Chapter 1

Review on some medicinal plants of Zingiberaceae Family
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1.1. Introduction

Medicinal plants have been used for centuries as remedies for human diseases. Treatments with the use of various plants have historically formed the basis of sophisticated traditional medicine, preceding the established scientific literature by thousands of years. With the advancement of science, the source of the medicinal properties associated with these treatments has been investigated. This quest for understanding has led to an explosion in the last hundred years in the areas of isolation, biological activity, structural elucidation and the chemical synthesis of natural products.¹

Natural products represent a significant source of drug compounds that are currently on the market for the treatment of a variety of diseases and some of them are used as dietary supplements, as dyes, flavouring agents, or ingredients in the cosmetics industry for meeting demand for effective and safer use.

Natural products from plants find application in several therapeutic formulations. These compounds belong to different chemical classes (alkaloids, phenolics, terpenoids, etc.) and have chemically diverse and complex structures. One area of natural product is the study of terpenes, also referred to as terpenoids or isoprenoids. Terpenoids are one of the largest groups of natural compounds identified from diverse sources including plants, microbial sources and marine
sponges. They play an important role in nature, but have also served as a source of naturally occurring medicinal compounds, which in turn provide the basis for the synthesis of biologically active molecules. The terpenoids may be divided into subgroups based on the number of isoprenoid units with molecular formula - \((C_5H_8)_n\). This vast group of naturally occurring substances, contains an immense range of structural diversity (over 200 skeletal types), which includes acyclic, monocyclic, bicyclic, tricyclic and tetracyclic compounds. One of these subgroups, the sesquiterpenes or sesquiterpenoids, possess 15 carbons, derived from the assembly of three isoprenoid units. As with all the other terpene groups, many sesquiterpenes possess biological activities - antimicrobial, antitumour and cytotoxic. The guaianolides represent one of the largest groups of sesquiterpene lactones with over 200 known naturally occurring compound.\(^2\,^3\)

Zingiberaceae family is an important natural resource that provides many useful products for food, spices, medicines, dyes, perfume and aesthetics.\(^4\) It constitutes a vital group of rhizomatous medicinal and aromatic plants characterised by the presence of volatile oils and oleoresins of export value and widely distributed in India, and in tropical and subtropical regions of Asia (specially Thailand, Indonesia and Malaysia). India is one of the richest and diverse regions for Zingiberaceae, having 22 genera and about 170 species. The NE region of India is a zone of greatest concentration where 19 genera and about 88 species are reported.\(^5\) The important genera coming under Zingiberaceae are Curcuma, Kaempferia, Hedychium, Amomum, Zingiber, Alpinia, Elettaria and Costus. Most of the members of Zingiberaceae are found here at wild states,
which are yet to be explored. They are well known for their use in traditional medicine.\textsuperscript{5-11}

Generally, the rhizomes of this family are aromatic, tonic and stimulant. They are rich sources of essential oils that consist of numerous complex terpenoid mixture. Many terpenoids compounds with varied physiological activities - antimicrobial, antiarthritic, antioxidant, anticancer, antiinflammatory, antidiabetic, anti-HIV, neuroprotective and larvicidal etc. have been identified in the essential oils of Zingiberaceous plants.\textsuperscript{12-21}

1.2. Multipotential bioactivities of Zingiberaceae family

Some plants in this family exhibit a wide spectrum of pharmacological properties. Many researchers have reported on different potential bioactivities of different members of Zingiberaceae family.

\textbf{Table 1} The Biological activities of different members of Zingiberaceae family

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Botanical name</th>
<th>Parts used</th>
<th>Bioactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>\textit{Alpinia allughas} (Retz.) Rosc. (Manipuri - Pullei)</td>
<td>Fruits and rhizome</td>
<td>Antioxidant\textsuperscript{22}</td>
</tr>
<tr>
<td>2</td>
<td>\textit{Alpinia galanga} (Linn.) Wild (Manipuri - Kanghu)</td>
<td>Rhizome</td>
<td>Anti-inflammatory\textsuperscript{23}, Antiallergic\textsuperscript{24}, Gastroprotective\textsuperscript{25}, Cytotoxicity\textsuperscript{26}, Neuroprotective effect\textsuperscript{27}, Antioxidant and Antibacterial\textsuperscript{28}</td>
</tr>
<tr>
<td>3</td>
<td>\textit{Alpinia nigra} BURTT. (Manipuri - Pullei)</td>
<td>Tender shoot and rhizome</td>
<td>Flukicidal\textsuperscript{29}, Antimycobacterial\textsuperscript{30}, Free radical scavenger and antibacterial agent\textsuperscript{31,32}</td>
</tr>
<tr>
<td>4</td>
<td>\textit{Alpinia zerumbet} (Pers.) Burtt. et Sm. (Manipuri - Elaichi Achouba)</td>
<td>Rhizome</td>
<td>Psychopharmacological and antioxidant effects\textsuperscript{33}</td>
</tr>
<tr>
<td>No.</td>
<td>Plant Name</td>
<td>Part</td>
<td>Functions</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------</td>
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<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5</td>
<td><em>Amomum aromaticum</em> Roxb. (Manipuri - Kukrubi)</td>
<td>Seeds</td>
<td>Antimycobacterial20</td>
</tr>
<tr>
<td>6</td>
<td><em>Amomum subulatum</em> Roxb.</td>
<td>Pods</td>
<td>Antimicrobial34, anti-inflammatory, analgesic and antispasmodic35</td>
</tr>
<tr>
<td>7</td>
<td><em>Amomum zingiber</em> L. (Hindi - Baba elaichi)</td>
<td>Rhizome</td>
<td>Antibacterial and Antifungal34</td>
</tr>
<tr>
<td>8</td>
<td><em>Costus speciosus</em> Sm. (Manipuri -Khongban takhellei)</td>
<td>Rhizome</td>
<td>Antidiabetic and antilipidemic effect36, Antioxidant37</td>
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<tr>
<td>9</td>
<td><em>Curcuma aeruginosa</em> Roxb. (English - pink and blue ginger)</td>
<td>Rhizome</td>
<td>Anti-androgenic effect38, Antimicrobial50</td>
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<td>10</td>
<td><em>Curcuma amada</em> Roxb. (Manipuri -Yai-heinouam)</td>
<td>Rhizome</td>
<td>Antibacterial40, Cholesterol lowering activity41, Antioxidant and antibacterial42, antitubercular43</td>
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<tr>
<td>11</td>
<td><em>Curcuma angustifolia</em> Roxb. (Manipuri - Yaipan)</td>
<td>Rhizome</td>
<td>Antifungal44</td>
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<tr>
<td>12</td>
<td><em>Curcuma aromatica</em> Salisb. (Manipuri - LamYai)</td>
<td>Rhizome</td>
<td>Inhibition of proliferation of hepatoma45, Anticancer46, Larvicidal activity47, Antioxidant48</td>
</tr>
<tr>
<td>13</td>
<td><em>Curcuma caesia</em> Roxb. (Manipuri –Yaimu)</td>
<td>Rhizome and seed</td>
<td>Anti-inflammatory and anti-asthmatic in ayurvedic medicines49, anti-microbial efficacy of essential oils50</td>
</tr>
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<td>14</td>
<td><em>Curcuma comosa</em> Roxb.</td>
<td>Rhizome</td>
<td>Antioxidant51, Proinflammatory52</td>
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<td>15</td>
<td><em>C. heyneana</em></td>
<td>Rhizome</td>
<td>Anti-inflammatory53</td>
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<tr>
<td>16</td>
<td><em>Curcuma kwangsiensis</em></td>
<td>Rhizome</td>
<td>Anti-tumour54</td>
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<td>17</td>
<td><em>Curcuma leucorrhiza</em> Roxb. (Manipuri - Yai angouba)</td>
<td>Rhizome</td>
<td>Antioxidant and antimicrobial55</td>
</tr>
<tr>
<td>18</td>
