



## Diversity of plants of Zingiberaceae family and their ethnomedicinal use in Northern coastal Odisha, India

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### Abstract

Zingiberaceae is the largest family of the order Zingiberales and plants of the family are mostly distributed throughout the tropics and sub tropics the world. Being aromatic and rich in diverse bioactive compounds plants of this family are economically, ethnomedicinally and pharmaceutically very important. Apart from their traditional use as spices, food, ethnomedicine, dyes, perfume etc., they have got a huge future potential in new drug development due to their antimicrobial, anti-inflammatory, anti-diabetic, anti-cancer and antioxidant characteristics. In the present study, the diversity of the plants of Zingiberaceae family has been studied in an underexplored region of Northern coastal Odisha and the ethnomedicinal practices associated with these plants in the region were also documented. Ten species of the family have been identified in this study including *Curcuma amada* Roxb., *Curcuma angustifolia* Roxb., *Curcuma aromatica* Salisb., *Curcuma caesia* Roxb., *Curcuma Longa* L., *Hedychium coronarium* Koenig., *Kaempferia galanga* L., *Zingiber montanum* (Koenig.) Link ex A. Dietr., *Zingiber officinale* Rosco. *Zingiber zerumbet* (L.) Smith. Out of these plants, only two species i.e., *C. Longa* L. and *Z. officinale* Rosco. are commercially cultivated, whereas, remaining ones are gradually losing their ethnic and economic importance due to the fading ethnobotanical knowledge in the younger generation. Awareness about these species is highly essential for their much-needed conservation for the posterity

**Keywords:** Herbal medicine; Antimicrobial property; Bioactive compounds; Kuldiha wild life sanctuary; Eastern Ghats hills.

### Introduction

Zingiberaceae is the largest family of order Zingiberales with about 50 genera and more than 1600 species which are widely distributed throughout the tropics and sub tropics of Asia, Africa, Australia and America (Kress *et al.*, 2002; Jena *et al.*, 2020). Major genera of Zingiberaceae family include *Alpinia* (225 species), *Globba* (100 species), *Amomum* (90 species), *Zingiber* (80 species), *Renealmia* (70 species), *Curcuma* (54 species), *Boesenbergia* (50 species), *Hedychium* (40 species) etc. (Hartati *et al.*, 2014). The systematic position of Family Zingiberaceae is as follows:

“Kingdom-Plantae  
Sub kingdom-Tracheobionata  
Super division- Spermatophyta  
Division- Magnoliophyta  
Class- Magnoliopsida  
Sub class-Zingiberadeae  
Order-Zingiberales

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### Family- Zingiberaceae (Ansar *et al.*, 2020)”

India is one of the richest regions of Zingiberaceae having nearly 20 genera and around 200 species (Kumar *et al.*, 2013). Plants of Zingiberaceae family are found along the length and breadth of the country i.e., they can grow in diverse landforms and climatic conditions including the coastal area to high altitude of Western Ghats and Himalayas. Furthermore, some grow as schiophytes whereas some prefer to grow under direct sun light at high boost. Though plants of Zingiberaceae family are distributed throughout India, the North-East region has been reported to host the highest diversity of plants of the family including 19 genera and about 88 species (Ved and Mehrotra, 1995). Yet many regions of India need scientific survey for systematic documentation of the diversity of the plants of Zingiberaceae family. One such poorly documented region of India is the northern coastal tracts of Odisha along the Bay of Bengal. The state of Odisha in India with diverse topography and climatic conditions is endowed with rich biodiversity. The Northern Coastal region of Odisha in particular, harbors various ecologically significant regions such as stretches of Eastern Ghats hills and a varieties of fluvio-marine land forms including estuaries, mudflats, beaches, and alluvial plains along the nearly 100 km long coast line roughly ranging from the Surbarnarekha river estuary in the North to the Dhamara river estuary in the south. Of late, scientific surveys have been carried out in this region on the diversity of medicinal plants and their ethnomedicinal uses and gradually research findings are published in recent times (Panda *et al.*, 2013; Panda *et al.*, 2016; Mishra *et al.*, 2015; Mohapatra *et al.*, 2018). However, studies on the medicinal plants of Zingiberaceae family which are frequently used in ethnomedicinal practice are extremely rare from the region.

A significant fraction of the world's population in the developing countries depends on traditional medicine for their primary health care. Therefore, scientific documentation of the ethnomedicinal practices of any region is the need of the time to maintain the sustainability of these practices. Moreover, documentation of indigenous medicinal knowledge of plant species has contributed to a number of modern drug formulations for basic health care (Cox, 2000; Bibi *et al.*, 2014). In the above context, the broad objective of this work is to study the diversity of the medicinal plants of Zingiberaceae family growing in the Northern coastal Odisha and to document the ethnomedicinal practices associated with these plants in the region.

