CHAPTER - IV
The family Zingiberaceae includes nineteen different genera namely - Mantisia, Globba, Hemiorchis, Roscoea, Cautleya, Curcuma, Gastrochilus, Kaemferia, Hitchenia, Hedychium, Amomum, Zingiber, Costus, Cyphostigma, Elellaria, Elettariopsis, Scaphochlamys, Alpinia & Rhynceanthus. Among the above, the two genera Curcuma and Zingiber are used regularly as spices.

*Curcuma longa* Linn is used for coloring and flavoring different food preparations. It also has a number of medicinal uses. It is used as a stomachic, tonic and blood purifier in the Indian system of medicine.

The second genus Zingiber is used for flavoring foodstuff. Ginger has been used as a spice as early as 400 B.C and has been cultivated in India since time immemorial. There are a number of commercial varieties of ginger, namely- Jamaican ginger, Indian ginger, African ginger, Chinese ginger Japanese ginger- obtained from *Z. mioga* Rose and Martinique ginger- obtained from *Z. zerumbet* (L) Smith. All species are known to possess essential oils, which imparts a characteristic flavor to the species. The rhizomes are rich in the essential oils. The dried rhizomes are powdered and used to flavor foods such as pies, puddings, cookies, pastries, biscuits etc. It is also used for seasoning.
mixtures, meat and fish preparations. The pleasant warm taste and flavor of ginger beer and ginger ale is due to the ginger present in them. The Central Food Technological Research Institute (CFTRI), Mysore has developed a number of ginger flavored products like effervescent and vitaminized effervescent ginger powders. Dried ginger is also used to manufacture ginger oil, oleoresin and essence of ginger. Medicinally, ginger is also used as a carminative and a stimulant to the gastrointestinal tract. It is used as a household remedy for flatulence and colic. Ginger extracts are used as an adjunct to many tonics and stimulants. It is considered to be an anti depressant and forms an ingredient of some anti-narcotic preparations. Veterinarians use ginger as a stimulant and a carminative in atonic indigestion of horses and cattle.

The genus Zingiber has been reported to include twenty-four species. (Hooker, 1872). Among them, fifteen are reportedly found naturally in the Indian Peninsula and eight in Assam.

The species found in Assam are:

Among the above eight species, three species viz. *Z. officinale* Rose, *Z. zerumbet* (L) Smith and *Z. purpureum* Rose, have been reported to be used in some part or the other of the world, either for culinary purposes or medicinally. Another species, *Z. capitatum* Roxb. also has tremendous medicinal value.

Keeping all the above characters, qualities and uses of ginger in mind, four species viz. *Z. officinale* Rose, *Z. zerumbet* (L) Smith, *Z. purpureum* Rose, and *Z. capitatum* Roxb have been selected for the present study. *Z. zerumbet* (L) Smith is not consumed in Assam, but a commercial variety of ginger, namely Martinique ginger has been reported (W.O.I.) to be obtained from it. All the four species have tremendous medicinal value and since they are already in use in the traditional system of medicine, they can be considered to have minimum mammalian toxicity. They can thus be tested for the possible efficacy against fungi causing disorders in humans, like respiratory problems and other allergies.
SELECTED ZINGIBER SPECIES:

(i) *Zingiber capitatum* Roxb. (PLATE-III)

It belongs to the family Zingiberaceae and has not been reported to be consumed. It is found all over the forests of Assam.

TAXONOMIC DESCRIPTION:

This species is a leafy, perennial rhizomatous herb. Stem leafy, 3-4 ft in height. Leaves 30-36×2.5-4.2 cm, gradually tapering to a point, erectoportent, usually pubescent beneath. The flowers are borne on sessile spikes. The spikes are densely flowered, erect and oblong to oblong cylindrical, 7.5-15×2.5-4.2 cm, in diameter. The bracts are closely imbricate, subcoriaceous and green with a narrow edge. Corolla- tube as long as the bract, segments 1 inch, pale yellow; lip pale yellow, unspotted, mid-lobe orbicular, emarginated, 0.6 cm broad, basal auricles large, oblong, obtuse, bright red. Capsules bright red, the size of a small olive; valves ovate. Seeds black, shining, aril large, lacerated, white.

ESSENTIAL OIL:

The rhizomes, on distillation yield an essential oil.
Zingiber capitatum Roxb.

PLATE - III
USES:

It is used medicinally as a household remedy.

(ii) *Zingiber officinale* Rosc. (PLATE-IV)

A member of the family Zingiberaceae, it is known as 'ardraka' in Sanskrit, 'adrak' in Hindi, 'aada' in Assamese and 'ginger' in English.

TAXONOMIC DESCRIPTION:

It is an herbaceous, rhizomatous perennial plant having a leafy stem, growing up to 90cm in height. The leaves are lanceolate, glabrous beneath, sub-sessile, 17×8 cm, dark green, evenly narrowed to form a slender tip. Flowers borne on spikes which are oblong-cylindric, 2.5-7.5×2.5 cm in diameter; peduncle 15-30 cm; bracts about 2.5 cm long, greenish, sub-orbicular cuspidate; corolla segments greenish-yellow with a small, dark purplish-black lip, lanceolate, subequal, under an inch long; mid-lobe orbicular, lateral ovate; lip shorter than segments. Stamen dark purple, as long as the tip.

Rootstock biennial, bearing many sessile tubers. Rhizomes are aromatic, thick lobed, pale-yellowish, differing in shape and size in the different varieties.
Zingiber officinale Rosc.

PLATE - IV
ESSENTIAL OIL:

It is obtained by subjecting the aseptically pulverized rhizome to hydro distillation. The oil contains sesquiterpene hydrocarbons and alcohols, monotorpenoids and associated compounds (W.O.I.). Zingiberene (α and β zingiberene) having the molecular formula C_{15}H_{24} is the predominant sesquiterpene hydrocarbon & Zingiberol (C_{15}H_{26}O) is the major sesquiterpene alcohol present in the oil. The major constituent of the volatile fraction from stored oil is ar-curcumene and from fresh oil is Zingiberene. An oleoresin is present, the commercial preparations of which contains gingerol, shogaol and zingerone. The oil is light yellow or greenish yellow in color. The physical characteristics of the oil are - sp.gr. 27°, 0.8690; [α] d _{0} -54° at 30°; nD28, 1.4891 and sap. val. 20 max., acid val. 1.0, ester val. 7.4 and ester val. after acetylation 30.5.

USES:

Ginger is used widely as a spice for culinary preparations. It is also used for flavoring a great variety of foods, for preparation of confectionary items, pickle, canning, preparation of ginger beer and ginger ale etc. Dried ginger is used for flavoring pies, puddings, cookies, pastries and biscuits. Ginger may also be used to protect edible oils and fats from rancidity as it possess antioxidant properties.
Medicinally, it has carminative and stimulating properties. It can be used externally as a stimulant and rubefacient. Ginger has also been reported to contain an antihistamine factor. It is listed as an anti-depressant and an ingredient in anti-narcotic preparations. The rhizome is said to be a new source of a proteolytic enzyme. This culinary ginger (*Zingiber officinale*) is also eaten, or made into a tea for indigestion as well as increased circulation of the blood and an increased sense of well-being.

The oil is primarily used for flavoring confectionary, table sauces and soft drinks. It is also used in the perfumery industry.

Since all parts of the rhizome of this species have been used for human consumption in various farms, the essential oil can be safely used to test its antifungal efficiency against human pathogenic *Aspergillus* species.

(iii) *Zingiber purpureum* Rosc. (PLATE-V)

It is a slender herb, belonging to the family Zingiberaceae and cultivated widely all over tropical Asia, including Assam. It is known as ‘Vanardraka’ in Sanskrit & ‘Banada’ in Assamese and Hindi.
Zingiber purpureum Rose.

PLATE - V
TAXONOMIC DESCRIPTION:

A slender herb arising from a stout, perennial root stock, which is light brown in color and deep yellow within. Stem 1-2 m long, leaves sessile, oblong-lanceolate, and pubescent beneath along mid-rib. Flowers borne on spikes: spike 10-15×4.5-5 cm in diameter, peduncles long, 7.5-30 cm; bracts broadly ovate, bright red or greenish red, acuminate, glabrous or pubescent. Flowers yellow, corolla tube whitish, as long as the bract, upper broader and more concave; segments 2.5×0.6 cm long and broad, with unspotted mid-lobe. Stamens yellowish – white, shorter then the lip. Flowers in July-August in Assam.

ESSENTIAL OIL:

On hydro distillation, the rhizomes yield a pale yellow essential oil. The major constituent of the oil is a tertiary alcohol – terpinen-4-ol. Besides this these are a number of other components present in smaller fractions, which have identified as - α- and β- pinenes, sabinene, myrcene, terpinene, limonene, p-cymene and terpinolene.

The physical constants of the oil are – Sp. gr. 27°, 0.895; [α]D - 33.2°; nD, 1.489; ester val after acetylation 36.5% by wt. of total alcohols (calculated as C10H18O) in the oil.
USES:

The rhizome possesses medicinal properties and is used widely as medicine in Tropical Asia. It is credited with stimulant and carminative properties and is sometimes used medicinally as a substitute for *Z. officinale*. The rhizome extract is also useful in diarrhea and colic. The camphoraceous odor and the warm spicy taste of the rhizome are used for flavoring food preparations.

The oil is used as a source of terpinen-4-ol, which is widely employed in the perfumery industry, for the preparation of artificial geranium, pepper, rose and other oils and also in soap perfumes and flavor compositions.

(iv) *Zingiber zerumbet* (L) Smith. (PLATE-VI)

A member of the family Zingiberaceae, it is known as ‘Karporaharidra’ in Sanskrit, ‘Narkachur’ in Hindi and ‘Borahu’ in Assamese and shampoo ginger in English.

TAXONOMIC DESCRIPTION:

The plant is a biennial herb, arising from a large, tuberous, aromatic rootstock, which is yellow inside. In Assam, it is found growing luxuriantly in the forests and also cultivated in the fields.
Zingiber zerumbet (L) Smith.

PLATE - VI
Leafy stem, leaves are oblong-lanceolate, glabrous beneath, 3-4 ft long; petiole very short. Flowers borne on spikes of variable sizes; spikes globose, oblong, very dense; bracts 2.5-4.2 cm, orbicular, closely appressed, having a greenish red to dark red margin. Spikes 7.5-10×4.2 cm in diameter, peduncle 15-30 cm. Corolla segments whitish, lip sulphur – yellow, unspotted, mid-lobe orbicular, emarginated, basal lobes large.

ESSENTIAL OIL:

The rhizome yields a fragrant essential oil on hydro distillation. They also possess a fixed oil and an ether soluble resin. The oil contains monoterpenes and several sesquiterpenes. The major constituents are the sesquiterpene hydrocarbon - humulene (C_{15}H_{27}) and the monocyclic sesquiterpene ketone - zerumbone (C_{15}H_{22}O). The oil also contains a good amount of the monoterpenes -camphene (major constituent), camphor, α- and β- pinenes, Δ³ - careen, limonene and cineole.

The physical characteristics of the oil are – nD 28.5°, 1.501; [α] d, + 20.1°; acid val, 5.1.
USES:

The rhizome is employed medicinally for the treatment of cough, stomachache, asthma, worms, leprosy and other skin diseases. They possess a strong, aromatic ginger-like flavor. The essential oil is used in India, in the perfumery and soap industry as a perfume, after blending it with other perfumes. Shampoo ginger was used as medicine for sprains, indigestion and other ailments. In traditional use, the root is ground with a stone mortar and pestle, and the pulp placed in a cloth and loosely bound around the injured area. To ease a stomachache, the ground and strained root material is mixed with water and drunk. For a toothache or a cavity, the cooked and softened root is pressed into the hollow and left for as long as was needed.

Zerumbone, major constituent of the oil, has been reported to inhibit the growth of *Micrococcus pyogenes* var. *aureus* and *Mycobacterium tuberculosis*.

All the four species discussed above are known to be used medicinally, either as topical applications or orally. So we can consider them as having minimum or no mammalian toxicity. They can be safely used and tested for the cure of other human problems like -- allergies of the respiratory tract, mycoses etc.
The rhizomes of each of the four species when subjected to hydro distillation in a Clevenger’s Apparatus, yielded noticeable amounts of essential oil. Studies conducted by various workers have revealed the presence of five major components of the oil, namely – zingerone, zingiberone, zingiberene, zingiberol and zerumbone.

Beside the above five main constituents, the ginger oil has a number of other constituents in smaller fractions like: ar-curcumene, gingerol, shogaol, humulene, limonene, camphene and camphor to name a few. All the above components makes ginger oil very spicy and imparts in it a pleasant, aromatic, warm and pungent taste.

Zingerone:

Nonura, 1920; Manmich, 1927 and Richter, 1952 have reported it to be one of the chief constituents of ginger oil. It imparts a biting taste to the oil. Physically they occur in the form of needles or plates. Chemically, it is \(3\)-methoxy-4-hydroxy benzylacetone.

Richter, 1952 has suggested that it can be prepared synthetically by condensing vanillin with acetone and reducing the double bond in the side chain with sodium amalgam.
It has a molecular weight of 294 and the chemical formula $C_{11}H_{14}O_3$.

Its melting point is $36^\circ C - 37^\circ C$.

Hcilbron and Bunbury, 1953, have suggested the structural formula:

![Zingerone Structural Formula]

**Zingerone:**

It is a constituent of ginger oil having the chemical formula $C_{15}H_{24}O$ and a molecular weight of 220. Mukherjee, 1948 has suggested the following structural formula:

![Suggested Structure of Zingerone]
Zingiberene:

It is a natural hydrocarbon isolated from ginger oil and is always contaminated with bisabolene. It has a molecular weight of 204 and is represented by the formula C₁₅H₂₄. Two structures have been suggested which do not resemble each other. Soffer et al., 1944 suggested the following structure:

\[
\begin{align*}
\text{CH}_3 \\
\text{H}_3\text{C} \\
\text{CH}_3 \\
\text{CH}_3
\end{align*}
\]

**ZINGIBERENE (SOEFFER et al., 1944)**

While, Ruzicka and Van Veen (1929) suggested the following structure:

\[
\begin{align*}
\text{CH}_3 \\
\text{H}_3\text{C} \\
\text{H}_3\text{C} \\
\text{H}_3\text{C}
\end{align*}
\]

**ZINGIBERENE (RUZICKA & VAN VEEN, 1929)**

It is a sesquiterpene hydrocarbon having two isomers α and β - Zingiberene.
Zingiberol:

It is a constituent of ginger oil having a molecular weight of 222. Its formula is C\textsubscript{15}H\textsubscript{26}O, as suggested by Brooks (1916). It is a sesquiterpene alcohol, which is a mixture of $\beta$-cudesmol stereoisomers.

![Zingiberol](image)

Zerumbone:

It has been extracted by fractional distillation as a fraction of the oil of *Zingiber zerumbet*. It is a monocyclic sesquiterpene ketone, having the molecular formula C\textsubscript{15}H\textsubscript{22}O. It is a major constituent of the oil of zerumbet and has been reported to inhibit the growth of *Mycobacterium tuberculosis* and *Micrococcus pyogenes var. aureus* (W.O.I.).

![Zerumbone](image)