<td><em>Curcuma longa</em> L. (Manipuri - Yaingang)</td>
<td>Rhizome</td>
<td>Anti-inflammatory56-57, Antioxidant58, Antifungal59, antibacterial60, anti-HIV61, anti-tumour62, Cytotoxic63, Anti-Arthritic64, Antidepressant activity65, Antiviral effect66</td>
</tr>
<tr>
<td>19</td>
<td><em>Curcuma malabarica</em> Vel.</td>
<td>Rhizome</td>
<td>Antimicrobial67</td>
</tr>
<tr>
<td>20</td>
<td><em>Curcuma wenyujin Y.</em> H. Chen et C. Ling</td>
<td>Rhizome</td>
<td>Anti-influenza68</td>
</tr>
<tr>
<td>No.</td>
<td>Scientific Name</td>
<td>Part Used</td>
<td>Potential Bioactivities</td>
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<tr>
<td>-----</td>
<td>-------------------------------------</td>
<td>---------------</td>
<td>----------------------------------------------------------------------------------------</td>
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<tr>
<td>21</td>
<td>Curcuma xanthorrhiza Roxb.</td>
<td>Rhizome</td>
<td>Antimicrobial(^{69}), Antioxidant(^{70-71}), Antibacterial(^{72})</td>
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<tr>
<td>22</td>
<td>Curcuma zedoaria Rosc. (Hindi - Kakhur)</td>
<td>Rhizome</td>
<td>Anti-inflammation(^{73}), vasorelaxant, hepatoprotective, and inhibitory activity of NO production(^{74-76}), Anticancerous activity(^{77}), anti-angiogenesis effect(^{78})</td>
</tr>
<tr>
<td>23</td>
<td>Elettaria cardamomum Maton (Hindi - Elaichi)</td>
<td>Seeds and pods</td>
<td>Anti-inflammatory(^{79-82})</td>
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<td>24</td>
<td>Hedychium coccineum (Manipuri - Takhellei angangba)</td>
<td>Flower, rhizome and stem</td>
<td>Antibacterial(^{83}), Anti-inflammatory(^{84}), cytokines(^{85}), cytotoxic(^{86})</td>
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<td>25</td>
<td>Hedychium coronarium Koenig. (Manipuri - Takhellei angouba)</td>
<td>Flower, rhizome and stem</td>
<td>Antibacterial(^{87}), Antioxidant(^{88}), Cytotoxic activity(^{89})</td>
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<td>26</td>
<td>Hedychium spicatum SM. (Hindi - Kapoor Kachri)</td>
<td>Rhizome</td>
<td>Anti-allergic(^{90}), Anti-inflammatory(^{91}), Anti-inflammatory(^{95}), Anti-inflammatory(^{96}), Antimutagenic(^{97})</td>
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<td>27</td>
<td>Kaempferia galanga L. (Manipuri - Yaithammanmanbi)</td>
<td>Leaves and rhizomes</td>
<td>Larvicidal activity(^{90-92}), Antibacterial(^{93}), Cytotoxic(^{94})</td>
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<tr>
<td>28</td>
<td>Kaempferia parviflora</td>
<td>Rhizome</td>
<td>Anti-allergic(^{95}), Anti-inflammatory(^{96}), Antioxidant(^{97})</td>
</tr>
<tr>
<td>29</td>
<td>Kaempferia rotunda L. (Manipuri - Leipaklei)</td>
<td>Leaves and rhizomes</td>
<td>Insecticidal(^{98}), antimutagenic activity(^{99})</td>
</tr>
<tr>
<td>30</td>
<td>Zingiber cassumunar Roxb. (Manipuri - Tekhaoyaikhu)</td>
<td>Rhizome</td>
<td>Anti-inflammatory, antiallergic, antioxidant activity(^{100})</td>
</tr>
<tr>
<td>31</td>
<td>Zingiber montanum (Koen.) Link ex A. Dietr. (Manipuri - Tekhaoyaikhu)</td>
<td>Rhizome</td>
<td>Anti-inflammatory activity(^{101}), Antulcer(^{102}), Antioxidant and cytotoxic properties(^{103a})</td>
</tr>
<tr>
<td>32</td>
<td>Zingiber officinale Rosc. (Manipuri - Shing)</td>
<td>Rhizome</td>
<td>Rheumatism and inflammation of liver(^{104-105}), Hepatoprotective effects(^{106}), antioxidative and antimicrobial(^{107})</td>
</tr>
<tr>
<td>33</td>
<td>Zingiber purpureum Rosc.</td>
<td>Rhizome</td>
<td>Antifungal(^{108})</td>
</tr>
<tr>
<td>34</td>
<td>Zingiber zerumbet Smith. (Manipuri - Shingkha)</td>
<td>Rhizome</td>
<td>Anti-cancer, Anti-inflammation, Anti-HIV, Anti-alzheimer's disease, multipotential bioactivities(^{109})</td>
</tr>
</tbody>
</table>
1.3. Uses of some medicinal plants of Zingiberaceae family

Various plants belonging to the family Zingiberaceae are utilized as ornamentals, medicines or food (vegetables or spices). Rhizome extracts of some members of the medicinal Zingiberales are widely used in dietary intake as well as in the traditional system of medicine. In the genus *Alpinia*, *A. galanga* is the most important one, which finds varying uses in ayurvedic preparations such as “Rasnadi powder”. *Costus speciosus* is the only species in the genus *Costus* that is medicinally important. It is valued very much for its diosgenin content. Some Curcuma species are used as different crude drugs. In *Curcuma*, *C. longa* is the most popular one, which has been studied in greater depths already. *C. aromatica* is used in the treatment of skin diseases and is extensively used in vanishing creams. *Kaempferia galanga* has become very popular and is identified to have tremendous effect in curing bronchial and gastric diseases. In *Zingiber*, *Z. officinale* is used as a diet worldwide. Ginger and turmeric rhizomes have approximately 45 and 40% of starch, respectively.\textsuperscript{110, 182-183}

*Alpinia allughas* (Retz.) Rosc.

Young shoots of *A. allughas* are used as vegetables. Inflorescence is usually taken as appetizer. Rhizomes are used in gout and colic.\textsuperscript{18}

*Alpinia galanga* (Linn.) Willd

Inflorescence of *A. galanga* is consumed raw and rhizome is used as medicine. Root extract is abortifacient; fresh rhizome paste is applied to ringworms and skin diseases; rhizomes are stimulant, carminative; used in rheumatism and bronchial catarrh; herb is anti-tubercular; seeds are used for colic, diarrhoea and
vomiting.⁷

*Alpinia nigra* BURTT.

Rhizomes of *A. nigra* is used as vegetable locally and has medicinal properties.

*Alpinia zerumbet* (Pers.) Burtt. et Sm.

The capsule of *A. zerumbet* is used as spice and the rhizome as medicine. It is also grown as ornamental plant.

*Amomum aromaticum* Roxb.

The stem of *Amomum aromaticum* is consumed as vegetable. Rhizome and root extracts have hypoglycaemic and anthelmintic properties.⁵

*Amomum subulatum* Roxb.

Seed powder of *A. subulatum* is used in cough, vomiting, enlarged spleen and diseases of rectum; decoction given in abdominal pain and as a tonic to the heart and liver and also as a gargle in infection of teeth and gums. Rhizome and root extracts have hypoglycaemic properties.⁴ Oil extracted from seed is applied to inflamed eyelids.⁷

*Costus speciosus* Sm.

The rhizomes are useful in burning sensation, flatulence, constipation, helminthiasis, leprosy, skin diseases, fever, hiccough, asthma, bronchitis, inflammation and anemia. It is used to make sexual hormones and contraceptives.⁸

*Curcuma aeruginosa* Roxb.

The rhizomes of *C. aeruginosa* are used in traditional oriental medicine as a gastrointestinal remedy.
**Curcuma amada Roxb.**

The rhizome of *C. amada* (Mango ginger) is used for therapeutic purpose and in the manufacture of pickles, as a source of raw mango flavour. It is also used as an appetizer, alexteric, antipyretic, aphrodisiac and a laxative, stimulant, expectorant, diuretic, carminative and stomachic; rhizome paste is used as plaster in sprains and bone fractures.\(^7\) Rhizome paste mixed with hot water applied in inflammation (due to injuries), itching and skin diseases; decoction given in bronchitis, asthma, constipation and gastric troubles.\(^5\) It is also used in applying on piles and lightening the scars. It can be combined with other medicines to improve the quality of blood.

**Curcuma angustifolia Roxb.**

The rhizome is also used in commercial pickles. The inflorescence of *C. angustifolia* is used in the preparation of an indigenous curry Iromba by Manipuris. Rhizome paste is applied in leprosy, leu-coderma, burning sensations; decoction is given in asthma, jaundice, dyspepsia, kidney stones and anaemia.\(^5\)

**Curcuma aromatica Salisb.**

*C. aromatica* rhizomes are used as tonic, carminative, and externally in combinations with astringents, bitters and aromatics to bruises, in sprains and in snake-bite. Rhizome paste/powder is used externally in leukoderma, scabies and small pox; considered useful in blood diseases; juice is given orally as a strong remedy against rheumatism and also (mixed with juices of other gingers) administered for smooth delivery in N.E. India.\(^5\)
**Curcuma caesia Roxb.**

The rhizome of *C. caesia* is used externally for sprains and bruises, leukoderma, piles; decoction is given in asthma, epilepsy, tuberculous gland of the neck and with other ingredients given in weakness after child birth; juice is rubbed on the body in jaundice; boiled and eaten in N. E. India. For curing wounds, pimples, allergies, raw paste of rhizomes is applied externally. For migraine, 2 – 4 drops of fresh juice is poured in nose. For longevity, impotence, infertility, irregular menstrual flow, a spoonful powder from dried rhizomes is mixed with a spoonful of honey or a cup of milk is taken twice a day. For gastric troubles, a fresh piece of rhizome is chewed.

**Curcuma comosa Roxb.**

The rhizome of *C. comosa* has been used extensively in indigenous medicine and as an anti-inflammatory agent for treating postpartum uterine bleeding. It has also been widely used as an aromatic stomachic.

**Curcuma heyneana**

A slurry prepared from fresh rhizomes of *C. heyneana* is used to treat skin diseases; its crude extract is used to treat fatigue, helminth infections, obesity, and rhumatism; and its pulverized form is used as a component in beauty treatments.

**Curcuma leucorrhiza Roxb.**

The rhizomes of *C. leucorrhiza* are used in Singbhum, Bihar for treatment of enlarged liver and spleen, and ulcer in stomach.
**Curcuma kwangsiensis**

The rhizomes of *C. kwangsiensis* is used as a digestive and analgesic agent, and also for the treatment of menstrual disorders.\(^{54}\)

**Curcuma longa L.**

*C. longa* Linn. is extensively used as a spice, food preservative and colouring material commonly used in the Indian subcontinent. Since the time of Ayurveda (1900 BC) numerous therapeutic activities have been assigned to turmeric for a wide variety of diseases and conditions, including those of the skin, pulmonary, and gastrointestinal systems, aches, pains, wounds, sprains, and liver disorders.\(^{113}\)

**Curcuma malabarica Vel.**

The rhizomes of *C. malabarica* are used as starch which is reported to have medicinal properties.\(^{67}\) Starches extracted from this plant are used in diets for infants and convalescents due to their cooling and demulcent properties.

**Curcuma wenyujin**

The rhizomes of *C. wenyujin* are used as a Traditional Chinese Medicine (TCM) for the treatment of jaundice, thoracic-abdominal pain, arthralgia, hematuria, dysmenorrhea, epilepsy and psychataxia.\(^{68}\)

**Curcuma xanthorrhiza Roxb.**

The inflorescence of *C. xanthorrhiza* is consumed as vegetable by the Manipuri and also applied to bruises and sprains. Fresh root checks leucorrhoeal and gonorrheal discharges and purifies blood.
*Curcuma zedoaria* Rosc.

The rhizome of *C. zedoaria* has been used as a stimulant, stomachic, carminative, diuretic, anti-diarrheal, anti-emetic, anti-pyretic, and depurator, and also as an ointment for ulcers, wounds, and other skin disorders.\(^{114}\) The product ‘Zedoary’, used as a tonic and in perfumery, is obtained from the tubers of *C. zedoaria*.

*Elettaria cardamomum* Maton.

Seeds of *E. cardamomum* is used as spice. Seeds are used in the treatment of asthma and diseases of throat, liver, heart and kidney; they are well known for use as a masticatory, spice and condiment.\(^{5}\) Seed extracts are carminative, aromatic stimulant and diuretic.

*Hedychium coccineum*

*H. coccineum* is grown as ornamental plant. Flower is also offered in religious ceremonies by the Meiteis.

*Hedychium coronarium* Koenig.

The rhizomes of *H. coronarium* are used for the treatment of inflammation, skin diseases, headache, and sharp pain due to rheumatism in traditional medicine.\(^{11}\) Pharmacological studies have shown that an extract of *H. coronarium* has anti-inflammatory and analgesic effects in an animal model.\(^{115}\)

*Hedychium spicatum* SM.

The rhizome of *H. spicatum* in powder form is sprinkled as an antiseptic agent and also used as a poultice for various aches and pains. It is used as a carminative, stimulant, tonic and in dyspepsia, as well as in veterinary medicine.
It is also useful in liver complaints, as an expectorant and in urinary disorders.

Abir, the famous scented powder, is prepared from *H. spicatum*.

**Kaempferia galanga L.**

The rhizome of *K. galanga* has been used traditionally for the treatment of many ailments, such as stimulant, expectorant, diuretic and carminative. It is also employed in cosmetics, mouth-washes, hair tonics and toiletries.

**Kaempferia parviflora**

The rhizomes of *K. parviflora* have been used for the treatment of colic disorder and for peptic and duodenal ulcers.

**Kaempferia rotunda L.**

Rhizomes are used as an indigenous hair lotion. It is used for the treatment of swelling and healing of fresh wounds; used in abdominal pain and gastric troubles.

**Zingiber cassumunar Roxb.**

The rhizome of *Z. cassumunar* is used for the treatment of asthma, diarrhoea, colic. It is also used as a stimulant, carminative; and given as antidote to snake bite.

**Zingiber montanum (Koen.) Link ex A. Dietr.**

The rhizome of *Z. montanum* is given in diarrhoea, colic and used as a stimulant, carminative; used for flavouring food preparation and substituted for true ginger; also given as antidote to snakebite. Rhizome is used to treat fevers and intestinal disorder; various lotions and decoctions applied to swellings, rheumatism, bruise, numb feet, and painful parts. Traditional medicinal
practitioner uses this rhizome in the treatment of piles and cough in Manipur.

**Zingiber officinale Rosc.**

Ginger, the rhizome of *Z. officinale* Roscoe as a traditional medicine is used for management of such symptoms as the common cold, digestive disorders, rheumatism, neuralgia, colic and motion-sickness, as well as being an important spice to flavor foods and beverages. It has also been used as an antioxidant, antimicrobial, and antifungal agent.\(^{107}\) 6-Gingerol, the major gingerol in ginger rhizomes, has been found to possess many interesting pharmacological and physiological activities.

**Zingiber purpureum Rosc.**

Rhizomes are used against paralysis; and used as a neural or muscular stimulant.

**Zingiber zerumbet Smith.**

*Z. zerumbet* is used in the treatment of cough, asthma, worms, leprosy and other skin diseases. Rhizomes are used as spice and condiment. It has been used for the treatment of stomach ache, toothache, fever, sprain and indigestion. Young rhizome with pseudostem is used as vegetable.\(^ {109}\)

1.4. Some bioactive compounds isolated from Zingiberaceae family

The rhizomes of some medicinal plants of this family have been widely studied for the bioactive compounds present in them. Ten species have been also identified to possess various bioactive molecules.\(^ {103b}\) Numerous terpenoids compounds have been identified in the Zingiberaceous plants with varied physiological activities.\(^ {181}\)
Table 2. Biological activities of some *Curcuma* sesquiterpinoids

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Compound</th>
<th>Biological activity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bisabolane type sesquiterpinoids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Bisacurone</td>
<td>Anti-inflammatory, antioxidant,</td>
<td>116</td>
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<tr>
<td>2</td>
<td>4-Methoxy-5-hydroxy-bisabola-2,10-diene-9-one</td>
<td>Antileishmanial activity</td>
<td>116</td>
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<tr>
<td>3</td>
<td>Turmeronol</td>
<td>Anti-inflammatory</td>
<td>117-118</td>
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<tr>
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<td>Xanthorrhizol</td>
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<td>Zingiberene</td>
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<td>Curcumeneone</td>
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<td>Curcumadione</td>
<td>Antioxidant, hepatoprotective</td>
<td>137, 139</td>
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<td>Diphenylheptanoids</td>
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<td>7</td>
<td>bis-Demethoxycurcumin</td>
<td>Anti-cancer</td>
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<td>8</td>
<td>Curcumin</td>
<td>Antioxidant, anti-inflammatory, anti-cancer, hepatic fibrosis in type 2 diabetes mellitus, suppression of cholesterol</td>
<td>58, 60, 140-149, 179-180</td>
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<td>Germacrane type Sesquiterpinoids</td>
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<td>Curdione</td>
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<td>68, 150-152</td>
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<td>Dehydrocurdione</td>
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<tr>
<td>11</td>
<td>Furanodienone</td>
<td>Anti-inflammatory, anticancer</td>
<td>156-159</td>
</tr>
<tr>
<td>12</td>
<td>Isofuranodienone</td>
<td>Antimicrobial</td>
<td>137</td>
</tr>
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<td>13</td>
<td>Glechomanolide</td>
<td>Cytotoxic</td>
<td>137,139,160-161</td>
</tr>
<tr>
<td>14</td>
<td>Germacrone</td>
<td>Antiplasmodial, anti-inflammatory, antitumor, antiandrogenic, antimicrobial, cytotoxic, platelet derived growth factor inhibitor</td>
<td>162-165</td>
</tr>
<tr>
<td>15</td>
<td>(4S,5S)-Germacrone-4,5-epoxide</td>
<td>CYP3A4-Inhibition, p450-Inhibitor</td>
<td>160</td>
</tr>
<tr>
<td>16</td>
<td>Neocurdione</td>
<td>Hepatoprotective</td>
<td>137,139,151,164-165</td>
</tr>
<tr>
<td></td>
<td>Compound</td>
<td>Properties</td>
<td>References</td>
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<td>-------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>17</td>
<td>Zederone</td>
<td>Anti-inflammatory, antivenum, antiandrogenic, anti-cancer</td>
<td>137, 153-154, 156-157</td>
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<tr>
<td>18</td>
<td>Zederone epoxide</td>
<td>Anti-inflammatory, antioxidant</td>
<td>137, 156</td>
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<tr>
<td>19</td>
<td>Guaiane type Sesquiterpenoids</td>
<td></td>
<td></td>
</tr>
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<td>20</td>
<td>Aerugidiol</td>
<td>Anti-influenza, cytotoxic, liver injury, inhibited protein tyrosine phosphatase 1B</td>
<td>68, 137, 151, 165-166, 177</td>
</tr>
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<td>21</td>
<td>Alismoxide</td>
<td>Anti-influenza, antiallergic, anticomplementary activity, antiallergic</td>
<td>68, 137, 167-170</td>
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<tr>
<td>22</td>
<td>Curcumenol</td>
<td>Anti-influenza, hepatoprotective, COX2 inhibitor, antiandrogenic, analgesic, antioxidant</td>
<td>68, 151, 158, 165, 171-173, 178</td>
</tr>
<tr>
<td>23</td>
<td>Epiprocumenedol</td>
<td>Anti-inflammatory, inhibited protein tyrosine phosphatase 1B</td>
<td>137, 164, 174-175, 177</td>
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<tr>
<td>24</td>
<td>Isoeocurcumenol</td>
<td>Antiviral, antiandrogenic, platelet derived growth factor inhibitor</td>
<td>151, 153, 156, 165, 171</td>
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<tr>
<td>25</td>
<td>Isoisocumenedol</td>
<td>Antitumor</td>
<td>139, 164</td>
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<td>26</td>
<td>Procurcumadiol</td>
<td>Antimicrobial</td>
<td>153</td>
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<tr>
<td>27</td>
<td>Procurcumenol</td>
<td>Radical scavenging</td>
<td>164, 175</td>
</tr>
<tr>
<td>28</td>
<td>1α,8β-epidioxy-4α-hydroxy-5αH-guai-7(11),9-dien-12,8-olide</td>
<td>Anti-influenza</td>
<td>68</td>
</tr>
<tr>
<td>29</td>
<td>Guai-1(10),5,7(11),8-tetradien-12,8-olide</td>
<td>Antioxidant</td>
<td>176</td>
</tr>
</tbody>
</table>
(E)-labda-8(17), 12-diene-15, 16-dial  (E)-8b,17-Epoxylabd-12-ene-15,16-dial
(Antibacterial$^{32}$)

Heyneanone A
(inhibited protein tyrosine phosphatase 1B$^{177}$)

Curcumenone (Hepatoprotective$^{138}$)

enol-form

keto-form

1  R$_1$=R$_2$=OCH$_3$(curcumin)
2  R$_1$=H, R$_2$=OCH$_3$ (demethoxycurcumin)
3  R$_1$=R$_2$=H  (bis-demethoxycurcumin)

1α,8β-epidioxy-4α-hydroxy-5αH-guai-7(11),9-dien-12,8-olide
(anti-influenza$^{68}$)

Xanthorrhizol$^{119-135}$
Zerumbone
(anti-cancer\textsuperscript{109})

Dehydrocardinone
(Antiinflammatory\textsuperscript{135})

7-hydroxy hydichinal
(cytotoxic\textsuperscript{89})

Spicatanoic

7β-hydroxy-(E)-labda-8(17),12-diene-15,16-dial (Cytotoxicity\textsuperscript{86})

Kaempferol

Figure 1. Molecular structures of some of the bioactive compounds of Zingiberaceae family
1.5. Conclusion

Zingiberaceae family is well-known for its medicinal and economic significances. Many species are used as sources of indigenous medicines, vegetables, food flavours, spices, dyes, condiments as well as ornamentals. This family is widely known for its broad range of pharmacological activities. To study on its compounds offers many opportunities to investigate the various functions and prospects in various pharmaceutical studies. It becomes more evident about its potential from the bioactivities reviewed above based on the work of various researchers.
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