### Study area

Odisha is an eastern state of India which is located along the coast of Bay of Bengal. The northern region of the state consists of three districts viz. Bhadrak, Balasore and Mayurbhanj of which Bhadrak and Balasore are present in the coastal belt of Odisha. Present study was endeavoured in these two coastal districts of Odisha (Fig. 1). These two districts of Balasore and Bhadrak are associated with varied landforms including number of estuaries, mudflats, backwaters, sandy beaches, coastal plains and fragmented Eastern Ghat hills. This coastal tract of Northern Odisha is rich in biodiversity which are yet to be explored and documented. The northern coastal plain comprises the deltas of the Subarnarekha, the Budhabalanga and the Brahmani-Baitarani-Dhamara rivers and bears evidences of marine transgressions. Further, this region harbours three protected areas for wildlife including a sanctuary (Kuldiha), a National Park cum Ramsar Site (Bhitarkanika) and a Marine Sanctuary (Gahirmatha). The region is home to unique biotic resources including mangrove flora, seaweeds, medicinal herbs, etc. which need timely effort for their much-needed conservation.

Tropical monsoon climate prevails over the region. The summers have good amount of rainfall whereas the winters have little. Thus, normally three seasons are felt throughout the year i.e., summer (March -mid June), rain (mid-June- mid October) and winter (mid October-February). The temperature varies from 42°-10°C and the average rainfall amount is nearly 1600 mm. The total area of both the districts is nearly 2505 km<sup>2</sup> with a population of 1.507 million (2011 Census).

### Methodology

#### Field survey

Ethnobotanical survey involves interaction with the local people to know about the plants and their medicinal uses, so that the traditional knowledge about the plants is transferred from old to new generation through scientific documentation. In order to know the distribution pattern and natural habitat of Zingiberaceae plants, field surveys were conducted throughout the study region during the flowering season of Zingiberaceae i.e., during the month of July to October during the year from 2017- 2010. The plant species were identified preliminarily by the local aged persons and local experts and then it was confirmed with the help of regional

flora books (Haines, 1921; Saxena and Brahman, 1994-96). For documentation of the traditional ethnomedicinal knowledge of local communities of the study region, questionnaire was developed which mainly aimed to record the plant parts used, modes of drug preparation and their doses with respect to any disease. During the field visits questionnaire programmes were held among the experienced persons and local healers (*Kaviraj* and *Vaidyas*) among which more than 80 % were above 50 years old and remaining 20 % were between 30 to 50 years old.

### Plant processing

Plants and rhizomes specimens of Zingiberaceae family were collected from different parts of the study region. Photographs of these plants and their fresh rhizome were captured which are shown in Figure 2. The collected plants or the rhizomes were planted in the garden of the Department of Environmental science Fakir Mohan University, Balasore, Odisha for further taxonomical studies. Few parts of the collected rhizomes were washed properly and dried under shade for further experiments and for the preparation of drugs suggested by local people. The dried rhizomes were carefully maintained to keep them free from any microbial contamination.

### Result and Discussion

The field survey in the study region recorded 10 number of plant species of Zingiberaceae family. These are *Curcuma amada* Roxb., *Curcuma angustifolia* Roxb., *Curcuma aromatica* Salisb., *Curcuma caesia* Roxb., *Curcuma Longa* L., *Hedychium coronarium* Koenig., *Kaempferia galanga* L., *Zingiber mantanum* (Koenig.) Link ex A. Dietr., *Zingiber officinale* Rosco. and *Zingiber zerumbet* (L.) Smith. Brief description of each of the plant species along with their ethnomedicinal usage has been summarized in table 1 and discussed in the following sections.

#### **Curcuma amada Roxb.**

It is an herb with aromatic rhizome [Fig-2a]. The plant is up to 1 m height, bearing inflorescence from the middle of the leafy tuft. The root stock is small with root fibres which end with tubers (nodulose). Rhizomes smell like unripen mango and whitish-yellow colour. Leaves are oblong-elliptic, nearly 40-63 × 15-20 cm in dimension. Flowers are longer than bract and white or pale-yellow colour, exerted. Usually flowering occurs in month of Aug-Nov. Labellum exceeds the corolla and ovaries are three celled with many ovules.

*C. amada* commonly known as mango ginger and locally known as *Amba ada* is used as a flavouring agent in pickle, curry, soups and various street food preparations. Fresh rhizome paste is applied externally for the treatment of piles and to cure wounds and skin irritation. Rhizome paste with pepper seed paste is applied for the treatment of joint pain. The rhizome is frequently used in ethnomedicinal practices in other parts of India too. In Arunachal Pradesh, Manipur, Assam and Mizoram the paste and the extract of rhizome is used as to treat bronchiolitis and also used as a carminative and vulnerary (Basak *et al.*, 2010). In Manipur rhizome is used as a cooling agent and applied on sprain (Devi *et al.*, 2014).

Near about 68 volatile aroma compounds are present in *C. amada* among which car-3-ene and cis-ocimene is the cause of unripe mango flavour which is the most peculiar character of this species (Srivastava *et al.*, 2001; Singh *et al.*, 2003a, b; Mustafa *et al.*, 2005; Policegoudra *et al.*, 2011). Hexane, chloroform, ethyl acetate, acetone and methanol extracts from the dried rhizome are highly antibacterial against *Bacillus cereus*, *B. subtilis*, *Micrococcus luteus*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Enterococcus faecalis* and *Salmonella typhi* (Policegoudra *et al.*, 2007a, b).

#### **Curcuma angustifolia Roxb.**

*C. angustifolia* Roxb. is a perennial herb with pale yellow starchy rhizome [Fig-2b]. Plant height is nearly 1.5 to 2 m. Leaves are narrowly lanceolate, gradually acuminate towards the tip, thick & glabrous to touch and 16-42 × 7-13 cm in size. Rootstocks are prominent, rhizomes are small or mostly absent and root fibres end with tubers. Peduncles are covered with coloured sheath. Spikes terminate with deep magenta coloured coma bracts. Flowers are exerted, 4 cm long and white-yellow in colour and bloom in the month of May.

It is known as East Indian arrowroot and locally called *Palua* or *Drusti gada*. The plant and its products are variously used by the local people. Rhizome powder with water is given to children for easy digestion and against oral infection. The rhizome starch with milk is given to children and sick persons as a nutritional diet. Rhizome paste is used to cure dysentery. Rhizome juice is taken twice a day for 15 days for soothing coughs and against bronchitis. Young inflorescence is also used as food. In Arunachal Pradesh, Nagaland and Assam

the rhizome starch with milk is given to children as tonic and the rhizome paste is rubbed on the injuries of cattle caused by leech (Basak *et al.*, 2010). The inflorescence and rhizome are taken as vegetable and food flavouring agent (Devi *et al.*, 2014). In the Koraput district of Odisha the tuber powder is taken with water during indigestion, diarrhoea and other stomach disorders (Padhan and Panda, 2016).

Several medicinal properties of the plant like antioxidant, antimicrobial, anti-cancerous, hepato-protective and anti-inflammatory activities are attributed to the presence of several bioactive compounds like curzerenone,  $\gamma$ -eudesmol acetate, and germacrone (Jena *et al.*, 2020). The antioxidant activity of essential oil of *C. angustifolia* might be due to occurrence of major oxygenated sesquiterpenes constituents like epicurzerenone, curzerenone, neocurdione,  $\alpha$ -caryophyllene,  $\beta$ -elemene,  $\beta$ -eudesmol, and germacrone (Zhao *et al.*, 2010; Zhang *et al.*, 2017).

### **Curcuma aromatica Salisb.**

It is an annual herb with aromatic starch yielding rhizome [Fig-2c]. Plant height is up to 1.5 m. Rootstocks are prominent with robust branched rhizomes up to 3.5 cm diameter and light yellow inside. Root fibres end with tubers. Leaves are young at the time of flowering, mature leaves lanceolate-oblong, puberulous beneath. Inflorescence is lateral to the leaf tuft and bloom in May. Peduncle 11-17 cm; spike 16-21 cm long and 7-11.5 cm diameter; fertile bracts green, 5-6 cm long and tip rounded; coma bracts pink and about 6 cm long. Labellum is yellow and ovate. Stamminodes are present and ovary hairy.

*C. aromatica* Salisb. commonly known as white turmeric or wild turmeric has same vernacular name with that of *C. angustifolia* Roxb. i.e. *Palua*. The ethnomedicinal uses of both the herbs are also similar in the study region. The starch yielded from the rhizome is consumed with milk or water as easily digestible nutritional diet. Rhizome juice used to cure oral infection and bronchitis. Rhizome powder is used for the treatment of dysentery, diarrhoea, loose motion and other stomach disorders. Rhizome paste is applied for 30 days against leukoderma. Young inflorescence is also used as vegetable. Traditionally all parts of plant are used for purification of blood in Arunachal Pradesh and the rhizome paste with milk is consumed to treat blood dysentery and stomach pain (Kala, 2005). The rhizome paste with water is given to kill intestinal worm in Arunachal Pradesh, Assam, Manipur and Meghalaya (Basak *et al.*, 2010). In Tripura the rhizome is used for the treatment of flatulence and skin infection (Chakraborty *et al.*, 2012). Rhizome is used as tonic externally to cure sprains in Koraput Odisha (Pradhan and Panda, 2016).

GC-MS analyses of rhizome oil by Xiang *et al.*, (2017) has revealed nearly 78 bioactive constituents and the dominant compounds are 8,9-dehydro-9-formyl-cycloisolongifolene, germacrone, ar-turmerone, turmerone, ermanthin,  $\beta$ -sesquiphylloandrene and ar-curcumene. Essential oils of the rhizomes of the plants are more effective against fungi than bacteria and it also exhibits anti-tumour, anti-oxidant and anti-inflammatory activities (Xiang *et al.*, 2017).

### **Curcuma caesia Roxb.**

*C. caesia* is an herb with aromatic rhizomes [Fig-2d]. Rootstocks are prominent with thick root fibres that end up with tubers. The transverse section of the fresh rhizome show blue colour pigmentation in the shape of a ring. Plant height is about 1-1.5 m with lanceolate glabrous leaves having a deep purple shade in the middle of the leaf blade, size 50-60  $\times$  12-15 cm. Flowering bracts are green with a brownish red tinge whereas the coma bracts are deep bright purple. Flowers are pale yellow, reddish to the outer border and are shorter than their bracts. Flowering occurs in the month of May and June.

*C. caesia* is commonly known as black turmeric and locally known as *Kala haladi* or *Gada*. The rhizome paste with water is given to babies to get relief from stomach pain and also applied externally on the belly as a cooling agent. Rhizome paste is also used to treat oral infection and poisonous insect bite wounds. In Arunachal Pradesh, Assam, Mizoram the dried rhizome powder with the seed powder of *Andrographis paniculata* is applied to treat snake, insect and scorpion bite. Rhizome paste is applied for wound healing. Fresh rhizome juice with mustard oil is also consumed daily to avoid dysentery (Basak *et al.*, 2010). In Manipur rhizome is taken in the healing of cold, sprain and bruises (Devi *et al.*, 2014). The rhizome is used to treat bone fracture in West Bengal (Bose *et al.*, 2015).

Pandey and Chowdhury, (2003) have reported nearly 30 constituents including camphor, ar-turmerone, (Z)- $\beta$ -ocimene, ar-curcumene, 1,8-cineole,  $\beta$ -elemene, borneol, bornyl acetate,  $\gamma$ -curcumene etc. representing 97.48% of the oil. These bioactive compounds are responsible for various pharmacological properties like



antimicrobial, antioxidant, anti-inflammation, anticancer, hepato protective, diuretic and antiasthma activities of the rhizome of *C. caesia*.

### **Curcuma longa L.**

*C. longa* is a strongly aromatic herb with rhizomes which are deep orange yellow within [Fig-2e]. Plant height is around 1-1.5 m. Well developed root stock and nodulose roots are present. Leaves are also aromatic, oblong, glabrous, size 50-60 × 12.5-14.5 cm. Inflorescence is central to the leaf tuft and appearing with the leaves once the plants mature. Spikes are short with white coma bracts and usually bloom in the month of August. Flowers are few, yellow in colour and not exerted. Labellum is ovate, lateral staminodes are large and ovary is hairy at the top.

*C. longa* commonly known as turmeric and locally known as *Haladi* is very frequently used as a flavouring substance and as an ethnomedicine. Raw rhizome paste in form of a tablet is consumed daily for seven days for the treatment of intestinal worm infection in children. The paste of rhizome with coconut or mustard oil is used to get rid of any type of skin problem like burning, rashes, pimple, itching, cutting and also is applied with water, milk or milk cream for fairness and natural glow. Further, the turmeric paste is applied to clear the scars and dark spot of chickenpox and measles. The raw rhizome paste is also traditionally used as contraceptive pill by women. The leaf is used for the preparation of a traditional steam cake locally known as *Enduri pitha*. Apart from being used as a colouring and flavouring agent in culinary practices the turmeric power is also used as an antimicrobial preservative agent in homemade pickles. Turmeric is diversely used in ethnomedicine in other parts of India. In the North Eastern states of India, the crushed rhizome is taken orally before food and rhizomes are chewed for the treatment of asthma (Basak *et al.*, 2010). In Tripura the rhizome paste is applied in skin infection and rhizome juice is medicated for the treatment of Jaundice and menstrual period problems (Chakraborty *et al.*, 2012). Turmeric is also used to treat snake bite by the tribes of Koraput, Odisha (Raut, *et al.*, 2012). The tribes of Mayurbhanj, Odisha use rhizome paste in nasal bleeding and skin irritation (Rout & Panda 2010). The paste of fresh rhizome with equal amount of sugar candy is consumed in empty stomach with cold water for 21 days to cure blood setting piles (Rout *et al.*, 2009).

*C. longa* is cultivated throughout India Recently turmeric nano fibres have been developed which show effective antimicrobial activities against *Bacillus cereus*, *Escherichia Coli*, *Salmonella typhimurium* and *Staphylococcus aureus* and also possess good antioxidant activity and therefore it has potential application in different fields like pharmaceutical, nutraceuticals, components for food industries and bio-nano-composites (Gopi *et al.*, 2019). *C. longa* exhibits several medicinal properties like antioxidant, antimicrobial, anticancer, and anti-inflammatory etc. due to the presence of many valuable bioactive compounds (Bhutia and Sarangi 2017) which include Ar-Turmerone, Curlone,  $\alpha$ -Phellandrene, Eucalyptol,  $\beta$ -Himachalene,  $\alpha$ -Copen-11-ol etc. as identified by GCMS analysis (Sahoo *et al.*, 2019).

### **Hedychium coronarium Koenig.**

It is a perennial rhizomatous aromatic herb with conspicuous flowers [Fig-2f]. Plant is around 1-1.25 m high with distichously arranged lanceolate sessile leaves. Leaves are thin and silky in texture, size 20-45 × 2.5-6.5 cm. Inflorescence is terminal on a leafy stem in form of a strobilus (conical) spike, size 10-16.5 cm. Flowers are fragrant and white in colour. Calyx 3-3.5 cm long, sparsely hairy. Stamens do not much exceed the labellum and lateral staminodes oblong. Flowering occurs in the month of July-August.

*H. coronarium* Koenig. is commonly known as “white ginger lily” or “butterfly ginger” and locally known as *Torani* or *Gada*. Though mostly used as ornamental species, few respondents revealed their ethno-medicinal use in the study region. The fresh rhizome paste is used in the treatment of rheumatism. The rhizome extract is taken to cure diarrhoea and paediatric abdominal pains. Decoction of fresh rhizome or leaves is used for gargling to treat oral infection, tonsillitis and bad breath. Pradhan & Panda, (2016) have reported that tribes of Koraput district of Odisha use the rhizomes as vegetable during food scarcity and also use to treat rheumatism and loose motion. The rhizome paste is applied to cure body ache in Arunachal Pradesh (Kala, 2005). In Arunachal Pradesh and Mizoram local people use the extracts and paste of flower, rhizome and leaf as tonic, febrifuge, mild tranquiliser (Basak *et al.*, 2010). In Manipur local people use this rhizome as anti-vomiting ingredient (Devi *et al.*, 2014).

The presence of different class of organic polymeric molecules including alcohol, amine, flavonoid, phenols, alkanes, alkynes, halides, catholic acid, inorganic ions, nitrogenous compounds and ethers in *H. coronarium*

have been confirmed by FTIR spectra method (Pachurekar and Dixit, 2018). GC-MS analysis of the essential oils in the leaves and rhizome of *H. coronarium* was characterized by the presence of various bio active compounds like  $\beta$ -pinene, linalool, 1,8-cineole,  $\alpha$ -pinene  $\alpha$ -terpineol,  $\alpha$ -humulene and  $\beta$ -caryophyllene (Van Thanh *et al.*, 2014).

### **Kaempferia galanga L.**

It is a small aromatic herb with very short or almost no stems [Fig-2g]. Delicately aromatic rounded rhizomes with vertically oriented prominent root stock and tuberous roots are present. Leaves are thick, suborbicular, deep green in colour and usually lay flat on the ground in a rosette partially overlapping each other. Flowers (corolla and staminodes) are pearly white with purple spot on each side. Corolla is shorter than bracts and anthers are sessile with 2 small rounded lobes.

*K. galanga* is commonly known as kencur or resurrection lily or aromatic ginger and locally known as *Saparakachu*. Flakes of dried rhizome are chewed as a post meal digestive and for the treatment of sore throats, bleeding gum and toothache. Dried rhizome flakes are also consumed with *paan* as flavouring agent. The ash of leaves is applied on swollen breast after child birth for couple of weeks. The rhizome powder is used to avoid dandruff and scab form head traditionally in Arunachal Pradesh and Assam (Basak *et al.*, 2010). Rhizome juice is taken orally during malaria, indigestion and fever by the tribes of Koraput (Pradhan and Panda, 2016).

GC-MS analysis of the essential oils in the rhizome has revealed the presence of two major constituents i.e. trans-ethyl-p-methoxycinnamate and trans-ethyl cinnamate along with other important chemical compounds such as  $\delta$ -3-carene, 1,8-cineole, borneol, pentadecane which are responsible for most of the pharmacological properties of the plant such as antimicrobial, anti-neoplastic, mosquito repellent, nematocidal, anthelmintic, insecticidal antinociceptive and anti-inflammatory activities (Dash *et al.*, 2017; Raina and Abraham, 2016; Sulaiman *et al.*, 2008; Umar *et al.*, 2012).

### **Zingiber montanum (Koenig.) Link ex A. Dietr.**

It is a tall slender aromatic herb with leafy stem [Fig-2h]. Plant height is up to 2 m. Rhizomes are strongly aromatic with pale yellow colour in side. Roots are relatively fleshy. Leaves are linear-oblong or lanceolate and spread nearly at right angle from the stem. Leaves are pubescent beneath, leaf lamina size  $20-45 \times 2.5-4.5$  cm. Spikes with brownish green closely imbricate broad floral bracts arise with an elongated peduncle from the base of the stem. Above the ovary white flower present with segmented corolla. Corolla is pale yellow in colour. Fleshy scarlet red capsules contain seeds, polish black in colour with white aril.

*Z. montanum* is commonly known as Cassumunar ginger and locally known as *Bana Ada* or *Gada*. Dried rhizome flakes of the plant are used as a post meal digestive. Dried rhizome powder is consumed after dinner for the treatment of constipation. For paediatric use, dried rhizome is rubbed on a stone grinder with few drops of water to make a paste which is got licked by the new born babies and infants to treat various symptoms of stomach upset. The paste of rhizomes (*Z. montanum*, *Z. officinale* and *K. galanga*) is used as an antidote against snake venom in Arunachal Pradesh and Assam (Basak *et al.*, 2010). For the treatment of cough and headache rhizome is also used in Manipur (Devi *et al.*, 2014).

The plant extracts are rich in alkaloids, phenols, flavonoids, steroids, glycosides, tannins, terpenoids etc. and due to the presence of these compounds and other bioactive compounds in the essential oil they exhibit antimicrobial, antifungal, antioxidant, anti-inflammatory, anti-cancerous, antiallergic, antiulcer, radioprotective, allelopathic and acetylcholinesterase inhibitory activities (Al-Amin *et al.*, 2012; Pithayanukul *et al.*, 2007; Tewtrakul and Subhadhirasakul, 2007; Verma *et al.*, 2018; Wolff *et al.*, 1999).

### **Zingiber officinale Rosco.**

It is an aromatic herb with stout tuberous rhizomes and slender erect leafy stems [Fig-2i]. Plant height is nearly 0.5 to 1.2 m. Leaves are narrow, linearly lanceolate, glabrous, distichously arranged and leaf lamina size is  $11-14 \times 1.2-2$  cm. Spikes with green closely imbricate broad floral bracts arise with an elongated peduncle from the base of the stem. Flowers are greenish yellow with dark purple labellum. Stamen are also dark purple in colour and shorter than corolla. Capsules are red.

*Z. officinale* is commonly known as ginger and locally known as *Ada*. Just like any other parts of India, the raw rhizome of ginger is very frequently used as a spice and in ethnomedicine in the study region. A slice of

the fresh ginger rhizome is kept in mouth with little salt and chewed slowly to cure cough, cold, oral infection and tonsillitis. The ginger pastes with honey and leaf extracts of *Occimum santum* L. is consumed twice a day to cure cold and this medication is very frequently used to treat children. Fresh or dried ginger is one of the important ingredients along with clove, cinnamon stick, bay leaf and *Nyctanthes arbor-tristis* L. leaves in the preparation of herbal tea “*Kada*” the steam of which is inhaled and the tea is consumed to get fast relief from head or body ache, common cold and fever. The dried rhizome of ginger is locally known as “*Sunthi*” the powder of which is used consumed to treat flatulence and increase appetite. The tribal of Koraput district of Odisha burn the rhizome and crush it with 5 to 10 peeper seeds and consume orally to cure cold and cough (Raut, et al., 2012). Rhizome is used as spice and condiments and taken as medicine to cure cough and cold in Manipur (Devi, 2014)

The extract of fresh ginger rhizome contains essential oil, oleoresin phenolic compounds, eugenol, shogaols, zingerone, gingerdiols, gingerols, alkaloids, saponins, tannins, flavonoids, terpenoids, phenols and steroids etc, which are responsible for the antimicrobial and antioxidant potency (Bellik, 2014; Lucky et al., 2017; Pawar et al., 2011; Sasidharan and Menon, 2010).

### **Zingiber zerumbet (L.) Smith.**

It is a leafy aromatic herb mostly perennial under humid conditions [Fig-2j]. Plant height is up to 1.5 m. Elliptic-oblong, glabrous leaves are arranged distichously on each side of the stem. Leaf lamina are nearly 20-38 × 4-8 cm in size, leaves in the middle portion of the stem are the largest. Rhizomes are whitish outside and pale yellow inside with strong aroma. Ellipsoid-oblong spikes are borne on the elongated stout peduncles that arise from the base of the stem. Bracts are green during flowering and turn red afterwards. Flowers are uniformly yellow, 4cm long and exserted. Filaments are very short and anthers are pale yellow.

*Z. zerumbet* is commonly known as bitter ginger or shampoo ginger or pinecone ginger and locally known as *Sapa Gada* which literally means “Snake Antidote”. As the local name indicates, it is frequently used as an antidote to snake venom and the herb is planted at the backyards to repel snakes. Rhizome paste is applied on the wound twice a day for 3 days to treat snake bite. Decoction of fresh rhizome or leaves is also consumed twice a day against common cold and other pulmonary infections. Rhizome decoction with pepper and cumin seeds is used as remedy for fever by Malamalasar tribe of Parambikulam wildlife sanctuary Kerala (Yesodharan and Sujana 2007).

Different bioactive compounds including zerumbone,  $\alpha$ -humulene, humulene oxide I, camphene,  $\alpha$ -humulene, humulene oxide II, camphor, caryophyllene oxide 1,8-cineole,  $\beta$ -caryophyllene have been obtained from fresh and dried rhizomes of *Z. zerumbet* and presence of these compounds is responsible for antimicrobial, cytotoxic, antioxidant, antibacterial, anti-inflammatory, antipyretic, anti-allergic, immunomodulatory, antiplatelet aggregation, antiproliferative, anti-hyperglycaemic activities (Ghasemzadeh et al., 2016; Singh et al., 2014).

### **Conclusion**

In the present study as many as 10 plants Zingiberaceae family have been documented to have diverse ethnomedicinal uses in the study region. Out of these 10 species, only two species viz. *C. Longa* L., and *Z. officinale* Rosco. are cultivated as commercial crops whereas *K. galanga* L., *C. amada* Roxb., have gained certain degree of commercial importance; but rest of the species are gradually losing their importance. Gradual shifting of the dependence of native people from local-herbal medicine to modern allopathic medicine is leading to the shrinkage of ethnomedicinal knowledge. Moreover, encroachment of wetlands and edges of forests are leading to the habitat destruction of these valuable aromatic species. Therefore, it is the need of the time to identify such plants and document their ethnomedicinal uses so that future research in medical science can get valuable input.

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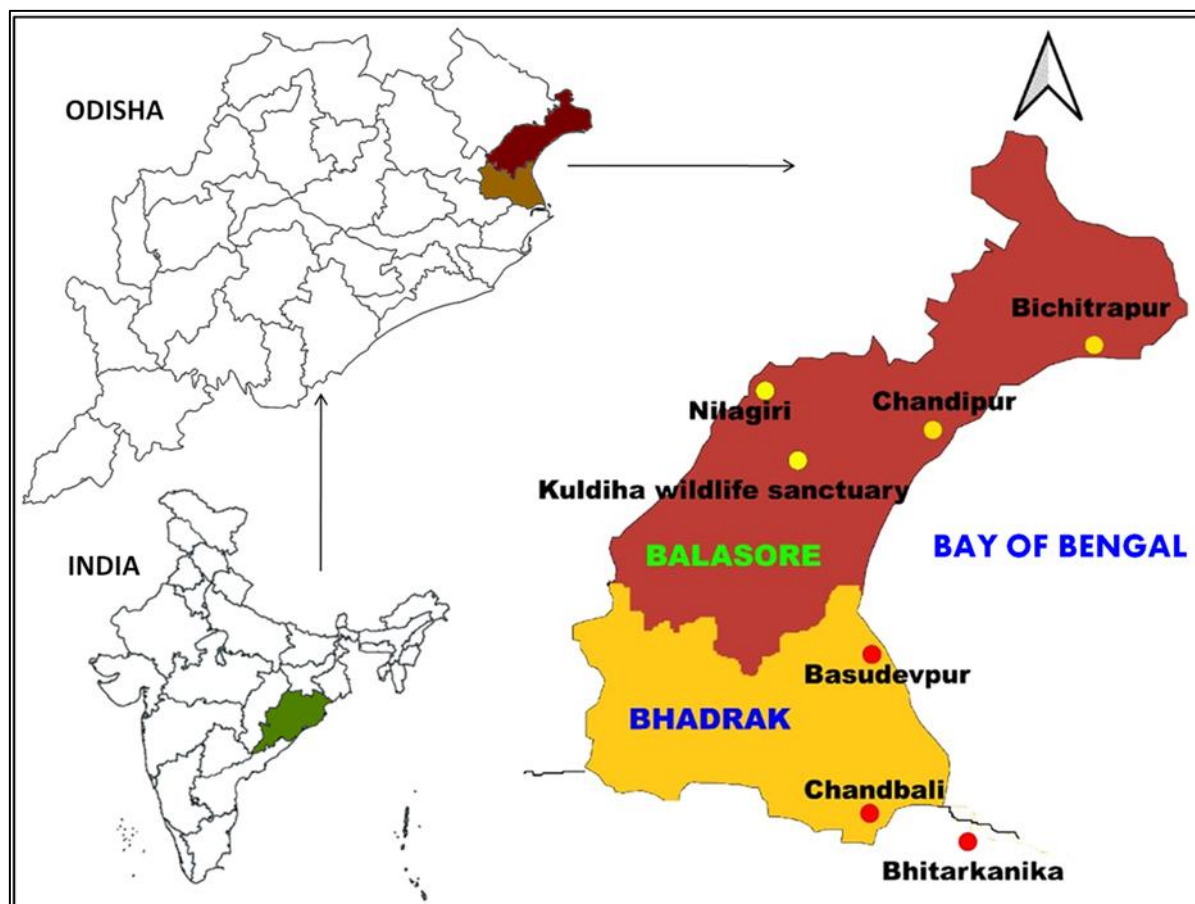
### **Conflict Of Interest**

All authors have declared that there is no such type of conflict of interest to publish this manuscript.

**Figure Captions**

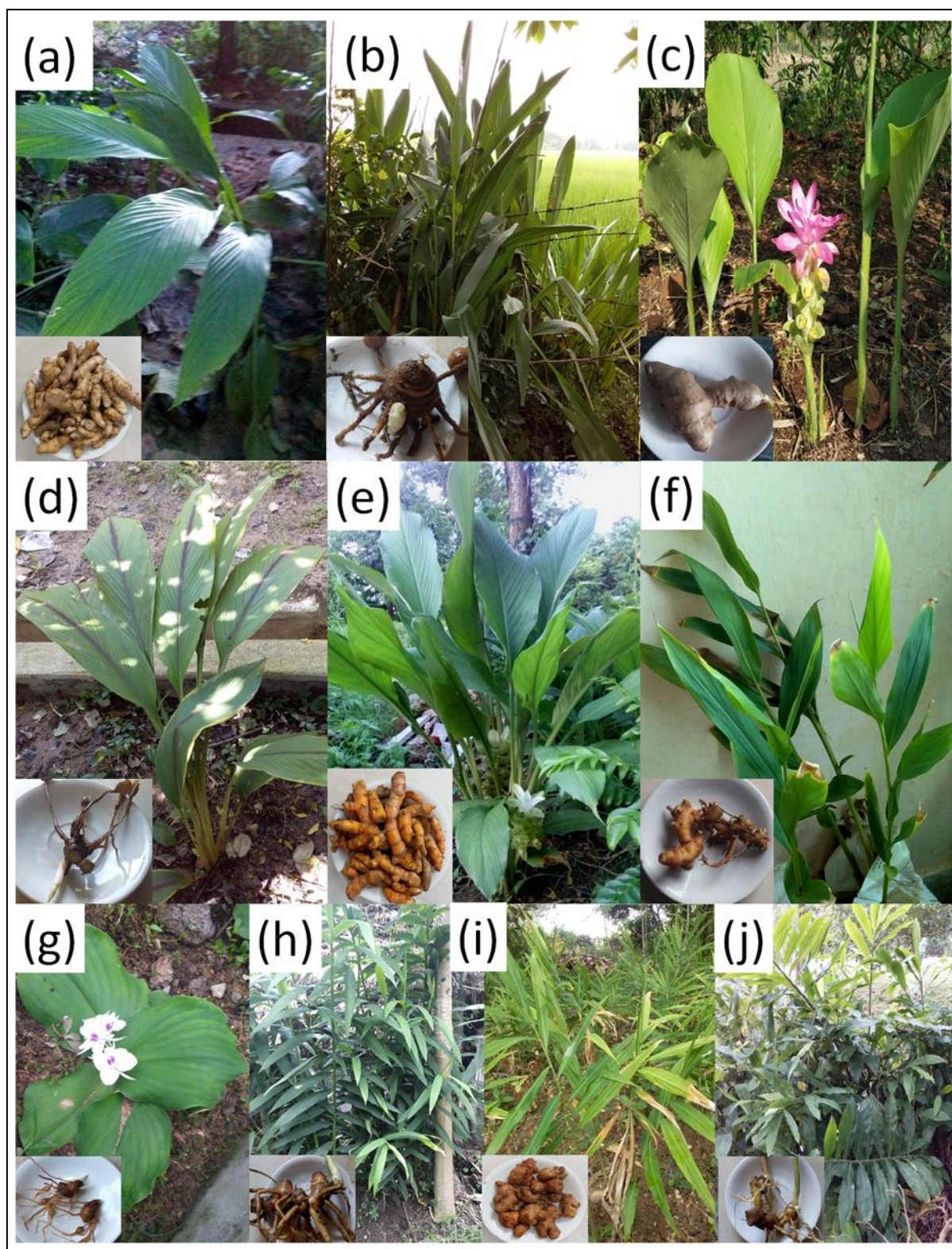
**Fig 1.** Northern coastal region of Odisha including two districts of Balasore and Bhadrak with important eco sensitive sites.

**Fig 2.** Different plants of Zingiberaceae family documented in the study region with their respective rhizomes (inset image). (a) *Curcuma amada* Roxb., (b) *Curcuma angustifolia* Roxb., (c) *Curcuma aromatica* Salisb., (d) *Curcuma caesia* Roxb., (e) *Curcuma longa* L., (f) *Hedychium coronarium* Koenig., (g) *Kaempferia galanga* L., (h) *Zingiber mantanum* (Koenig.) Link ex A. Dietr., (i) *Zingiber officinale* Rosco., (j) *Zingiber zerumbet* (L.) Smith.



**Fig 1.** Northern coastal region of Odisha including two districts of Balasore and Bhadrak with important eco sensitive sites.





**Fig 2.** Different plants of Zingiberaceae family documented in the study region with their respective rhizomes (inset image). (a) *Curcuma amada* Roxb., (b) *Curcuma angustifolia* Roxb., (c) *Curcuma aromatica* Salisb., (d) *Curcuma caesia* Roxb., (e) *Curcuma longa* L., (f) *Hedychium coronarium* Koenig., (g) *Kaempferia galanga* L., (h) *Zingiber mantanum* (Koenig.) Link ex A. Dietr., (i) *Zingiber officinale* Rosco., (j) *Zingiber zerumbet* (L.) Smith.

**Table 1:** Diversity and distribution of ethnomedicinally important plants of Zingiberaceae family in the study area

Sl. no.	Botanical Name	Local name	Habitat	Distribution in the study area	Rhizome sampling site	Parts used in ethnomedicine	Treatment of Diseases
1.	<i>Curcuma amada</i> Roxb.	<i>Amba ada</i>	Agricultural	Throughout study area mostly in the home gardens.	Basudevpur, Bhadrak	Rhizome	Piles, Joint pain, Wound, Skin irritation
2.	<i>Curcuma angustifolia</i> Roxb.	<i>Drusti Gada/ Palua</i>	Wild	Kuldiha wild life sanctuary and adjoining areas.	Nilagiri, Balasore	Rhizome	Oral infection, Dysentery, Indigestion, Bronchitis, