-producing states in India are Madhya Pradesh, Rajasthan, Gujarat, Andhra Pradesh, Telangana, Karnataka, Maharashtra, Assam, Orissa, Uttar Pradesh, West Bengal, Tamil Nadu and Kerala.

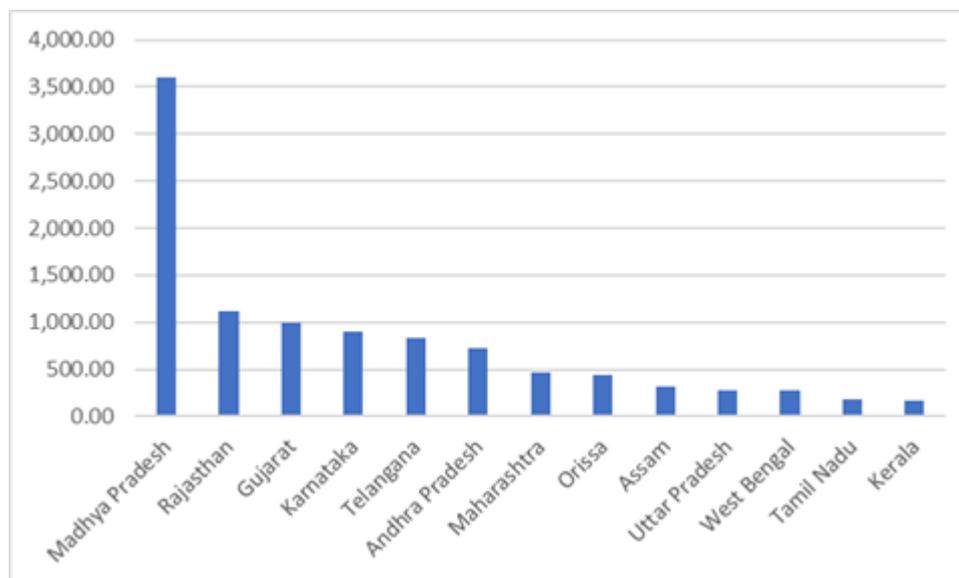
In southern region of India kerala, Tamilnadu and Andhra Pradesh, 40% production come from kerala and tamilnadu renowned for its diverse spices production, Black pepper, Turmeric and cardamom so, kerala called as spice garden of India and kerala is major black pepper and cardamom and in tamilnadu and Andhra Pradesh Turmeric and chilli.

Western region of India, Gujarat, Maharashtra and Rajasthan, produce **30%** spices production. Gujarat is leading producer of cumin, funnel and coriander and in Maharashtra high quality producing turmeric and chilli and they also have strong supply network.

Estimated state wise production of spices in 2023

| State | Estimated production (in thousand metric tons) |
|----------------|---|
| Madhya Pradesh | 3,594.79 |
| Rajasthan | 1,117.36 |
| Gujarat | 1,000.10 |
| Karnataka | 898.8 |
| Telangana | 836.2 |
| Andhra Pradesh | 720.24 |
| Maharashtra | 465.52 |
| Orissa | 439.54 |
| Assam | 316.11 |
| Uttar Pradesh | 277.65 |
| West Bengal | 275.02 |
| Tamil Nadu | 188.32 |
| Kerala | 162.87 |

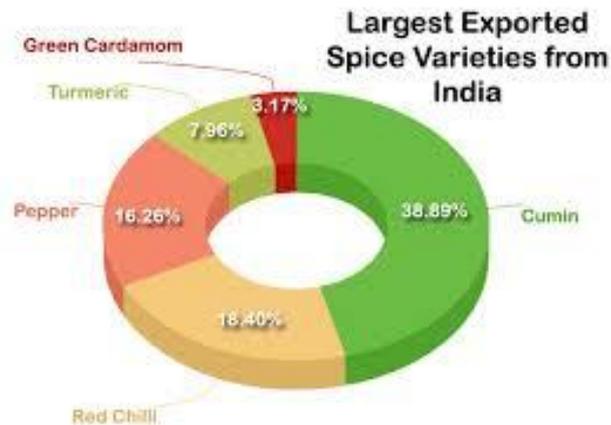
While Uttar Pradesh, Punjab, Haryana and Uttarakhand come under the Northern region of India occupy **20%** production of spices, Uttar Pradesh and Punjab is known for production of mustard and fenugreek and Uttarakhand is producing high quality of Asafoetida. Also for this production of spices government giving support for it.



Production of spices (in Thousand metric tons)

In Eastern region Bihar, Odisha, west Bengal and Assam contribute **10%** production of spices. West Bengal and Assam focus on production of Bay leaves and ginger. Odhisa and Bihar produces turmeric and chilli.

According to the statistics for saffron trade in 2019, Iran was ranked as the world's largest producer of saffron; supplying 430 tons of the total 450 tons of saffron produced Worldwide and is expected to reach 500 tons in 2020. **Saffron** is a spice that is grown in India, especially in Kashmir, which is known for its ideal climate for growing the crop. Here's some information about saffron production in India India's annual production of saffron is around 6-7 tons, while the annual demand is 100 tons. This means that India imports a large amount of saffron. Saffron is cultivated in about 2,825 hectares of land in Jammu and Kashmir.



Global Market Size Spices and Their Revenue

Spice market has divers demand throughout world because humans have appreciated spices for their flavor and medicinal qualities. Modern research demonstrated that spices have numerous health benefits. For example, cinnamon is a common spice that can be used in various food items and recipes. Anti-inflammatory strong anti-oxidant properties blood thinning triglyceride and cholesterol lowering effect are all credited to cinnamon. The global spices and seasonings market size reached US\$ 27.3 billion in 2023. The global spices market size was US\$ 15.50 billion in 2022. The market is projected to reach US\$ 41.2 billion by 2032, exhibiting a growth rate (CAGR) of 4.7% during 2023-2032. Revenue in the Sauces & Condiments market amounts to US\$262.30 Billion in 2024. The market is expected to grow annually by 6.17%. As of 2024, the spice and culinary herbs market reported revenue of over 666 million U.S. dollars in India.

Major Export Spices to Countries from India and Revenue

From ancient time India is the world's largest exporter of spices and spice products. In 2023-24, India exported 15,39,692 tons of spices worth \$4.46 billion, which was an all-time high. India's share of the global seasoning and spices market was 20.1% in 2024, and it's expected to lead the global market in revenue by 2030.

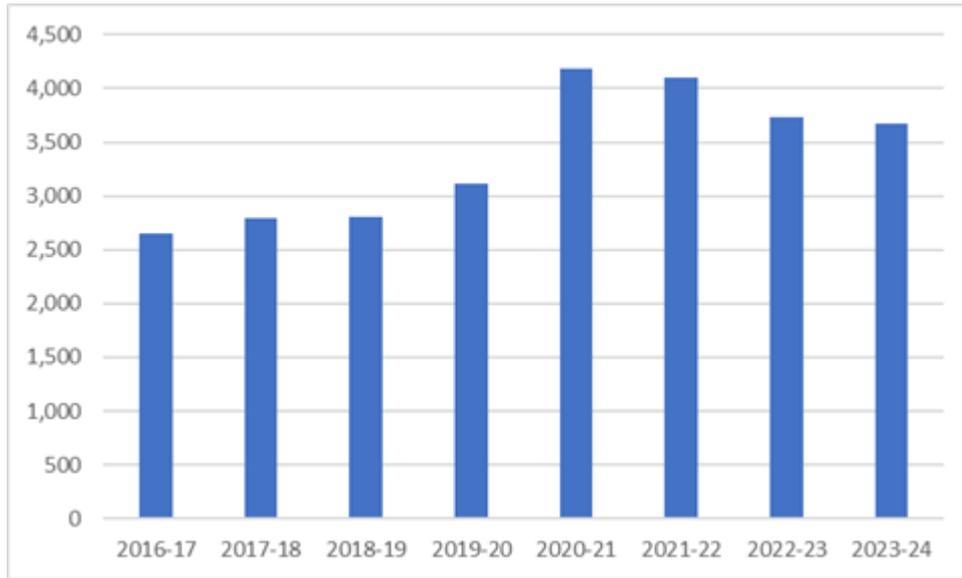
In 2023, the spices market in India was worth INR 1, 80,760 Crores. In 2023-24, India's spice exports reached an all-time high of \$4.46 billion. This was an increase from 2021-22, when India's spice exports were \$3.46 billion.

India exported spices and spice products to 159 destinations worldwide as of 2023-24 (until February 2024). The top destinations among them were China, the USA, Bangladesh, the UAE, Thailand, Malaysia, Indonesia, the UK, and Sri Lanka. These nine destinations comprised more than 70% of the total export earnings in 2023-24 (until February 2024).

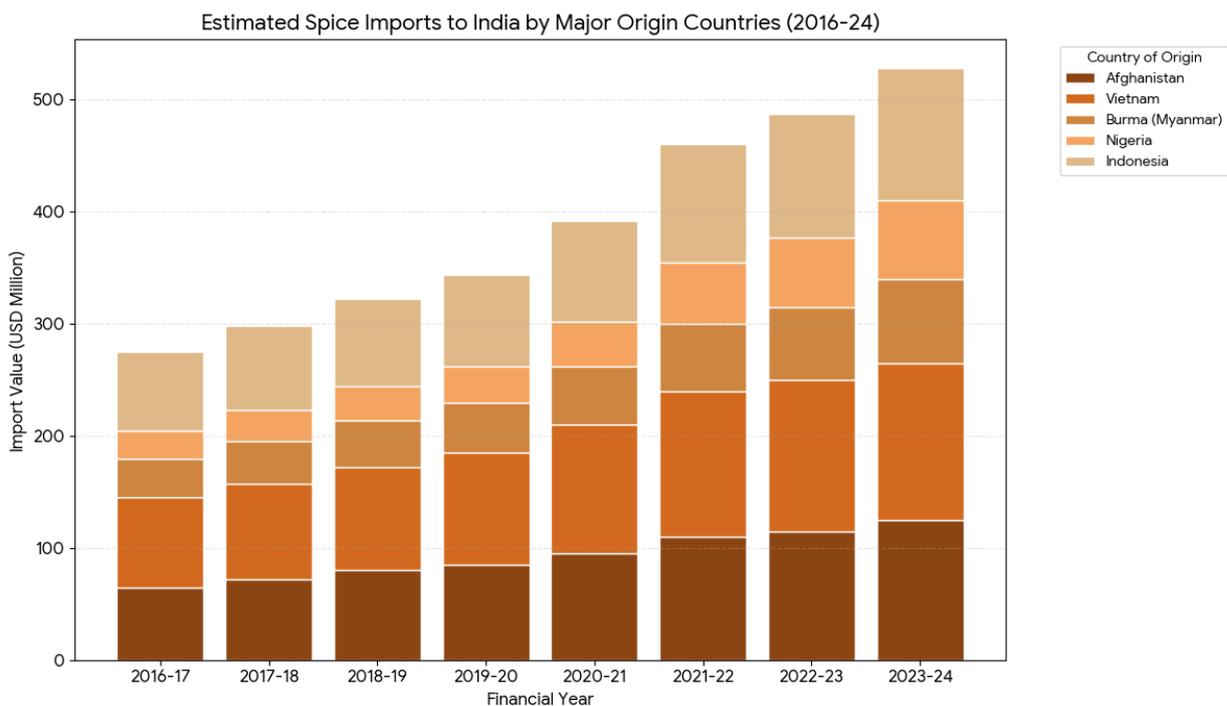
China imported spice valued at US\$ 725.76 million from India, while the USA imported spices worth US\$515. 91million. Bangladesh imported spices amounting to US\$ 296.55 million. Additionally, the UAE imported spices worth US\$ 214.76 million from India during 2023-24. Chilli was the most exported spice from India, followed by it cumin and turmeric is highly demanded in world.

State wise spices production in India

| Spices | States of India |
|------------------|---|
| Pepper | Kerala, Karnataka, Tamil Nadu. |
| Cardamom (Small) | Kerala, Karnataka, Tamil Nadu. |
| Cardamom (Large) | Sikkim, West Bengal. |
| Ginger | Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Meghalaya, Orissa, Arunachal Pradesh, West Bengal, Mizoram, Sikkim, Himachal Pradesh, Tamil Nadu, Uttaranchal, Chattisgarh, Jharkhand. |
| Turmeric | Andhra Pradesh, Karnataka, Orissa, Tamil Nadu, West Bengal, Maharashtra, Kerala, Assam, Bihar, Meghalaya, Tripura, Uttar Pradesh, Arunachal Pradesh, |
| Chilli | Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Madhya Pradesh, Uttaranchal. |
| Coriander | Rajasthan, Uttar Pradesh, Uttaranchal. |
| Cumin | Rajasthan, Gujarat, Uttar Pradesh |
| Fennel | Gujarat, Rajasthan, Uttar Pradesh |
| Fenugreek | Rajasthan, Uttar Pradesh, Gujarat, |
| Clove | Kerala, Tamil Nadu, Karnataka. |
| Saffron | Jammu & Kashmir |
| Garlic | Haryana, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh, Gujarat, Karnataka, Rajasthan, Chattisgarh, Bihar. |



Export Value of Indian Spices (Approx. in USD Millions/Crores)



The provided graph illustrates a consistent upward trajectory in India's spice imports from 2016 to 2024, nearly doubling in value over the eight-year period. While Vietnam and Afghanistan remain the dominant suppliers—primarily for Pepper and Asafoetida—there is a noticeable growth in imports from emerging partners like Nigeria. This trend highlights India's increasing reliance on global markets to meet the surging domestic demand for specific spices that are not produced locally in sufficient quantities.

UNIT II

PHOTOCHEMISTRY, ECONOMIC IMPORTANCE, MEDICINAL PROPERTIES AND USES OF FOLLOWING SPICES

1. RHIZOMES SPICES (GINGER AND TURMERIC)

A. GINGER

Botanical Name: *Zingiber officinale* Roscoe

Family: *Zingiberaceae*

Common Name: Adrak n = 11

Ginger is a perennial herb that is well known for its medicinal and aromatic properties. The scientific name of ginger is *Zingiber officinale* and it belongs to the family *Zingiberaceae* under monocotyledons. This plant is native to southeastern Asia but is now cultivated in many places of the world. The most used part of ginger is its rhizome, which grows underground and acts as a food reserve for the plant.

Morphology of Ginger

1. The ginger plants are perennial and grow up to a height of 1 meter. The diagram of ginger shows the morphology as follows:
2. Leaves are elongated, ranging between 15 to 30 cm in length. They are arranged in an alternate arrangement.
3. The plants bear white, pinkish flowers that turn into yellow color upon maturity. They are borne in an inflorescence where flowers are arranged in a cone-like spike covered by overlapping green-colored bracts.
4. Ginger is a monocot plant with a modified underground stem. The underground rhizome has many medicinal uses and is used as spice.
5. The rhizome bears shoot that is rolled leaves that emerge directly above the ground. These rolled leaves form a pseudostem and the original stem is underground. This rolled portion bears the aerial parts like inflorescence and leaves.

Phytochemistry of Ginger

Ginger content Alkaloids, flavonoids, tannin, saponin, glycosides, oxalates, phytates, phenols, steroids, and anthraquinone.

The essential oil 1 to 3% of the fresh rhizome contains mostly sesqui-terpenes, e.g., (–)-zingiberene (up to 70%), (+)-ar-curcumene β -sesquiphellandrene, bisabolene and farnesene. Mono-terpenoids occur in traces (β -phell-andrene, cineol, and citral). The pungency of ginger is caused by a non-volatile resin containing the same type of hydroxyaryl compounds that are also found in other spices of the ginger family: Zingerone, gingerols and shogaols. The pungent

gingerols degrade to the milder shogaols during storage; high gingerole content and good pungency thus indicate freshness and quality.

Economic Importance of Ginger

1. In Food Preparations: It is widely used for culinary purposes in the preparation of ginger bread, biscuits, cakes, puddings, soups and pickles.
2. Recovery of starch and manufacturing soft drinks from exhausted ginger (after recovery of volatile oil): Starch can be obtained from ginger residue after the recovery of oleoresin. Likewise, vitamin is effervescent or plain ginger powder can be obtained from the exhausted ginger.
3. Alcoholic Beverages: Ginger is also used for flavoring beverages, such as ginger beer, ginger ale and ginger wine.
4. In Medicine: According to the Ayurveda system of medicine, ginger is considered to be a stimulant and carminative and helps in the expulsion of gas in the stomach).
5. Ginger oil: It is used (a) as a flavorant in non-alcoholic beverages, confectionery and pickles, (b) in pharmaceutical industry as a carminative, rubefacient (causing redness, as of the skin), in gastritis and dyspepsia (indigestion), and (c) in perfumery as it imparts a distinctive smell of the oriental type.

Medicinal Properties of Ginger

1. Nausea relief: Ginger can help with nausea caused by pregnancy, chemotherapy, vertigo, and mild gastrointestinal infections. Ginger can be consumed as tea, candied ginger, or fresh ginger.
2. Anti-inflammatory: Ginger contains compounds that have anti-inflammatory properties. Ginger can help with joint pain and inflammation caused by arthritis.
3. Digestion: Ginger can help with efficient digestion and stomach upset.
4. Antioxidant: Ginger contains antioxidants that can help manage free radicals.
5. Cholesterol-Lowering: Ginger can help lower blood cholesterol levels.
6. Blood pressure-lowering: Ginger can help lower blood pressure.
7. Anti-microbial: Ginger has antimicrobial properties.
8. Anti-tumor: Ginger has anti-tumor properties.

Uses of Ginger

1. Ginger is a common spice used worldwide, whether for meals or as a folk medicine.
2. Ginger can be used for a variety of food items such as vegetables, candy, soda, pickles, and alcoholic beverages.
3. Ginger is a fragrant kitchen spice.
4. Young ginger rhizomes are juicy and fleshy with a mild taste.
5. They are of pickle in vinegar or sherry as a snack or cooked as an ingredient in many

dishes.

6. They can be steeped in boiling water to make ginger herb tea, to which honey may be added. Ginger can be made into candy or ginger wine.

Cultivation and Harvesting

- Grows best in warm, humid tropical climates.
- Optimum temperature: 25–30°C
- Soil: Loamy, well-drained, rich in organic matter.
- Propagation: Rhizome buds (setts).
- Harvesting: 7–9 months after planting.
- Major producers: India, China, Nigeria, Nepal, Indonesia.
- India's leading states: Kerala, Meghalaya, Arunachal Pradesh.

B. TURMERIC

Botanical Name: *Curcuma longa* L.syn. *C. domestica* Val.

Family: *Zingiberaceae*

Common Name: Haldi/Halad n = 31, 32

Turmeric has been cultivated since ancient civilizations in India and later in China. Over time, it spread through trade routes to the Middle East, Africa (especially becoming a staple in Ethiopian cuisine), and Europe. Today, turmeric is grown in India, China, Myanmar, Nigeria, and Bangladesh. Many countries around the world (including the US) are major importers of turmeric. This plant holds economic value as a culinary spice, dye, medicine, and coloring agent. It is culturally significant in India and China where it is a staple in their traditional cuisine and medicine, and has been established in Ethiopia as well.

Morphology of Turmeric

- General: Turmeric is a perennial, herbaceous species that grows up-to 3ft tall.
- Leaf morphology: The leaves of turmeric are broad, oblong, bright green, and have prominent parallel veins. They have sheaths near the base of the leaf before it attaches to the stem. The leaves are alternately arranged.
- Floral morphology: Turmeric flowers have large, bright pink-to-purple petals on top of a long flower stalk.
- Root: Turmeric has very shallow rhizomes that are thick, fleshy, and tan color with darker brown stripes. If these structures are cut open, they are bright orange and have a distinctive earthy smell. These roots are what turmeric is often known and used for.

Phytochemistry of Turmeric

- Curcuminoids: These fat-soluble, polyphenolic pigments give turmeric its yellow color. The

main curcuminoids are curcumin, demethoxy curcumin, and bisdemethoxy curcumin. Curcumin is the most active component and is responsible for many of turmeric's therapeutic effects.

- Volatile oils: Turmeric contains several volatile oils, including turmerone, atlantone and zingiberene.
- Proteins, sugars, and resins: Turmeric also contains proteins, sugars and resins.
- Acidic polysaccharides: Turmeric contains acidic polysaccharides, including Vitamin A, B, C, and D.

Economic Importance of Turmeric

1. Turmeric cultivation can provide income for farmers. For example, in Sri Lanka, turmeric cultivators earn an average of 11,095.238 rupees per season.
2. India is a major producer and exporter of turmeric, contributing 80% of the world's production. In 2020, India earned \$201,152 million from turmeric exports.
3. In India, turmeric contributed over 58 billion rupees to the economy in the fiscal year 2021.
4. Turmeric is a staple in traditional cuisine in India and China.
5. Turmeric is used in Indian clothing, such as saris and Buddhist monks' robes.
6. Turmeric has been used for medicinal purposes, including treating inflammation, arthritis, depression, liver disease, and more.

Medicinal Properties of Turmeric

1. Turmeric's active ingredient, curcumin, has anti-inflammatory properties that may help with muscle soreness, arthritis, and degenerative eye conditions.
2. Curcumin may help with digestion by stimulating the gallbladder to produce bile. However, turmeric can also irritate the stomach and cause abdominal pain if taken in large amounts.
3. Curcumin may help fight viruses like the flu and herpes, but most research has been done in a lab.
4. Curcumin may help boost levels of brain-derived neurotrophic factor (BDNF), a protein that can help with depression.
5. Curcumin may help with inflammation and oxidative damage, which are known to play a role in Alzheimer's disease.
6. Turmeric has been studied for its anti-cancer properties, but results are still preliminary.
7. Early studies suggest that turmeric may help prevent atherosclerosis, which can lead to heart attack or stroke.

Uses of Turmeric

1. Cooking: Turmeric is used in many cuisines around the world, such as in curries in India and tea in Japan.
2. Dietary supplement: Turmeric is promoted as a supplement for a variety of conditions,

including arthritis, digestive disorders, respiratory infections, allergies, liver disease, and depression.

3. **Anti-inflammatory:** Turmeric's active ingredient, curcumin, has anti-inflammatory properties that may help with inflammation, muscle soreness, and degenerative eye conditions.
4. **Cardiovascular health:** Turmeric may help improve blood flow and reduce LDL cholesterol levels.
5. **Brain health:** Turmeric may help improve memory and attention, and may delay or reverse age-related decreases in brain function.
6. **Digestion:** Turmeric may help with digestion and ulcerative colitis.
7. **Blood sugar:** Turmeric may help manage healthy blood sugar levels.
8. **Antiseptic:** In South Asian countries, turmeric is used as an antiseptic for cuts.

Cultivation and Harvesting

- Grows best in warm, humid tropical climates.
- Optimum temperature: 25–30°C
- Soil: Loamy, well-drained, rich in organic matter.
- Propagation: Rhizome buds (setts).
- Harvesting: 7–9 months after planting.
- Major producers: India, China, Nigeria, Nepal, Indonesia.

India's leading states: Kerala, Meghalaya, Arunachal Pradesh.

2. BULK SPICES (ONION AND GARLIC)

A. ONION

Scientific Name: *Allium cepa*

Family: *Amaryllidaceae*

Local Name: Pyaj and Kanda

Onions are among the world's oldest cultivated plants. They were probably known in India, China, and the Middle East before recorded history. Ancient Egyptians regarded the spherical bulb as a symbol of the universe, and the concentric spheres of the Aristotelian cosmos were also likened to an onion.

Morphology of Onion

1. The onion plant has a fan of hollow, bluish-green leaves that are arranged in a small, erect cluster. Young leaves are solid, but later become hollow and cylindrical.
2. The onion's bulb is formed by the concentric leaf bases of the developing plant swelling underground. The bulb is made up of shortened, compressed underground stems surrounded by fleshy modified scale leaves.
3. The onion plant has one or more leafless flower stalks that can grow up to 75–180 cm (2.5–6 feet) tall. The flower clusters are spherical and contain small greenish white flowers.
4. The onion's seeds are small and black, and are found inside dry, dehiscent fruits called capsules.
5. The onion plant has shallow, fibrous roots that can grow up to 30 cm long and spread radially about 30 cm from the stem.

Phytochemistry of Onion

Onion containing many chemical constituents such as flavonoids, alkaloids, saponins, organosulfur compounds, glycosides as well as vitamin-C & B6, **allicin** minerals, fiber, fat, Carbohydrate, and Potassium is also found. Major flavonoids present in *Allium cepa* are Quercetin, quercetin glucosides, quercetin -3, 4-di glucosides, and quercetin - 4- glucosides.

Economic Importance of Onion

1. Onions are a major source of foreign exchange earnings for the fruits and vegetables sector.
2. Onion production contributes to job creation in the agricultural sector.
3. Onion cultivation is a major source of income for producers and their families.
4. Onioncultivationhelpsensurefoodsecurityforproducersandurbanpopulations.
5. India exports a significant quantity of onions, which contributes to the country's economy.
6. Cold-pressed onion seed oil is used as flavoring in processed foods like salad dressing, sauces, soups, and meat. It also has antioxidant, antibrowning, hepatoprotective, and hypolipidemic properties.

Medicinal Properties of Onion

1. Cancer: Laboratory studies suggest that organosulfur compounds in onions may stop cancer cells from growing and multiplying.
2. Heart health: Onions contain chemicals that may help protect heart.
3. Diabetes: Onions contain bioactive compounds that may help body to make insulin.
4. Inflammation: Onions contain quercetin, an anti-inflammatory that may help with arthritis and bladder infections.
5. Digestion: Onions are rich in prebiotics that may help increase the number of friendly bacteria in gut.
6. Eye health: Selenium in onions helps body produce vitamin-E, which may help prevent conjunctivitis.
7. Onion helps in ailments such as headache, fever, toothache, cough, sore throat, flu, baldness, epilepsy, rash, jaundice, constipation, flatulence, intestinal worms, low sexual power, rheumatism.

Uses of Onion

1. The onion bulb is commonly eaten as food. Onion bulb and extract are also used to make medicine.
2. Onions are a common ingredient in cooking and can add color and flavor to dishes. Red onions are particularly good for adding color to salads, sandwiches, and burgers.
3. Onion peel extracts or infusions can sooth irritated skin, reduce redness, and promote wound healing.

Cultivation and Harvesting

- Grows in temperate to subtropical climates.
- Ideal temperature: 12–25°C
- Soil: Loose, well-drained loam with high organic matter.
- Sowing: Seeds, seedlings, or sets (small bulbs).
- Harvest: 90–150 days depending on cultivar.
- Major global producers: China, India, USA, Egypt, Turkey, Russia

Indian leading states:

- Maharashtra
- Karnataka
- Gujarat
- Madhya Pradesh

India is the second-largest global producer

B. GARLIC

Garlic, (*Allium sativum*) is a perennial plant of the amaryllis family (*Amaryllidaceae*), grown for its flavorful bulbs. The plant is native to central Asia but grows wild in Italy and southern France and is a classic ingredient in many national cuisines. The bulbs have a powerful onion like aroma and pungent taste and are not usually eaten raw.

Morphology of Garlic

Garlic plants grow about 60 cm (2feet) tall. Depending on the variety, the long leaves typically arise from a short hard stem above the bulb or emerge from a softer pseudo stem made up of overlapping leaf sheaths. The bulb is covered with membranous skin and encloses up to 20 edible bulblets called cloves. The spherical flower cluster is initially enclosed in a pair of papery tapered bracts; the bracts split open when the green-white or pinkish flowers bloom.

Phytochemistry of Garlic

1. Sulfur-containing compounds: Garlic's smell and taste come from organosulfur compounds, which also contribute to its pharmacological properties. These include allicin, ajoenes, vinyldithiols, and diallyl trisulfide.
2. Flavonoids: Garlic contains flavonoids, such as quercetin, which contribute to its antioxidant potential.
3. Saponins: Garlic contains saponins, which contribute to its antioxidant potential.
4. Phenolic compounds: Garlic contains phenolic compounds, which contribute to its antioxidant potential.
5. Vitamins: Garlic contains vitamins A, C, E, and B-complex vitamins.
6. Minerals: Garlic contains calcium, iron, magnesium, phosphorus, potassium, sodium, and zinc.
7. Other compounds: Garlic also contains essential oils, lectins, prostaglandins, adenosine, glycolipids, and phospholipids.

Economic Importance of Garlic

1. Garlic can be a profitable crop, with some estimates saying that it can produce up to \$10 per square foot. The average gross return for small, medium, and large farmers was Rs. 352,684.05, Rs. 423,629.64, and Rs. 447,700.36, respectively.
2. One way to increase profits from garlic is to sell garlic products in addition to fresh bulbs.
3. Government policies can impact garlic production, such as by providing superior seeds and fertilizers, stabilizing prices, and providing agricultural mechanization.
4. Garlic is a versatile plant with many uses, including as a spice and in medicine. It contains vitamins, minerals, and other components that are good for human health.

Medicinal Properties of Garlic

1. Antioxidant: Garlic is a powerful antioxidant that helps protect cells from damage by free

radicals.

2. Antibacterial: Garlic has antibacterial properties that can help clear up acne.
3. Anti-inflammatory: Garlic has anti-inflammatory properties.
4. Blood pressure: Garlic may help lower blood pressure, but the evidence is limited.
5. Cholesterol: Garlic supplements may help lower total cholesterol and LDL cholesterol levels in people with high levels of these blood lipids.
6. Exercise fatigue: Garlic may help improve the symptoms of exercise fatigue.
7. Memory: Garlic may help prevent cognitive and memory deficits, which may slow down the development of Alzheimer's disease.
8. Skin: Garlic's antibacterial properties and antioxidants can help clear up skin.
9. Wound infections: Garlic can help treat wound infections caused by the common cold, malaria, cough, and pulmonary TB.

Uses of Garlic

1. Garlic is a spice that has been used for health purposes for thousands of years. It can be used fresh, as a powder, or as an oil to flavor food, or applied topically to the skin.
2. Flavoring: Garlic can be used to add flavor to food without adding salt.
3. Dietary supplement: Garlic is often promoted as a supplement for heart and blood vessel health, such as high blood pressure and cholesterol.
4. Topical treatment: Garlic can be applied to the skin.
5. Antiseptic: Garlic juice can be used as an antiseptic to treat wounds.
6. Antimicrobial: Garlic can inhibit and destroy bacteria, fungus, and parasites.
7. Antioxidant: Garlic is a powerful antioxidant that protects cells from damage.
8. Anti-inflammatory: Garlic has anti-inflammatory properties.
9. Lipid-lowering: Garlic has lipid-lowering properties.
10. Exercise fatigue: Garlic may help improve exercise fatigue.
11. Cognitive health: Garlic may help protect against cognitive and memory deficits.

Cultivation and Harvesting

- Climate: Cool-season crop.
- Temperature: 10–20°C
- Propagation: By cloves (vegetative).
- Soil: Fertile, well-drained loam.
- Harvesting: 5–7 months after planting.

Major global producers:

- China (70% of global production), India, Bangladesh, South Korea, Egypt

3. LEAFY SPICES:

Spices that are used as leaf are considered as leafy spice. Leafy Spices includes: Mint, Coriander and Bay Leaves

A. MINT

Mint (genus *Mentha*), genus of 25 species of fragrant herbs of the mint family (Lamiaceae). Native to Eurasia, North America, southern Africa, and Australia, mints are widely distributed throughout the temperate areas of the world and have naturalized in many places.

Morphology of Mint

Mint plants are mainly aromatic perennials and they possess erect, branching stems and oblong to ovate or lanceolate leaves arranged in opposing pairs on the stems. The leaves are often covered in tiny hairs and have a serrated margin.

Phytochemistry of Mint

1. Terpenoids: These are present in the leaves of *Mentha arvensis*.
2. Salvianolic acids: Some species of mint contain salvianolic acids.
3. Rosmarinic acids: These are present in the leaves of *Mentha arvensis*
4. Phenolic acids: Mint contains many phenolic acids.
5. Flavonoids: These include luteolin and its derivatives, apigenin, acacetin, diosmin, salvigenin, and thymonin.
6. Essential oils: These colorless, pale yellow, or greenish yellow oils are made up of alcohols, ketones, esters, ethers, and oxides. The main constituents of mint essential oils include menthol, menthone, isomenthone, menthyl acetate, linalool, linalyl acetate, lippione, pulegone, carvone, piperitenone oxide, and cis-piperitone epoxide.

Economic importance of Mint

1. The essential oil from Japanese mint is the main source of menthol, which is used in many products, including cough drops, dentifrices, cosmetics, and mouth washes.
2. Mint oils Source of menthol and their aroma chemicals are used in the pharmaceutical, food, flavor, cosmetics, and beverage industries.
3. Mint is a cost-effective crop with potential for growth.
4. India is a global leader in mint oil production and export, contributing 80-85% of the world's production.
5. Global leader in production and export
6. Cost-effective crop.

Medicinal Properties of Mint

1. Stress: Mint can help reduce stress and anxiety.
2. Skin health: Mint can soothe skin irritation.
3. Respiratory health: Mint can help with cold and flu symptoms. Menthol, a chemical in mint, can help with congestion and coughs.

4. Digestive health: Mint can help with digestion, nausea, and irritable bowel syndrome. It can also help with morning sickness in pregnant women.
5. Brain health: Mint can help with memory retention and alertness.
6. Antispasmodic properties: Mint has antispasmodic effects that can calm the gastrointestinal tract.
7. Antimicrobial properties: Mint can kill some types of bacteria, fungi, and viruses.
8. Anti-inflammatory properties: Mint contains rosmarinic acid, an antioxidant and anti-inflammatory agent.

Uses of Mint

1. Mint adds flavor to foods and drinks, such as ice cream, tarts, lemonade, cocktails, and meat dishes. It's also commonly used in toothpaste, mouthwash, breath mints, and chewing gum.
2. Mint adds a cool burst of flavor to pesto, which can be used in salads, pasta, or as a garnish for chicken, fish, or lamb.
3. Mint tea is a strong diuretic and its aroma is used as a mild decongestant for illnesses such as the common cold. It also has anti-inflammatory properties, making it a great choice for people suffering from headaches and muscle aches.
4. Mint leaves can be chopped or sprinkled on fruit salads or salsa salads for an instant pick me up.
5. Mint's aromatic properties repel mosquitoes. The scent is contained in the stems, leaves, and flower of the plant, and is released when it is brushed up against or crushed.
6. Mint leaves are considered as an effective appetizer that helps in promoting the digestive system. It also calms the stomach muscles and the flow of bile.
7. Mint Reduce cold symptoms.
8. Mint Keep your mouth healthy.
9. Mint also helps in manage stresses

Cultivation and Harvesting:

- Climate: Warm, subtropical crop; prefers cool, moist conditions for vegetative growth and dry, sunny weather at harvest.
- Temperature: About 20–40°C during active growth; frost and extreme heat depress growth and oil yield.
- Propagation: By stolons/suckers and rooted cuttings (vegetative).
- Soil: Fertile, well-drained loam or sandy-loam rich in organic matter, pH 6.0–8.2.
- Harvesting: First cut 100–120 days after planting at full vegetative to early flowering stage; second cut 70–80 days after first harvest.

Major Producers (Menthol Mint / *Mentha arvensis*): India (leading producer and exporter of menthol mint and mint oil).

China (important producer of mint and menthol products).

Other contributors include parts of Southeast Asia and some temperate regions where suitable climate and distillation facilities exist.

B. CORIANDER

Scientific Name: *Coriandrum sativum* L.

Family: Amaryllidaceae

Local Name: Coriander

Phytochemistry: Coriander contains many bioactive phytochemicals, including terpenoids, phenylpropenes, isocoumarins, fatty acids, and phytosterols. It also contains polyphenols, such as caffeic acid, protocatechuic acid, and glycitin, due to which coriander produces antioxidant properties.

It also contains vitamin A, riboflavin, niacin, folic acid, vitamin C, vitamin K, and carotene. All these elements help prevent Osteoporosis.

Economic Importance of Coriander:

Coriander is used in many ways, including:

- **Garnishing:** Coriander leaves are used to garnish dishes.
- **Flavoring:** Coriander leaves are used to flavor curries, soups, and chutneys.
- **Spice:** Dried coriander is used as a spice.

Medicinal Properties of Coriander:

Coriander has many medicinal properties, including:

- **Antioxidant:** Coriander is rich in antioxidants which help boost the immune system.
- **Blood pressure:** Coriander can help control blood pressure by causing blood vessels to dilate.
- **Diabetes:** Coriander can help control diabetes and high blood sugar.
- **Digestion:** Coriander can help with digestion and gut health.
- **Skin and hair:** Coriander can help protect the skin and hair.
- **Iron:** Coriander seeds are a rich source of iron and can help prevent anemia.
- **Calcium:** Coriander is a rich source of calcium, which is important for bone re-growth.
- **Antiarthritic:** Coriander seeds contain compounds like cineole and linoleic acid that can help prevent arthritis.

Cultivation and Harvesting:

- **Climate:** Cool–season to mild tropical crop; prefers cool, dry, frost-free weather especially during flowering and seed formation.

- Temperature: Optimum growth and seed set at about 17–25 °C; growth and quality are reduced below 10 °C and above 30 °C.
- Propagation: By seeds (schizocarps split into two halves before sowing).
- Soil: Fertile, well-drained loam or silt-loam; can grow in a range of soils but does best in loams with pH 6.0–8.0 and no waterlogging.
- Harvesting: 90–140 days after sowing depending on variety and season; seeds are harvested when they turn greenish-brown to straw-coloured and are fully developed.

Major Global Producers (Coriander Seed):

India (largest producer and exporter, especially Rajasthan, Madhya Pradesh, Gujarat, Andhra Pradesh).

Countries around the Mediterranean, Eastern Europe, and parts of Asia and Latin America also contribute significantly to world production (e.g., Morocco, Russia/Ukraine region, Bulgaria, Mexico), with exact shares varying by year.

C. BAY LEAF

Scientific Name: *Laurus nobilis* L.

Family: Lauraceae

Local Name: Bay leaf, Teejpatta

Bay leaf (*Laurus nobilis*) is an evergreen perennial shrub that belongs to the laurel family (Lauraceae). It has been used for 1000 years, and it is an essential ingredient in cooking and in many traditional practices. Bay leaf is grown in variety of ecologic and climatic conditions. Wet, sandy soil that has a large quantity of water or some moist atmospheric conditions close to the ocean shore is the optimum and the best conditions for rapid luxuriant growth.

Phytochemistry:

The difference in fragrance and aroma is due to the presence of essential oils in leaves as well as other parts of the plant. It has flavonoids, tannins, eugenol, citric acid, carbohydrate, steroids, alkaloids, triterpenoids, and essential oils. Antioxidant properties were well studied in the extract of bay leaf to have phenolic compounds. Tanine or tanat acid isolated from some part of plants. Bay leaf has good and main source of vitamin A and many minerals.

Economic Importance of Bay Leaf:

Bay leaves have much economic importance in different ways:

Cooking

Bay leaves are used in many cuisines and preparations, including Indian, Mediterranean, Caribbean, and European. They add an earthy flavour to soups, stews, sauces, and more. Bay leaves are also used in curry powders, oils, teas, cheeses, and liquors.

Wood Working

The wood of the bay leaf tree is used to make wooden bowls, spoons, tables, jewelry boxes, cabinets, and doors etc.

Stringed Instruments

The tone wood of the California bay leaf plant is used to make violins and guitars.

Pest Repellent

Bay leaves are a natural insect and bug repellent. The dried and powdered leaves can be sprinkled around the house to repel cockroaches, ants, fleas, and other bugs.

Pharmaceutical and Cosmetics Industries

Essential oils extracted from bay leaves are used in these industries.

International Trade

Bay leaves are often dried and packaged for international markets, which boosts the income of growers and exporters.

Bay leaves are also used in traditional and folk medicine for a variety of purposes, including treating respiratory disorders, gastrointestinal issues, and diarrhea.

Medicinal Properties of Bay Leaf:

- **Wound Healing Activity:** Many studies shows that bay leaf possesses better wound healing activity.
- **Antioxidant Activity:** Ethanol extracts of *L. nobilis* showed powerful antioxidant activities.
- **Anticonvulsant Activity:** *L. nobilis* leaf essential oil showed anticonvulsant activity in mice.
- **Analgesic and Antiinflammatory:** *L. nobilis* essential oil showed analgesic and antiinflammatory activities.
- **Antimutagenic Activity:** Ethyl acetate extract of bay leaf has 3-kaempferyl *p*- coumarate antimutagen.
- **Antiviral Activity:** *L. nobilis* essential oil containing beta-ocimene, 1,8-cineol, alpha-pinene, and beta-pinene constituents were reported for inhibitory activity in vitro against SARS-CoV and HSV-1 replication.
- **Antimicrobial Activity:** *L. nobilis* essential oil, methanolic extract of seed oil showed antibacterial activity.

Cultivation and Harvesting:

- **Climate:** Warm to mild, Mediterranean-type crop; prefers full sun and warm, moist but not waterlogged conditions, with protection from severe frost when young.
- **Temperature:** Best growth roughly between 15–30 °C; established trees can tolerate light frost down to about –5 to –7 °C but severe cold damages foliage and shoots.

- Propagation: By semi-hardwood stem cuttings, layering, or side-root cuttings (vegetative); seed is possible but slower and less reliable.
- Soil: Fertile, well-drained loam or sandy-loam with good organic matter; prefers slightly acidic to neutral soils, around pH 6.0–8.0.
- Harvesting: Leaves can be plucked once plants are established (usually 2–3 years after planting for field trees); thereafter, 2–4 leafy pickings per year are done when shoots are fully expanded and dark green, avoiding very young or yellowing leaves.

Major Global Producers (Bay Laurel / Culinary Bay Leaves):

Grown widely in Mediterranean and subtropical regions, with notable production and export from countries such as Turkey, Greece, and nearby Mediterranean nations.

Also cultivated on a smaller commercial scale in parts of India (Northeast, Himalayan foothills, South), the Americas, and other warm regions, mainly to supply local spice and herbal markets.

4. BARK SPICES

A. CINNAMON

Scientific Name: *Cinnamomum verum*

Family: Lauraceae

Local Name: Dalchini

Cinnamon is a spice obtained from the inner bark of genus *Cinnamomum*. It is mainly grown in Sri Lanka followed by Malabar, Cochin, China and Sumatra. Cinnamon is used mainly as an aromatic condiment

Cinnamaldehyde, eugenol, caryophyllene, cinnamyl acetate and cinnamic acid are the major compounds found in its essential oil. These compounds showed a wide range of pharmacological activities such as antioxidant, antimicrobial, anti-inflammatory, anticancer, antidiabetic, wound healing, anti-HIV, anti-anxiety and antidepressant etc.

Phytochemistry:

Polyphenols and volatile phenols are the two chemical classes which are isolated from Cinnamon. It mostly contains ferulic acids, caffeic, gallic, vanillic, protocatechuic and *p*-coumaric along with the polyphenols.

All types of cinnamon contain the active ingredient cinnamaldehyde, which accounts for between 65 and 80% of the essential natural oil.

Medicinal Properties:

Cinnamon has many medicinal properties:

- **Antioxidant:** Cinnamon contains polyphenols, which are plant compounds that have antioxidant properties.
- **Anti-Inflammatory:** Cinnamon's antioxidant compounds also contribute to its anti-inflammatory effects.
- **Antimicrobial and Anti-Fungal:** Cinnamon is thought to have many medicinal and soothing properties.
- **Blood Sugar Management:** Cinnamon may help lower blood sugar and reduce the risk of type-2 diabetes. It may also improve insulin sensitivity.
- **Heart Disease Prevention:** Cinnamon could lower your triglycerides and total cholesterol levels, which could help prevent heart disease.
- **Neurodegenerative Diseases:** Cinnamon may help with neurodegenerative diseases like Alzheimer's and Parkinson's disease.
- **Wound Healing:** Cinnamon has wound healing properties.
- **Hepato-Protective Effects:** Cinnamon has hepato-protective effects.

Cultivation and Harvesting:

- Climate: Warm, humid tropical crop (evergreen tree).
- Temperature: 20–30°C; cannot tolerate frost or prolonged cold below about 15°C.
- Propagation: Mainly by seeds; also, by semi-hardwood cuttings, air layering, and tissue culture.
- Soil: Well-drained sandy or lateritic loam, rich in organic matter; slightly acidic to neutral pH; waterlogging must be avoided.
- Harvesting: First bark harvest usually 2–4 years after planting, when plants are about 1.5–2 m tall; coppiced and bark peeled 1–3 times per year, often soon after rainy seasons when bark slips easily.

Major Global Producers (True Cinnamon, *Cinnamomum verum*):

Sri Lanka (dominant, around 80–90% of world Ceylon/true cinnamon supply)

India, Madagascar, Seychelles and some other tropical countries in smaller quantities.

5. FLOWER SPICES

A. CLOVE

Scientific Name: *Syzygium aromaticum*

Family: Myrtaceae

Local Name: Lawang, Laung

Clove is a spice with a strong aroma and a hot, pungent taste. Clove is also known as *Syzygium aromaticum*. They are used to flavor many foods, especially meats and baked goods. Clove is native to Indonesia, but is now cultivated in many parts of the world, including India

Phytochemistry:

Essential oils

Clove buds contain 15–20% essential oil, with eugenol, eugenyl acetate, and β -caryophyllene as the main components.

Phenolics

Clove contains many phenolics, including eugenol, flavonoids, phenolic acids, hydroxybenzoic acids, hydroxyphenyl propens, and gallic acid derivatives.

Tannins

Clove contains tannins, such as gallo- and ellagitannins.

Clove also contains other phytochemicals like monoterpenes, sesquiterpenes, hydrocarbons, lipids, sterols, and triterpenoids.

Medicinal Properties:

Clove has many potential medicinal properties as follows:

- **Pain relief:** Clove oil contains eugenol, which can help reduce pain and fight infections. Clove oil is often used as a natural remedy for toothaches and gum discomfort.
- **Anti-Inflammatory:** Clove contains anti-inflammatory chemicals, such as eugenol and flavonoids, which can help reduce inflammation and alleviate pain.
- **Antioxidant:** Clove is rich in antioxidants, which can help protect cells from damage caused by free radicals.
- **Antimicrobial:** Clove has antibacterial and antifungal properties.
- **Antiviral:** Clove essential oil contains phenylpropanoids, monoterpenals, and monoterpenols, which can demonstrate antiviral efficacy in vitro.
- **Antidiabetic:** Some studies suggest that taking clove along with ginger may help reduce blood sugar levels in type 2 diabetes.
- **Liver Health:** Clove may help protect the liver from free radicals that can damage cells and lead to cirrhosis.
- **Itching Relief:** Applying clove oil to the skin may help ease itching.

Cultivation and Harvesting:

- **Climate:** Strictly a tropical, warm, humid crop; requires high rainfall (often 1,500–2,500 mm or more annually) and performs best in lowland humid tropics rather than cool conditions.
- **Temperature:** Grows optimally around 21–30°C; trees are very sensitive to cold and are damaged by temperatures below about 10–15°C, so frost-prone or cool-season climates are unsuitable.
- **Propagation:** Mainly by seed (fresh, fully developed “mother cloves” with short viability); commercial propagation by vegetative means such as cuttings or layering is possible but far less common than seed propagation.
- **Soil:** Deep, fertile, loamy to clay-loam soils that are rich in organic matter, moist but well-drained, slightly acidic to neutral (around pH 5.5–7.0); waterlogging and very shallow or compact soils reduce survival and yield.
- **Harvesting:** Economic yields generally start about 7–8 years after planting, with full bearing around 15–20 years; flower buds are harvested when fully grown but still closed, as they turn from green to a light pink stage, then dried to obtain cloves.

Major Global Producers (Clove Buds, *Syzygium aromaticum*):

- Indonesia (largest producer and consumer, especially for kretek cigarettes)
- Madagascar
- Tanzania (notably Zanzibar and Pemba)
- Comoros
- Sri Lanka and a few other tropical countries, including small but significant areas in India

B. SAFFRON

Scientific Name: *Crocus sativus* L.

Family: Iridaceae

Local Name: Keshar

Crocus sativus L. is a perennial spicy herb. It is commonly consumed as a spice or coloring in foods. Saffron is a spice derived from the flower of this herb. It is commonly known as the "saffron crocus". The vivid crimson stigma and styles, called threads, are collected and dried for use mainly as a seasoning and coloring in food.

Phytochemistry:

Saffron is a noteworthy medicinal and spicy plant because of its powerful odor and intensive natural yellow color. Phytochemical researches have revealed that the color is mainly due to the degraded carotenoid compounds, crocin and crocetin. The flavor comes from the carotenoid oxidation products, mainly safranal and the bitter comes from glucoside picrocrocin

Medicinal Uses of Saffron (*Crocus sativus*) Plant:

- **Cardiovascular Health:** Saffron helps in cardiovascular disease by reducing oxidative stress, inflammation, and atherosclerosis. It also helps with blood pressure, coronary artery disease, and other cardiovascular ailments.
- **Brain Health:** Content of Saffron helps in memory function, Alzheimer's disease, depression and nervous system disorders.
- **Immune System:** Saffron is a rich source such as riboflavin and vitamin B that helps maintain a healthy immune system.
- **Sleep:** Saffron helps improve sleep quality and duration by increasing melatonin levels and acting on brain receptors.
- **Anti-Inflammatory:** Study on Saffron showed that it has anti-inflammatory properties.
- **Antioxidant:** Saffron contains antioxidants keeps brain and nervous system healthy.
- **Aphrodisiac:** Saffron may have aphrodisiac properties, especially for people taking antidepressants.
- **PMS:** Saffron may help improve PMS-related depression.
- **Weight loss:** Saffron may help suppress appetite and aid weight loss.
- **Seizures:** Saffron may help shorten some types of seizures.

Cultivation and Harvesting:

- **Climate:** Cool–temperate to Mediterranean-type crop; saffron prefers hot, dry summers and cool to cold winters rather than a strictly tropical climate.
- **Temperature:** Ideal during active growth and flowering is about 15–20°C, with corms tolerating winter cold down to around –5 to –10°C under well-drained conditions and summer dormancy at 23–30°C for good flower induction.
- **Propagation:** By corms (vegetative); daughter corms are separated and replanted, as *Crocus sativus* is sterile and does not set viable seed.
- **Soil:** Fertile, well-drained sandy loam or loam with good organic matter, low to moderate humidity, and near-neutral to slightly alkaline reaction (around pH 6–8); waterlogging quickly causes corm rot.
- **Harvesting:** Corms are usually planted in late summer; lowering occurs in autumn about 6–8 weeks after planting, and stigmas are hand-harvested daily as flowers open; fields are often kept in place for 3–5 years before corms are lifted and replanted.

Major Global Producers (Saffron, *Crocus sativus*):

- Iran (by far the dominant producer, often contributing 80–90% of world saffron output)
- India (notably Jammu & Kashmir and some parts of Himachal Pradesh)
- Spain, Greece, Morocco and a few other countries with suitable temperate–Mediterranean climates in smaller quantities

6. FRUIT SPICES

A. CHILLI

Scientific Name: *Capsicum annuum*

Family: Solanaceae

Local Name: Mirchi

Capsicum plants are mostly native to the northern regions of South America and southwestern North America. They are grown for their fruits, which are used in many cuisines and food preparations around the world. Capsicum fruits can be eaten raw, cooked, pickled, roasted, or dehydrated dried form.

Phytochemistry:

- **Capsaicin:** Capsaicin is a fat-soluble compound that gives chili peppers their hot and pungent taste. It is a bioactive phytochemical that interacts with pain- and heat-sensing neurons, causing a burning sensation.
- **Capsaicinoids:** It is a molecular alkaloid structure found only in the genus Capsicum.
- **Carotenoids:** Other phytochemicals (carotenoids) include Keto-carotenoids, capsanthin, capsorubin, cryptocapsin, and capsanthin-5,6-epoxide that give chili peppers their red color. Capsanthin is the major carotenoid in chili peppers, followed by zeaxanthin and beta-carotene.
- **Phenols:** Chlorogenic acid, Caffeic acid, Syringic acid etc. are the phenolic compounds that are distributed mainly in the Capsicum genus.
- **Flavonoids:** Apigenin, luteolin, quercetin, zeaxanthin etc. are the group of flavonoids found in chilli.
- Other phytochemicals found in chili peppers include gallic acid, catechin, rutin, protocatechuic acid, p-coumaric acid, ferulic acid, and quercetin.

Economic Importance:

Chilli has many economic uses as follows:

- **Employment:** The production and export of chilli provide employment for farmers, agricultural laborers, agronomists, pesticide companies, seed companies, traders, warehouses, auction-based companies, exporters, and food processing industries.
- **Condiment:** Chilli is a condiment used in many dishes, including hot sauce, sauces, chutneys, and pickles.
- **Medicinal:** Chilli has medicinal uses, including as a rubefacient and local stimulant for tonsillitis.
- **Oil:** Dried chilies are used to make chili oil; cooking oil infused with chili.

Medicinal Properties:

- **Pain Relief:** Capsaicin present in chilli peppers can be used as a topical agent to relieve pain. It's also used as a medication for arthritis and to reduce post-operative pain.
- **Anesthetic:** A new chilli called Dragon's Breath is so potent that it can numb human skin, making it a potential medical anesthetic.
- **Digestion:** Red chilli powder as well as green chillies can help with digestion by stimulating the production of gastric juices.
- **Weight Management:** Red chilli powder can help with weight management by increasing metabolism and acting as an appetite suppressant. Green chillies may also help with weight management.
- **Cardiovascular Health:** Chilli peppers help in lowering blood cholesterol and reverse blood clotting.
- **Antimicrobial and Anticancer Properties:** Chilli peppers have antimicrobial and anticancer properties. Chillies are also rich in vitamins and minerals, including vitamin A, vitamin C, iron, and dietary fiber.

Cultivation and Harvesting:

- **Climate:** Warm-season crop; *Capsicum annuum* (chilli/sweet pepper) prefers a warm, moderately dry climate and is injured by frost, though under protected cultivation it is often described as a cool-season crop provided day temperatures stay below about 30°C.
- **Temperature:** Optimal growth and fruit set generally occur between about 18–30°C, with 20–25°C particularly favourable; growth slows markedly below about 15°C and flower/fruit set is reduced above roughly 32–35°C.
- **Propagation:** By seeds (sexual); seed is raised in nursery beds or trays and 25–35-day-old seedlings are transplanted to the main field or protected structures, rather than vegetative propagation by cloves.
- **Soil:** Fertile, well-drained sandy loam to loam soils with good organic matter and pH around 5.5–7.0 are ideal; deep, friable soils with good moisture-holding capacity give the best yields, while waterlogging should be avoided.
- **Harvesting:** First harvest usually starts about 60–90 days after transplanting (roughly 3–4 months from sowing), and picking continues at 7–10-day intervals for several months depending on variety and whether fruits are harvested green or fully ripe.

Major Global Producers (*Capsicum annuum* Peppers and Chillies): China (largest producer globally, leading both in fresh and dried chillies/peppers), Mexico, Turkey, Indonesia.

India (one of the top producers and a major exporter of dried chilli), along with several other countries such as Spain and the USA in smaller but significant volumes.

B. CORIANDER

Scientific Name: *Coriandrum sativum*

Family: Apiaceae

Local Name: Dhania, coriander

Coriandrum sativum is an annual herb of the Apiaceae family. It is commonly known as coriander or dhania, and its different parts are consumed worldwide. In addition to its culinary values, coriander is also often consumed as a traditional medicine. It is used as fresh or in dried form.

Phytochemistry:

Coriander (*Coriandrum sativum*) contains many phytochemicals, including:

- **Essential Oils:** Coriander seeds contain phytochemicals with antimicrobial, antioxidant, and insecticidal properties. Coriander essential oil also has anti-inflammatory pharmacological activities.
- **Linalool:** Linalool is a monoterpene compound in coriander is an essential oil that can mildly prevent cell proliferation.
- **Phenolics:** Coriander seeds and leaves contain polyphenols and flavonoids with antioxidant properties.
- **Other Phytochemicals:** Coriander also contains cardiac glycosides, terpenoids, steroids, saponins, and alkaloids.

Medicinal Properties:

Coriander seeds have many medicinal uses, including:

- **Digestion:** Its seed can help in digestion by stimulating the liver to produce bile and digestive enzymes. They can also help with diarrhea, flatulence, indigestion, and nausea.
- **Blood Sugar:** According to studies on animals, coriander seeds can help lower blood sugar levels. It has been shown that coriander seeds can increase insulin release and remove sugar from the blood.
- **Menstrual Health:** Coriander seeds can help regulate menstrual cycles and treat heavy bleeding. They can also help with bloating, cramps, and pain during cycle.
- **Skin Health:** Coriander seeds can be used as a skin exfoliator to remove dead skin cells and blackheads. The vitamins and minerals in coriander can also help restore the skin's elasticity.
- **Detoxification:** Water of soaked seeds of coriander can help flush toxins from the body, especially heavy metals like lead and mercury.
- **Infections:** Coriander contains antimicrobial compounds that can help fight infections and food borne illnesses.

- **Brain Health:** Study on coriander showed anti-inflammatory properties that may protect against brain disorders.
- **Mouth Ulcers:** Coriander contains citronellol compound, which can help heal mouth ulcers and prevent bad breath.

Cultivation and Harvesting:

- **Climate:** Cool-season crop; coriander prefers a cool, dry, frost-free climate and is commonly grown as a rabi/temperate-season crop in many regions.
- **Temperature:** Optimal growth is around 15–25°C; it generally performs well between about 10–29°C, while higher temperatures hasten bolting and reduce yield and quality.
- **Propagation:** By seeds; the dry schizocarp (fruit) is split or lightly crushed into two mericarps and sown directly, as coriander is not propagated vegetatively by cloves.
- **Soil:** Fertile, well-drained loam, sandy loam, or silt loam with good moisture-holding capacity is ideal; coriander can grow on various soils but prefers pH about 6–8 and does not tolerate waterlogging.
- **Harvesting:** For grain, the crop is usually ready in about 90–120 days after sowing depending on variety and season; plants are harvested when most fruits turn straw-yellow and then dried and threshed. For leafy coriander, cutting may start 30–45 days after sowing.

Major Global Producers (Coriander Seed):

India (one of the leading producers and exporters of coriander seed), Russia and CIS countries, Morocco, Canada and some European and North African countries in smaller but significant quantities

C. BLACK PEPPER

Scientific Name: *Piper nigrum*

Family: Piperaceae

Local Name: Black pepper, Kali Mirch, Kali miri

Black pepper belongs to iperaceae family. It is native to the Malabar Coast of India. Black pepper is grown in many tropical regions around the world, with Vietnam, India, Brazil, China, and Sri Lanka being the major contributors. Black pepper is also known as the "king of spices" because of its commercial and economic value.

The berries of the black pepper plant are harvested when they turn from green to red or yellow. Black pepper is a good source of vitamin K, iron, and manganese etc. It also contains trace amounts of protein, dietary fiber, and other essential nutrients.

Phytochemistry:

Piper nigrum, also known as black pepper, contains many phytochemicals which includes:

- **Piperine:** The main bioactive compound in black pepper, piperine is a naturally occurring alkaloid that gives black pepper its spiciness. It also contains other alkaloids, including homologues of piperine, such as isopiperine, chavicine, and isochavicine etc.

Medicinal Properties:

Black pepper, has many medicinal uses, including:

- **Digestion:** Black pepper can help with digestion by increasing the amount of hydrochloric acid in the stomach.
- **Anti-Inflammatory:** Black pepper has anti-inflammatory properties.
- **Anti-Diabetic:** Black pepper has anti-diabetic properties and can help lower cholesterol and triglycerides.
- **Anti-Cancer:** Black pepper can have an anticancer effect on breast, colon, cervical, and prostate cell lines.
- **Anti-Arthritic:** Black pepper can have anti-arthritic properties.
- Black pepper also contains many phytochemicals, including alkaloids, flavonoids, carotenoids, terpenoids, and piperine.

Economic Importance:

Piper nigrum has economically important for a number of reasons,

- **Food:** Black pepper is a key ingredient in many foods, and is used as a flavoring agent.
- **Medicine:** Black pepper is used to treat a variety of ailments, including malaria, arthritis, nausea, fever, migraine headaches, poor digestion, and strep throat.
- **Preservative:** Black pepper's essential oils (EO) have antioxidant and antibacterial properties, making them potentially useful as food preservatives.
- **Insect Repellent:** In some parts of the world, black pepper is used as an insect repellent and moth killer.

Cultivation and Harvesting:

- **Climate:** Warm, humid tropical crop; black pepper is a perennial vine of the humid tropics and requires high rainfall and humidity, not a cool-season climate.
- **Temperature:** Thrives in a temperature range of about 20–30°C, with overall tolerance roughly 10–40°C; growth and yield decline in prolonged cool conditions below about 15°C or very high heat and low humidity.
- **Propagation:** By vegetative cuttings (single-node or multi-node stem cuttings taken from healthy runner/orthotropic shoots) rooted in nursery beds or polybags; seed propagation is not used commercially.
- **Soil:** Deep, fertile, well-drained soils (sandy loam to clay loam or lateritic) rich in organic matter, slightly acidic to neutral, with good water-holding capacity but no water stagnation around the root zone.

- **Harvesting:** First economic harvest usually begins 3–4 years after planting; spikes are picked when berries turn from green to just turning yellowish or red, then dried to make black pepper, while fully ripe, de-skinned berries are used for white pepper.

Major Global Producers (Black Pepper, *Piper nigrum*):

Vietnam (leading producer and exporter globally)

Brazil, Indonesia, India (important producer and exporter, especially from the Western Ghats).

Other significant producers include Sri Lanka and some countries in Southeast Asia and Latin America in smaller volumes.

D. STAR ANISE

Scientific Name: *Illicium verum*

Family: Schisandraceae

Local Name: Chinese star, Chakra ful, Fulchakri.

Illicium verum is a medium-sized evergreen tree native to South China and northeast Vietnam. Star anise is a medium-sized evergreen plant that produces star-shaped fruits. Its star-shaped pericarps harvested just before ripening is a spice that closely resembles anise in flavor. The fruits are used as a spice in cooking, and the seeds are sometimes chewed after meals to help with digestion. Star anise is also used in traditional Chinese medicine to treat skin inflammation, stomach aches, and rheumatic pain.

Phytochemistry:

Illicium verum contains many phytochemical compounds, including:

- **Essential Oils:** The main component of the essential oil in star anise is trans-anethole, a phenylpropanoid compound.
- **Phenylpropanoids:** A frequently reported component of star anise.
- **Flavonoids:** A frequently reported component of star anise.
- **Lignans:** A characteristic chemical marker of the species.
- **Sesquiterpenes:** A characteristic chemical marker of the species.
- **Neolignans:** A major chemical compound present in *I. verum*.
- **Monoterpenoids:** A major chemical compound present in *I. verum*.
- **Organic Acids:** A chemical constituent of star anise.
- **Alcohols:** It is a chemical constituent of star anise.
- **Simple Hydrocarbons:** A chemical constituent of star anise.

Medicinal Properties:

Illicium verum, has many medicinal uses as follows:

- **Antiviral:** Star anise is an important ingredient in Chinese medicinal herbs and has antiviral properties. It is also the source of shikimic acid, which is used in oseltamivir (Tamiflu), an antiviral medication for influenza.

- **Heart Health:** Star anise may improve heart health by regulating blood pressure, controlling blood lipid levels ultimately reducing plaque buildup in the heart.
- **Digestion:** Star anise water can be used to improve digestion and metabolism. It will help in weight loss.
- **Pain Relief:** Some compounds of Star anise can relieve pain.
- **Colic and Stomach Pain:** In the United States and Mexico, star anise is used to treat colic pain in infants and stomach pain.
- **Sedative:** Star anise can be used to treat nervousness and sleeplessness.
- **Fragrance:** Star anise has been used as a fragrance in Europe since long ago.
- **Expectorant:** Star anise has been used as an expectorant in Europe since the 16th century.
- **Cosmetic Ingredient:** Star anise can be used in cosmetics as a skin conditioning component, fragrance, or deodorizing agent.
- **Oral Hygiene:** Star anise seed contains essential oil which can be used as an oral hygiene ingredient.

Cultivation and Harvesting:

- **Climate:** Subtropical to warm–temperate, humid crop; star anise prefers regions with mild, humid conditions and reasonably cool (but not freezing) winters rather than true cold or very hot, dry climates.
- **Temperature:** Grows best where the mean annual temperature is roughly 12–21°C, with optimal growth often cited around 15–21°C; the tree is sensitive to hard frost and also suffers in extremely hot, dry conditions, so sites with moderate temperatures and good humidity are preferred.
- **Propagation:** Mainly by seed, sown fresh because viability declines rapidly if seeds are dried; vegetative propagation via cuttings or grafting is possible but less commonly used commercially compared with seed.
- **Soil:** Deep, fertile, well-drained loam or sandy-loam soils rich in organic matter, with moist but not waterlogged conditions and slightly acidic to neutral pH (about 5.5–7); star anise does poorly on calcareous or very poorly drained soils.
- **Harvesting:** Trees generally begin bearing 4–6 years after planting and reach good commercial yields later; the star-shaped fruits are harvested just before or as they turn from green to brown and are then dried to develop full aroma, with harvesting typically once or several times a year depending on climate and management.

Major Global Producers (Star Anise, *Illicium verum*):

China (by far the dominant producer and exporter of commercial star anise), Vietnam (a major producer and exporter, especially from northern provinces) Smaller quantities are produced in countries such as India, Laos, and a few other suitable subtropical areas, but these are minor compared with China and Vietnam.

E. CUMIN

Scientific Name: *Cuminum cyminum*

Family: Apiaceae

Local Name: Cumin, Jeera

Cumin is a spice that is native to Egypt, the Mediterranean, and South Asian countries. It is a low growing annual herb with much branches. It has many culinary, traditional, and pharmacological uses.

Phytochemistry:

The phytochemical composition of *C. cyminum* includes:

- **Bioactives:** Alkaloids, flavonoids, terpenoids, and cuminaldehyde
- **Other compounds:** Anthraquinone, coumarin, glycoside, protein, resin, saponin, tannin, and steroid acids
- **Essential oils:** Cumin aldehyde, γ -Terpinine, α -Sabinin, α -Flandren, α -Kadinin, p-Cymene, and α -Pinene.
- **Other Biological Activities:** Antioxidant, Antibacterial, Antifungal, Anti-inflammatory, Antidiabetic, Insecticide, and Immunomodulatory.

Economic Importance:

Economic importance of cumin includes

- **Spice:** Cumin is a popular spice in many ethnic cuisines, and is the second most popular spice in the world followed by black pepper. It is used to flavor foods, beverages, liquors, and more.
- **Cash Crop:** Cumin is a cash crop for farmers in arid and semi-arid regions of many countries like India, Iran, Syria, Pakistan, and Turkey.
- **Exports:** India is the world's largest consumer of cumin seeds, and also exports to many countries.
- **Essential Oils:** Essential oils of cumin are used in the agrochemical industry to manage pests and vectors.
- **Pharmaceutical:** In many pharmaceutical industries cumin is used in preparation of medicine. These medicines are used to treat digestive disorders, diarrhea, and wounds etc. It is also considered an alternative antimicrobial agent.

Medicinal Properties:

In Ayurvedic medicine, cumin is used to treat a variety of illnesses, such as dyspepsia, diarrhea, and digestive abnormalities etc.

- **Gastrointestinal Issues:** Cumin can help with diarrhea, dyspepsia, colic, gas, and bowel spasms. A 2013 study found that cumin essential oil drops improved symptoms of irritable bowel syndrome (IBS).

- **Skin Conditions:** studies on cumin showed that cumin oil can help with acne, eczema, scabies, and psoriasis.
- **Antimicrobial:** Cumin content has shown antibacterial and antifungal properties; it can inhibit the growth of fungi that causes food spoilage.
- **Antioxidant:** Cumin contains bioactive compounds like terpenes, phenols, and flavonoids which showed antioxidant properties.
- **Anti-Inflammatory:** Cumin has anti-inflammatory properties.
- **Blood Sugar:** Cumin may help lower blood sugar.
- **Weight Management:** Cumin may be used for healthy weight management.
- **Other Uses:** Cumin can be used to treat hoarseness, eye problems, and strengthen bones etc.

Cultivation and Harvesting:

- **Climate:** Cool-season, dry winter crop; cumin prefers a cool, dry climate with plenty of sunshine and low humidity during vegetative and flowering stages, and is sensitive to frost and unseasonal rain.
- **Temperature:** Seeds germinate at about 2–5°C, with optimum germination and growth around 20–30°C; the crop needs roughly 120 frost-free days, and both very low temperatures (frost) and high humidity at flowering severely reduce yield.
- **Propagation:** By seeds (direct sowing); cumin is an annual and is not propagated vegetatively by cloves.
- **Soil:** Fertile, well-drained loam to sandy-loam soils with good organic matter are ideal; it can grow on a range of light to medium soils but waterlogging must be avoided, and a near-neutral pH around 6.5–7.5 is preferred.
- **Harvesting:** Crop duration is about 100–120 days after sowing; plants are harvested when most umbels turn brown and seeds harden but before shattering, then dried and threshed.

Major Global Producers (Cumin, *Cuminum cyminum*):

India (largest producer and exporter, especially Rajasthan and Gujarat), Iran, Turkey and Syria, Egypt and some other Mediterranean and West Asian countries in smaller but significant quantities.

F. FENNEL

Scientific Name: *Foeniculum vulgare*

Family: Apiaceae

Local Name: Saunf, Badishep

Fennel is a flowering plant species of apiaceae family. It is a hardy, perennial herb producing yellow flowers and feathery leaves. It is indigenous to the shores of the Mediterranean but become widely naturalized in many parts of the world.

Phytochemistry:

F. vulgare contains a variety of phytochemicals, including:

- **Volatile Oil:** Fennel contains 1–3% volatile oil, which contain up of about 50–60% anethole and 20% de-fenchone.
- **Phenolic Compounds:** Fennel contains phenolic compounds like trans-anethole, estragole, fenchone, kaempferol, quercetin, and rosmarinic acid.
- **Other Compounds:** Fennel also contains d- α -pinene, d- α -phellandrene, dipentene, methyl chavicol, feniculum, anisaldehyde, and anisic acid.
- Fennel is also a good source of vitamins and minerals, including calcium, potassium, sodium, iron, phosphorus, thiamine, riboflavin, niacin, and vitamin C.

Economic Importance:

Fennel has economic value as a spice and as a crop that can be profitable to farmers:

- **Spice:** Fennel is a spice that is commonly used in India as a refreshing material after meals. India exported 26,000 to 37,000 tonnes of fennel every year. The main export areas of fennel are Japan, the USA, the UK, Canada, Singapore, Saudi Arabia, and the U.A.E.
- **Crop:** Fennel can be a profitable cash crop to grow. It is studied that fennel production is highly profitable for India.

Nutritional Value:

Fennel is a good source of many compounds like vitamin C. It is essential for collagen synthesis and helps prevent damage caused by the sun, pollution, and smoke. Fennel also contains potassium, sodium, iron, vitamin B1, vitamin B2, and niacin.

Medicinal Properties:

Fennel has many medicinal properties, including:

- **Digestion:** Fennel can help with digestion by reducing inflammation and bacteria that cause gas. It is found that fennel oil may help in irritable bowel syndrome.
- **Period Cramps:** Fennel can help ease period cramps by reducing the production of hormones that contribute to painful periods.
- **Colic:** Fennel can help improve colic symptoms in babies.

- **Antioxidants:** Fennel contains many antioxidants, like rosmarinic acid, chlorogenic acid, quercetin, and apigenin. These can help in fighting cell damage and reduce the risk of chronic diseases.
- **Blood Pressure:** Fennel contains potassium, which can help keep blood pressure at a healthy level.
- **Antibacterial:** Fennel has antibacterial and antifungal properties and can treat a variety of bacterial, fungal, viral, and mycobacterial disorders.
- **Anti-Inflammatory:** Fennel has anti-inflammatory properties.
- **Anti-Anxiety:** Fennel extract may have anxiolytic properties. Fennel can be eaten raw or cooked in many ways, including in salads, soups, stews, or baked dishes.

Cultivation and Harvesting:

- **Climate:** Cool-to-moderately warm–season crop; fennel (*Foeniculum vulgare*) performs best in a cool, dry to moderately moist climate and is often grown as a winter/temperate-season crop in many regions.
- **Temperature:** Ideal temperature range for growth is about 15–25°C; it tolerates somewhat cooler and slightly warmer conditions, but frost and very high temperatures or hot, dry winds during flowering and seed set reduce yield and quality.
- **Propagation:** By seeds; fennel is usually established by direct sowing in the field or garden, sometimes by transplanting seedlings, but it is not propagated vegetatively by cloves.
- **Soil:** Fertile, well-drained loam, sandy-loam, or black soils rich in organic matter with pH about 6.5–8.0 are ideal; soil should be loose, humus-rich, and moist but not waterlogged to avoid root and crown rots.
- **Harvesting:** For seed (spice), crop duration is typically about 5–7 months from sowing; umbels are harvested when most seeds turn greenish-yellow to light brown and are partially dry, then further dried and threshed to obtain clean fennel seed. (Leafy and bulb fennel may be harvested earlier depending on use.)

Major Global Producers (Fennel Seed, *Foeniculum vulgare*):

India (one of the leading producers and exporters of fennel seed, especially from Gujarat and Rajasthan) China, Egypt, Turkey, and some Mediterranean and West Asian countries also produce significant quantities, but production is not dominated by Bangladesh or South Korea.

G. CARAWAY

Scientific Name: *Carum carvi*

Family: Apiaceae

Local Name: Shahi jira, meridian fennel and Persian cumin

Caraway is also known as meridian fennel and Persian cumin. It is a biennial plant in the family Apiaceae. It is native to western Asia, Europe, and North Africa. It has a distinctive aroma reminiscent of anise and a warm, slightly sharp taste.

Phytochemistry:

Caraway seeds contain many phytochemicals, including:

- **Essential Oils:** Contain monoterpene hydrocarbons, oxygenated monoterpenes, oxygenated sesquiterpenes, aldehydes, ketones, esters, and fatty acids. The main components of caraway essential oils are carvone and limonene.
- **Phenolic Compounds:** Caraway seeds contain phenolic compounds, which are more significant than typical antioxidant compounds.
- **Other Compounds:** Caraway seeds also contain triacylglycerol, polysaccharides, lignins, flavonoids, tannins, proteins, resins, wax, and mineral salts.

Economic Importance:

Carum carvi is economically important because of it is used in the food and pharmaceutical industries:

- **Food:** Seeds of caraway are used in baking goods like breads and rolls for their flavor, texture, and visual appeal. They are also used in traditional cuisines of Europe and the Middle East.
- **Pharmaceuticals:** Caraway is used in traditional medicine to treat indigestion, pneumonia, and other conditions. They are also used as an appetizer, carminative, and galactagogue.
- **Aroma Industry:** As caraway seeds contain 3-5% volatile oil, it is used in the aroma industry. Caraway's tuberous roots are also edible and are popular in India, China, and other regions.

Medicinal Properties:

Caraway seeds have many biological properties, including:

- **Antioxidant:** Caraway seeds have antioxidant properties due to their phenolic compounds.
- **Antimicrobial:** Caraway essential oils have antimicrobial properties against Gram-positive and Gram-negative bacteria as well as fungi.
- **Anticancer:** Caraway essential oils have anticancer activity against colorectal adenocarcinoma (Caco-2) and liver cancer cell line.

- **Hypoglycemic:** Caraway has hypoglycemic properties.
- Caraway seeds are a versatile spice that can be used in rye bread, meat dishes, stews, pickles, and cheeses.

Cultivation and Harvesting:

- **Climate:** Cool-season herb; caraway grows best in temperate, cool conditions and is generally treated as a cool-season or biennial crop, often sown so that vegetative growth occurs in cool weather.
- **Temperature:** Optimal growth is usually around 13–21°C; it tolerates low temperatures down to about 4–5°C during early growth, while high temperatures and hot, humid conditions reduce vigour and seed yield.
- **Propagation:** By seeds; caraway is normally established by direct seeding in the field because it resents root disturbance and is not propagated vegetatively by cloves.
- **Soil:** Fertile, well-drained loam or sandy-loam with good organic matter and a slightly acidic to neutral pH around 6.0–7.0 is ideal; the crop can tolerate a wider pH range (about 5.8–7.5) but is sensitive to waterlogging.
- **Harvesting:** Usually grown as a biennial; the seed crop is harvested in the second year when the umbels and seeds turn brown and dry (late summer), cutting the plants or umbels and drying them before threshing to collect the aromatic seeds.

Major Global Producers (Caraway, *Carum carvi*):

European countries such as Finland, the Netherlands, and other parts of Central and Eastern Europe (important commercial producers). Some production also occurs in Canada and other temperate regions of North America, as well as in parts of West Asia and North Africa, but global output is not dominated by China, India, Bangladesh, South Korea, or Egypt.

H. BISHOPS WEED

Scientific Name: *Aegopodium podagraria*

Family: Apiaceae

Local Name: Ajwain

Bishops weed is a herbaceous perennial grows from underground rhizomes. The stems are erect, hollow, and grooved. The upper leaves are ternate, broad and toothed. It flowers in spring and early summer. Numerous flowers are grouped together in an umbrella-shaped flower head known as a compound umbel.

Phytochemistry:

- The seeds of bishop's weed contain 2% to 4.4% brownish-colored oil, known as ajwain oil. The major constituent of the oil is thymol (35% to 60%).

- The seeds also contain fiber (11.9%), carbohydrates (38.6%), tannins, glycosides, moisture (8.9%), protein (15.4%), fat (18.1%), saponins, flavone, and mineral matter (7.1%) containing calcium, phosphorous, iron, and nicotinic acid.
- The nonthymol fraction (thymene) contains para-cymene, gamma-terpinene, alpha- and beta-pinenes, dipentene, alpha-terpinene, and carvacrol. Minute amounts of caphene, myrcene, and alpha-3-carene also have been found in the plant.
- Alcoholic extracts contain a highly hygroscopic saponin. From the fruits, a yellow, crystalline flavone and a steroid-like substance have been isolated.

Cultivation and Harvesting:

- **Climate:** Cool-season, temperate herb; *Aegopodium podagraria* (ground elder) prefers cool to mild climates with partial shade and regular moisture, and is commonly found in temperate Europe and similar regions rather than warm tropical areas.
- **Temperature:** Grows well in a broad cool–mild range roughly from about 10–25°C; it tolerates winter cold and light frosts, going dormant in colder months and regrowing from underground rhizomes in spring.
- **Propagation:** Mainly by rhizomes and root fragments (vegetative) and also by seed; the plant spreads very aggressively through creeping rhizomes in the soil, not by cloves.
- **Soil:** Fertile, humus-rich, well-drained loam or loamy garden soil with consistent moisture is ideal; it tolerates a range of soils but thrives in moist, moderately fertile, well-drained conditions.
- **Harvesting:** As it is primarily a wild/medicinal and sometimes edible weed rather than a standard field spice crop, there is no fixed 5–7 month cropping cycle; leaves and young shoots can be harvested repeatedly during the growing season (spring to early summer) once plants are well established.

Major Global Producers:

There are no recognised “major producing countries” for *Aegopodium podagraria* comparable to commercial spice crops; it grows wild or naturalised mainly in Europe and parts of temperate Asia and North America, and is not commercially produced on a large scale in China, India, Bangladesh, South Korea, or Egypt.

8. SEED SPICES

A. CARDAMOM

Scientific Name: *Elettaria cardamomum*

Family: Zingiberaeae

Local Name: Elaichi

Cardamom is one of the oldest known spices in the world. It flourishes in Evergreen forests of Western Ghats of South India and are considered as the centre of origin. Cardamom is commercially cultivated for its dried fruits.

Phytochemistry:

Cardamom contains many phytochemicals as follows:

- **1,8-cineole:** It is a potent antioxidant that gives green cardamom its pungent aroma.
- **α -terpinyl acetate:** A major bioactive constituent of cardamom
- **Terpineol:** A major phytochemical compound in cardamom capsules. It also contains limonene, linalyl acetate.
- **Linalool:** A major phytochemical compound in cardamom capsules
- **Sabinene:** A major phytochemical compound in cardamom capsules
- **Eucalyptol:** A major phytochemical compound in cardamom capsules.
- Cardamom also contains carbohydrates, proteins, minerals, lipids, flavonoids, and carotenoids.

Cultivation and Harvesting:

- **Climate:** Warm, humid tropical crop grown under evergreen forest or plantation shade; cardamom requires high, well-distributed rainfall (about 1,500–4,000 mm/year) and does not tolerate frost or dry, hot winds.
- **Temperature:** Thrives at mean temperatures roughly 15–35°C, with best performance in stable, warm, humid conditions typical of tropical rainforests; growth and yield decline sharply when temperatures fall below about 10°C or when there are large fluctuations and dry heat.
- **Propagation:** Mainly by seedlings and by division of rhizomatous clumps; nursery-raised seedlings from selected high-yielding types are commonly transplanted, and vegetative multiplication through suckers/rhizome division is also used, but it is not propagated by cloves.
- **Soil:** Deep, fertile, well-drained forest loam or rich, organic-matter-laden loam/lateritic soils with good moisture-holding capacity and slightly acidic reaction (around pH 5.0–6.8) are ideal; waterlogging and very sandy, drought-prone soils are unsuitable.

- **Harvesting:** Flowering usually starts 2–3 years after planting, with economic yields from about the 4th year; capsules are picked by hand as they reach full size but before turning yellow or splitting, in multiple pickings over a long season (often 2–3 main harvest rounds per year depending on region).

Major Global Producers (Green Cardamom, *Elettaria cardamomum*):

- Guatemala (currently the largest producer and exporter by volume).
- India (notably Kerala, Karnataka, and Tamil Nadu) as a major traditional producer and exporter.
- Sri Lanka and some other tropical countries (e.g., Tanzania) contribute smaller shares.

Medicinal Properties:

Medicinal uses of cardamom include:

- **Digestion:** Cardamom can help with many digestion problems like heartburn, intestinal gas, constipation, and irritable bowel syndrome. A pinch of cardamom powder in warm water or herbal tea after meals helps digestion.
- **Breath Freshener:** Chewing cardamom seeds can help freshen breath and keep your mouth moist.
- **Blood Pressure:** Cardamom may help lower blood pressure.
- **Diabetes:** Cardamom may help manage diabetes.
- **Dental Health:** Cardamom may help prevent cavities and other dental health issues.
- **Inflammation:** Cardamom can help ease inflammation and protect cells from oxidative stress.
- **Breathing:** Cardamom improves breathing by increasing airflow to the lungs.
- **Nausea and Vomiting:** Cardamom seed powder may help with mild to moderate nausea and vomiting during pregnancy.

B. NUTMEG

Scientific Name: *Myristica fragrans*

Family: Myristicaceae

Local Name: Jaifal

Nutmeg is a dark-leaved evergreen tree cultivated for two spices derived from its fruit: nutmeg, from its seed, and mace, from the seed covering. It is also a commercial source of nutmeg essential oil and nutmeg butter. Nutmeg tree is native to Maluku islands. The spice has a distinctive pungent fragrance and a warm, slightly sweet taste. It is used to flavor many kinds of baked foods.

Phytochemistry:

- **Essential Oils:** The main content of nutmeg's essential oils are monoterpenes, phenylpropenes, and sesquiterpenes etc. Some important phytochemicals in nutmeg's essential oil include myristicin, safrole, limonene, terpine-4-ol, β -pinene, α -pinene, and sabinene.
- **Other Compounds:** Nutmeg also contains alkaloids, phytates, tannins, oxalates, flavonoids, steroids, carbohydrates, proteins, fats, starch, and mucilage.
- **Bioactive Constituents:** Myristicin, elemicin, safrole, and eugenol are bioactive constituents in nutmeg that produce its flavor and aroma.

Medicinal Properties:

Nutmeg has many medicinal uses, including:

- **Anti-Inflammatory:** Nutmeg's anti-inflammatory properties can help protect against leaky gut.
- **Digestive Health:** Nutmeg can help relieve indigestion, bloating, and gas. Nutmeg oil can also treat diarrhea.
- **Pain Relief:** Nutmeg can help reduce joint and muscle pain. Nutmeg oil can also dissolve kidney stones and treat infections of the kidney.
- **Brain Health:** Nutmeg contains compounds that can boost mood and help relieve pain. Research suggests that it may help slow cognitive decline in individuals with Alzheimer's disease.
- **Antibacterial:** Nutmeg has antibacterial properties that can help fight oral pathogens that cause disease and bad breath.
- **Antioxidants:** Nutmeg is a rich source of antioxidants, it helps to protect against serious conditions such as cancer, heart disease, and liver disease.

Cultivation and Harvesting:

- **Climate:** Warm, humid tropical crop; nutmeg thrives in regions with high, well-distributed rainfall (about 1,500–3,500 mm per year) and cannot tolerate frost or prolonged dry, hot winds.
- **Temperature:** Grows best at mean temperatures around 22–30°C; flowering and fruit set are adversely affected by temperatures above about 35°C and by cold conditions, so a stable, frost-free tropical climate is essential.
- **Propagation:** Mainly by seed, which must be sown fresh because viability declines quickly; for uniform, high-yielding plantations, vegetative methods such as approach grafting, epicotyl grafting, and budding onto selected rootstocks are increasingly used, but it is not propagated by cloves.

- Soil: Friable, deep, fertile, well-drained clay loam, sandy loam, or red lateritic soils rich in organic matter, with good moisture-holding capacity and slightly acidic to neutral pH (about 5.5–6.5), are ideal; waterlogging and very shallow or compact soils are unsuitable.
- Harvesting: Seedling trees usually start bearing about 7–9 years after planting and reach full production around 15–20 years; fruits take roughly 6–9 months to mature after flowering and are harvested when the fleshy pericarp splits to expose the seed and crimson aril, after which nutmeg (seed) and mace (aril) are separated and dried.

Major Global Producers (Nutmeg and Mace, *Myristica fragrans*):

Indonesia (one of the largest producers and exporters globally) Grenada (a major exporter, often called the “Island of Spice”) India and Sri Lanka, along with a few other tropical countries, produce smaller but significant quantities.

8. GUMS/RESINS SPICES:

A. ASAFOETIDA

Scientific Name: *Ferula asfoetida*

Family: Ferulaceae

Local Name: Hing, Devils dung

Asafoetida is dried latex collected from the rhizome or tap root of species of ferula. It is used as flavoring agent in food and food preparations. It is also consumed in small quantity as medicine. The species are distributed from the Mediterranean region to Central Asia. In India it is grown in Kashmir and in some parts of Punjab.

Phytochemistry:

- **Resin:** It contains ferulic acid, coumarins, sesquiterpene coumarins, and other terpenoids.
- **Gum:** Contains glucose, galactose, l-arabinose, rhamnose, glucuronic acid, polysaccharides, and glycoproteins
- **Volatile Fraction:** Contains sulfur-containing compounds, monoterpenes, and other volatile terpenoids

Medicinal Properties:

- **Antioxidants:** Asafoetida has been found to be a good source of antioxidants.
- **Good for Digestion:** One of the most common uses of asafoetida is as an indigestion aid.
Reduce symptoms of IBS: Due to its potential effects on digestion, asafoetida is thought to help to reduce symptoms associated with IBS.
- **Antibacterial, Antifungal, and Antimicrobial Effects:** Studies have found that asafoetida may protect against pathogens, such as various strains of *Streptococcus* bacteria
- **Lower Blood Pressure:** Asafoetida may help lower blood pressure by relaxing blood vessels. However, research is limited to animals
- **Potential Anticancer Effects:** Animal and test-tube studies suggest that asafoetida may help stop the growth and spread of certain cancer cells, including breast and liver cancer
- **Protect Brain Health:** Several animal studies have indicated that asafoetida may help safeguard against memory loss and nerve damage in the brain.
- **Ease Asthma Symptoms:** Studies have shown asafoetida to have a relaxing effect on airway smooth muscles, which is important for the treatment of asthma.
- **Lower the Blood Sugar Levels:** It is found that 22.7 mg of asafoetida extract per pound (50 mg per kg) of body weight helped reduce fasting blood sugar level.

Cultivation and Harvesting:

- **Climate:** Cool, dry temperate–arid crop; *Ferula asafoetida* (asafoetida, hing) naturally grows in cold desert and dry temperate regions with low rainfall, abundant sunshine, and very low humidity, rather than in warm, humid tropics.
- **Temperature:** Vegetative growth is optimal around 10–20°C; the plant can tolerate winter lows down to about –4 to –5°C and summer highs up to roughly 35–40°C, but prolonged wet or humid conditions are harmful.
- **Propagation:** Mainly by seeds; seeds are sown directly in the field or in nursery beds (often in late autumn or early spring) because the species has a long taproot and does not transplant or divide well, and it is not propagated by cloves.
- **Soil:** Deep, well-drained sandy or sandy-loam soils, often calcareous and low in organic matter, are preferred; the crop tolerates a wide pH range from slightly acidic to alkaline but is very sensitive to waterlogging.
- **Harvesting:** Plants usually require 4–5 years after sowing before tapping; the aerial parts die back, and the root crown is exposed and incised to collect the milky latex, which dries into the oleo-gum-resin (asafoetida); tapping may continue on the same plant for one or more seasons until yield declines.

Major Global Producers (Asafoetida, *Ferula asafoetida*):

Iran and Afghanistan are the traditional and principal producers and exporters of raw asafoetida resin.

Smaller quantities are obtained from parts of Turkmenistan and neighbouring Central/West Asian regions; India is a major importer and processor but only recently started small-scale cultivation in cold desert areas and is not yet a major global producer.

Practical Course: SEC2 (ii)
ii) KITCHEN PHARMACY – I: SPICES

Course type: Skill Enhancement Course

Credit: 1;

Contact Hours: 30 clock hours;

2 hour/ week

Marks: 50

1. Preservation of Ginger rhizomes in to dried form (Sunth)
2. Isolation of Curcuminoids from *Curcuma longa*
3. Extraction of Essential oil from Cinnamon bark
4. Extraction of Essential oil from Garlic
5. Extraction of essential oil from Clove
6. Test of Saffron
7. Isolation of Alkaloids from Chilli
8. Extraction of Essential oil from Cumin, Fennel, Caraway, Bishops weed

PRACTICAL

1. PRESERVATION OF GINGER RHIZOMES IN TO DRIED FORM (SUNTH)

Ginger (*Zingiber officinale* Rosc.) (Family: Zingiberaceae) is a most adequately used rhizome as spice. It is a herbaceous perennial. India is a leading producer of ginger in the world. Ginger is cultivated in most of the states in India. However, states namely Karnataka, Orissa, Assam, Meghalaya, Arunachal Pradesh and Gujarat together contribute 65 per cent to the country's total production. Ginger grows well in warm and humid climate and is cultivated from sea level to an altitude of 1500 m above sea level. Several cultivars of ginger are grown in different ginger growing areas in India and they are generally named after the localities where they are grown.

Ginger attains full maturity in 210-240 days after planting. Harvesting of ginger for vegetable purpose starts after 180 days based on the demand. However, for making dry ginger, the matured rhizomes are harvested at full maturity i.e. when the leaves turn yellow and start drying. Irrigation is stopped one month before harvest and the rhizome clumps are lifted carefully with a spade or digging fork. In large scale cultivations, tractor or power tiller drawn harvesters are also used. The dry leaves, roots and soil adhering on the rhizomes are manually separated. Late harvest is also practiced, as the crop does not deteriorate by leaving it for some months underground. In India, domestic market prefers fresh green ginger for culinary use while two types of dried ginger i.e. bleached and unbleached are produced for export purpose. The most important criteria in assessing the suitability of ginger rhizomes for particular processing purposes is the fibre content, volatile-oil content and the pungency level. The relative abundance of these three components in the fresh rhizome is governed by its state of maturity at harvest.

Processing of Ginger

Processing of ginger to produce dry ginger (Sunth) basically involves two stages peeling of the ginger rhizomes to remove the outer skin and sun drying to a safe moisture level. Peeling serves to remove the scaly epidermis and facilitate drying. Peeling of fully matured rhizomes is done by scrapping the outer skin with bamboo splits having pointed ends and this accelerates the drying process. Deep scraping with knives should be avoided to prevent the damage of oil bearing cells which are present just below the outer skin. Excessive peeling will result in the reduction of essential oil content of the dried produce. The peeled rhizomes are washed before drying. The dry ginger so obtained is valued for its aroma, flavour and pungency.

Indian dried gingers are usually rough peeled when compared to Jamaican gingers, which are clean peeled. The rhizomes are peeled only on the flat sides and much of the skin in between the fingers remains intact. The dry ginger so produced is known as the rough peeled or unbleached ginger and bulk of the ginger produced in Kerala are of this quality.

Drying

The moisture content of fresh ginger at harvest is about 80-82% which is brought down up to 10% for its safe storage. Generally ginger is sun dried in a single layer in open yard which takes about 8 to 10 days for complete drying. The sun dried ginger is brown in colour with irregular wrinkled surface. The yield of dry ginger is about 19-25% of fresh ginger depending on the variety and climatic zone. Polishing, cleaning and grading Polishing of dried ginger is done to remove the dry skin and the wrinkles developed on the surface during drying process. It is generally done by rubbing against hard surface. Cleaning of dry ginger is done manually to remove the extraneous matter and the light pieces. Once the ginger is cleaned and it is graded manually based on size of the rhizome, its colour, shape and the extent of residual lime (in the case of bleached ginger).

Storage

Dry ginger, packaged in gunny bags are highly susceptible to infestation by insects during storage. Fully dried rhizomes can be stored in airtight containers such as high density polyethylene or similar packaging materials. Long term storage for more than two years would result in deterioration of its aroma, flavour and pungency.

Bleached Ginger

Bleached ginger is produced by dipping scrapped fresh ginger in a slurry of slaked lime, Ca(OH)_2 , followed by sun drying. As the water adhering to the rhizomes dry, the ginger is again dipped in the slurry. This process is repeated until the rhizomes become uniformly white in colour. Dry ginger can also be bleached by the similar process. Liming gives ginger a better appearance and less susceptibility to the attack of insect pests during storage and shipping.

2. ISOLATION OF CURCUMOIDS FROM *CURCUMA LONGA*

Curcuminoids are the major constituents of *Curcuma longa* or commonly known as turmeric. Curcuminoid consists of curcumin, demethoxycurcumin, and bisdemethoxycurcumin. The main curcuminoid isolated from turmeric is curcumin. Curcumin, a yellow crystalline polyphenol with low molecular weight, is extracted from rhizome of turmeric. Turmeric belongs to the perennial herb named *Curcuma longa* L.

Several studies have reported that curcumin exhibits a variety of interesting biological activities, such as antimicrobial, antioxidant, antiviral, antiinflammatory, and anti-cancer activities.

Requirements:

Turmeric powder, Silica gel, dichloromethane, methanol, Soxhlet apparatus, chloroform etc.

Isolation of Curcumin

Turmeric was cleaned and washed under flowing tap water and left to dry at room temperature. The turmeric was crushed and grinded until become powder. A 500 mg of turmeric powder were prepared for extraction with soxhlation method where ethanol and dichloromethane were used as solvents. Extraction was stopped when the solvent no longer turned orange, the results were compared. The isolation was carried out by column chromatography on silica gel with dichloromethane-methanol as mobile phase.

Column Chromatography:

Sample preparation:

1. 100 gm of fine powdered rhizome were subjected to soxhlet extraction using acetone as solvent (6 hours).
2. The extract was filtered and concentrated in rotary evaporator, this crude curcuminoid mixture contained curcumin, demethoxycurcumin, bisdemethoxycurcumin.
3. Silica gel column chromatography Acetone extract was subjected to column chromatography in silica gel (60-120 mesh) glass column.
4. 5 gm of crude Curcuminoids were mixed with 8 gm of silica gel and loaded on to the column of 46×2 cm and eluted with chloroform followed by chloroform:methanol with increasing polarity.
5. All the collected fractions were subjected to TLC silica gel 60 F254 plate using chloroform:methanol (95:5) as the developing solvent system and detected as yellow spots.
6. And similar fractions with the R_f values were pooled and the organic solvent was removed by rotary evaporator.
7. The total curcuminoid content of each curcuminoid collected were analysed by UV spectrophotometry at 420 nm.

Result: It is clear from the observation that the curcuminoid were isolated from the *Curcuma longa* sample.

3. EXTRACTION OF ESSENTIAL OIL FROM CINNAMON BARK

Cinnamomum zeylanicum (Dalchini) is one of the oldest herbal medicine known. It is an evergreen tropical tree, belonging to the Lauraceae family. Cinnamon barks and leaves are widely used as spice and flavoring agent in foods and for various applications in medicine. Cinnamon is often used for medicinal purposes due to its unique properties. The essential oil from its bark is rich in trans-cinnamaldehyde with antimicrobial effects against animal and plant pathogens, food poisoning and spoilage bacteria and fungi. The bark and leaves of *Cinnamomum sp* are commonly used as spices in home kitchens and their distilled essential oils are used as flavoring agent in the food and beverage industries. The bark of the tree is dried and used for spice. In the United States, cinnamon is used to flavor cereals, grain-based dishes, and fruits. Cinnamon is among the world's most widely used spices and is relatively inexpensive. Cinnamon contains antioxidants and other active ingredients which are found in the water-soluble portions of cinnamon, and not the cinnamon oil. It is through these components that cinnamon is believed to produce its associated health effects.

Soxhlet Extraction Method

100g of cinnamon stick were mashed into smaller pieces and placed inside a thimble made from thick filter paper, which was then loaded into the main chamber of the Soxhlet extractor. The extraction solvent used was ethanol. The solvent was heated to reflux at temperature above 100°C for 5 and 10 hours. After the extraction, the products were collected and purified using rotary evaporator at fixed temperature 50°C. After rotovap, the samples were left under fume hood for one hour to make sure all the ethanol left in the oil crude was completely vaporized to the environment.

Test for Active Compound using HPLC

The active compound in cinnamon, cinnamaldehyde was tested using High Performance Liquid Chromatography (HPLC). The HPLC was run using a reversed-phase C18 column. The mobile phase comprising a mixture of methanol–acetonitrile–water in volume ratio of 35:20:45 was delivered at a flow rate of 1.0 cm³/min, and the detection for all samples to detect cinnamaldehyde was done at 221 nm. Time used for the process was 20 min with temperature 38°C. The volume injection for each sample was 50µl.

The water used was dehydrogenized water (dH₂O). The mobile phase was chosen based on the experiment done by A. 10µg of essential oil samples were diluted in 10ml methanol for all four samples used for HPLC. The standard used was 95% pure procured from Sigma Aldrich.

4. EXTRACTION OF ESSENTIAL OIL FROM GARLIC

Garlic (*Allium sativum*) is widely used for flavoring purposes in food and food preparations. Specially in Asia and other continents. Garlic (*Allium sativum*) has played an important dietary as well as medicinal role for centuries. The major components of garlic essential oil are 3-vinyl-4H-1,2-dithiin, diallyl trisulfide, diallyl sulfide, diallyl disulfide, propyl allyl disulfide, and dimethyl disulfide. Many scientist reported that diallyl disulfide and diallyl trisulfide, the two major organosulfur compounds derived from garlic essential oil, could inhibit platelet thromboxane formation, and hence platelet aggregation. It is further indicated that garlic (*Allium sativum* L.) essential oil were effective in reducing the chemical formation of N-nitrosamines (NAs), and suggested that diallyl sulfur compounds in garlic essential oil might also act as nitrite scavengers. Supercritical fluid extraction (SFE) of active compounds from plant material is a promising field for the industrial application of SFE since it has certain advantages over steam distillation and solvent extraction (SE). SFE can be performed at lower temperatures, thereby preserving the original extract composition and properties. Unfortunately, SFE method also has some disadvantages that prohibit its industrial uses because of high equipment investment and small extraction scale.

Steam distillation is a common method for extracting garlic oil:

1. **Prepare the garlic:** Clean and crush the garlic into a powder with a diameter of 0.2–0.5 mm.
2. **Steam:** Place the crushed garlic in a distillation column and steam it.
3. **Cool:** Send the steam to a cooling tower to condense it.
4. **Separate:** Separate the oil and water in the condensate using an oil-water separating column.

Result:

By using the above process essential oil is extracted. Following observations were obtained.

- **Yield:** It takes about 500 grams of garlic to produce around 1 gram of garlic oil.
- **Odor:** Steam-distilled garlic oil has a pungent, unpleasant odor, which is due to the presence of diallyl disulfide.
- **Color:** Steam-distilled garlic oil is brownish-yellow in color.
- **Strength:** Undiluted garlic oil is 900 times stronger than fresh garlic and 200 times stronger than dehydrated garlic.
- **Extraction rate:** The extraction rate of garlic oil can be as high as 0.5%.

5. EXTRACTION OF ESSENTIAL OIL CLOVE

Clove oil is an essential oil that's derived from clove trees *Syzygium aromaticum*, is native to Southeast Asia, although today you may find it growing in other locations, too. Clove oil is produced by distilling the dried flower buds that are collected from the clove tree. Other parts of the tree, such as the stem and leaves, may also be used. Clove oil, which ranges in color from colorless to light yellow and has a strong, spicy aroma, has been used for centuries in a variety of applications. In this article, we'll take a closer look at the potential benefits of this oil and how you can use it at home.

Clove oil has traditionally been used for a variety of purposes, including:

- As an antimicrobial, to help kill bacteria
- As a pain reliever for conditions such as toothache and muscle pain
- For digestive upset
- To relieve respiratory conditions like cough and asthma

Procedure

To extract eugenol from a natural source, many methods are practiced globally. Researchers reported many therapeutic benefits of eugenol such as antimicrobial, antiviral, and antioxidant effects. The primary mechanisms involved in its therapeutic effects are free radical scavenging activity, blocking the generation of reactive oxygen species, inhibiting the production of reactive nitrogen species, enhancing cytoantioxidant potential, and disordering DNA and proteins. Nutraceuticals impart many benefits in treating chronic diseases such as diabetes, obesity, cardiovascular conditions, and cancer. Nutraceuticals are available as food supplements, functional food, and medicinal food. The product's efficacy relies upon bioavailability, making this product effective by using a suitable carrier. The motive of using a carrier is to protect the encapsulated molecule from external conditions, preserve functionality, and deliver effectively to the target site. It is free from unwanted effects and is cheaper because it is obtained from a natural source.

Hydrodistillation is also a widely used method of extracting essential oils. For this method, part of the plant is first dried and ground. This powdered sample is then taken into a 500 mL volumetric flask and soaked in water. This is further subjected to hydrodistillation for 4–6 h. The volatile distillate is collected and saturated with sodium chloride following the addition of a suitable organic solvent. After this, the hydro and solvent layers are separated and dehydrated using anhydrous sodium sulfate. Later, the sample/extract is recovered and concentrated by heating over a water bath at 60°C. This method yields an average of 11.5% yield with 50.5%–53.5% of eugenol. This can further be optimized using different additions.

6. TEST FOR SAFFRON

Saffron is a spice obtained from the flower of *Crocus sativus*. It is commonly known as the "saffron crocus". The vivid crimson stigma and styles, called threads, are collected. It is dried for use mainly as a seasoning and colouring agent in food. The saffron crocus was mainly propagated throughout Eurasia and was later spread to parts of North Africa, North America, and Oceania.

Saffron is a powerful spice high in antioxidants. It has been linked to health benefits, such as improved mood, libido, and sexual function etc.

There are a few ways to test the quality of saffron, including:

Water Test

Soak a few saffron threads in hot water for 5–20 minutes:

Color: Real saffron will slowly release a golden-yellow color, while fake saffron will quickly release an artificial red dye and the threads will disintegrate.

Taste: The water from real saffron will have a floral and earthy taste, while fake saffron will lack flavour or have a bitter metallic taste.

Rubbing Test

Wet a couple of saffron strands and rub them against your fingers:

Integrity: Real saffron will not break and will turn your fingers a light orange or yellow. Fake saffron may break apart or disintegrate or leave a dark red color on your fingers.

Taste Test

Place a thread of saffron in your mouth:

Smell: Quality saffron should smell sweet.

Taste: Quality saffron should not taste sweet.

Baking Soda Test

Mix saffron and baking soda in a small cup filled with water:

Color: If the mixture is yellow, then you are looking at pure saffron.

7. ISOLATION OF ALKOLOIDS FROM CHILLI

Capsaicinoids are a group of phenolic alkaloids specific to peppers, and the most abundant of these components are capsaicin (8-methyl-N-vanillyl-6-nonenamide) and dihydrocapsaicin (N-(4-Hydroxy-3-methoxybenzyl)-8-methylnonanamide). Capsaicin is used as an analgesic, as well as in the treatment of arthritis, due to its physico-chemical properties, antimicrobial, anti-inflammatory properties and therapeutic ability and several studies shown its effect in cardiovascular and gastrointestinal disorders. Capsaicin is also used in self-defense products such as paralyzing sprays, as well as natural oral supplements, since it causes severe inflammation when it comes into contact.

Requirements:

Chillies, Containers or trays, Solvent (alcohol, naphtha, acetone, etc.), Fine-knit sieve or pantyhose.

Procedure:

Wash the chillies with distilled water and blend until they are reduced to a pulp and add 1 liter of solvent for each kilogram of chillies. Leave to rest for 2-3 days. Now filter the mash to separate the liquid with a sieve or women's pantyhose.

Now just wait until it evaporates, leave the container in the open air for a few days. At the base, a layer of capsaicin will form. At that point, you can scrape it off and crush it into powder. To speed up the evaporation it can be kept in water bath.

Result

Alkaloid is isolated from the given material.

8. EXTRACTION OF ESSENTIAL OIL FROM: CUMIN, FENNEL, CARAWAY, BISHOPS WEED

CUMIN

Cumin (*Cuminum cyminum*) is annual plant of Apiaceae family. It is an essential spice in almost all the culinary preparations such as soups, cakes, breads, cheeses, etc. This plant can be originating from Egypt or Syria. Nowadays it is being developed intensively in India, China, Turkey and Iran. Cumin has quite varied medicinal properties, which are stomachic, diuretic, stimulative, astringent and analgesic. Cumin oil is pale yellow to brownish yellow liquid.

Requirement

100 gms of dried and pulverized cumin seeds, Mortar and Pestle, Diamonium Sulphate, Hexane, diethyl ether, Soxhlet apparatus, Centrifugation, Test tube, Flasks, Measuring Cylinder etc.

Procedure

The extraction of the essential oil of cumin is achieved by using the hydrodistillation process and Soxhlet extraction method.

Hydrodistillation

The ground *C. cyminum* L. (4 g) were extracted with 150 mL of water steam for 3 h using a Clevenger-type hydrodistillation extractor. After hydrodistillation, 0.16 mL of essential oil was obtained. The extracted essential oil was transferred into a volumetric flask using three rinses of hexane. The extract was dried over anhydrous Na₂SO₄. The solution was concentrated under a N₂ stream to around 0.5 mL, and 6 mL of n-nonane was added as an internal standard to it prior to gas chromatography (GC). The essential oil is partially water soluble, 10 to 20 mL of diethyl ether is used in order to carry out the separation of the organic phase containing essential oil (the higher part) from the aqueous phase (liquid-liquid extraction type).

Soxhlet Extraction

Soxhlet extraction was carried out in standard apparatus for 12 h on 4 g ground *C. cyminum* L. with 200 mL hexane. The extract was concentrated under a N₂ stream until around 0.5-mL volume remained, and 6 mL of n-nonane was added to the concentrate as an internal standard prior to the GC.

FENNEL

Fennel is one of the important supernatural fragrances producing plant, generally known as Saunf (*Foeniculum vulgare* Mill) family Apiaceae. It is a group of annual, biennial or perennial herb. It is widely cultivated all over India. Fennel is used as spices and also as an important ingredient in various folklore medicines throughout the world. Moreover, this plant has been investigated extensively for several medicinal and therapeutic activities and has been reported for possessing carminative, flavouring, antioxidant, antibacterial, antifungal and mosquito repellent properties.

Fennel oil is an essential oil that has several applications in various industries. Fennel oil is produced from fennel seed by using Soxhlet extraction.

Requirement

100 gms of dried fennel seeds, Mortar and Pestle, Acetone, Ethanol, Methanol, N-hexane, Soxhlet apparatus, Centrifugation, Test tube, Flasks, Measuring Cylinder etc.

Procedure

The extraction of the essential oil of fennel is achieved by using the Soxhlet extraction, simple maceration and water maceration method.

Simple Maceration

Alcohol Maceration

In this process, the fennel (25g) is placed with the whole of the solvent (100ml) in a closed vessel for 7 days. During this period shaking is done occasionally. After 7 days the liquid is strained and marc is pressed. Water Maceration This method is similar to alcohol maceration where water is used instead of alcohol.

Percolation

- Comminution of fennel (powder 25g)
- Imbibition of fennel (4 hours at room temp.)
- Packing (a filter paper is placed on the bottom to support the column of drug and over the moistened drug another filter paper is placed having weight on it).
- Maceration (percolator is set aside for 48 hours)
- Percolation (extraction was carried out)

Soxhlet Extraction

- The operational conditions include optimized sample, temperature, extraction time, and ratio of fennel to solvent.
- Temperature: The operating temperature for experiments carried out was varied from 70°C to 75°C.

- Extraction time: The term extraction time is used for the duration of time it took for experiment to run. In this research, the experiments were carried out from 2, 4 and 6 hours of extraction time.
- Ratio of fennel to solvent: The experiments being carried out using the equipment set up. The ratio of fennel to solvent was 25 gm. Fennel sample to 100ml of solvent was used.

Percentage Yield

The following formula was used to determine the essential oils yield:

$$\text{Essential oils yield(\%)} = \frac{W1(\text{extraction}) (\text{g})}{W2(\text{sample})(\text{g})} \times (100) \%$$

Where W1 = (extraction) net weight of oils (grams)

W2 = total weight of fennel (grams)

ResultS:

Simple Maceration Result

Highest fennel oil was founded in solvent n-hexane

Percolation Result

Highest fennel oil was founded in solvent acetone

Soxhlet Extraction

Highest fennel oil was founded in solvent acetone

CARAWAY

Caraway oil is used as medicine and may help with digestion and stomach and intestinal spasms. However, there is no good scientific evidence to support its use for other conditions.

Hydrodistillation In order to isolate essential oils by hydrodistillation, the aromatic plant material is packed in a still and a sufficient quantity of water is added and brought to a boil; alternatively, live steam is injected into the plant charge. Due to the influence of hot water and steam, the essential oil is freed from the oil glands in the plant tissue. The vapor mixture of water and oil is condensed by indirect cooling with water. From the condenser, distillate flows into a separator, where oil separates automatically from the distillate water.

Mechanism of Distillation

Hydrodistillation of plant material involves the following main physicochemical processes:

1. Hydrodiffusion
2. Hydrolysis
3. Decomposition by heat

Hydrodiffusion

Diffusion of essential oils and hot water through plant membranes is known as

hydrodiffusion: In steam distillation, the steam does not actually penetrate the dry cell membranes. Therefore, dry plant material can be exhausted with dry steam only when all the volatile oil has been freed from the oil-bearing cells by first thorough comminution of the plant material. But, when the plant material is soaked with water, exchange of vapors within the tissue is based on their permeability while in swollen condition. Membranes of plant cells are almost impermeable to volatile oils. Therefore, in the actual process, at the temperature of boiling water, a part of volatile oil dissolves in the water present within the glands, and this oil-water solution permeates, by osmosis, the swollen membranes and finally reaches the outer surface, where the oil is vaporized by passing steam.

Hydrolysis: Hydrolysis in the present context is defined as a chemical reaction between water and certain constituents of essential oils. Esters are constituents of essential oils and, in the presence of water, especially at high temperatures; they tend to react with water to form acids and alcohols. However, the reactions are not complete in either direction and the relationship between the molal concentrations of various constituents at equilibrium is written as:

$$K = \frac{(\text{alcohol}) \times (\text{acid})}{(\text{ester}) \times (\text{water})}$$

where K is the equilibrium constant.

Therefore, if the amount of water is large, the amounts of alcohol and acid will also be large, resulting in a decreased yield of essential oil. Furthermore, since this is a time-dependent reaction, the extent to which hydrolysis proceeds depends on the time of contact between oil and water. This is one of the disadvantages of water distillation.

BISHOP'S WEED

Bishop's weed is a member of the Apiaceae plant family and is native to Egypt. It is commonly used in Indian cuisine and is also found in other South East Asian countries. Essential oil is extracted from bishop's weed, also known as ajowan, using steam distillation or hydrodistillation:

Process

The seeds, leaves, or flowers of the bishop's weed plant are subjected to steam or hot water to separate the essential oils from the plant's oil glands.

Result

The thermal energy from the steam releases the volatile components of the plant, which are then delivered to a condenser. The condenser separates the essential oils from the condensed water molecules.

KITCHEN PHARMACY - I: SPICES

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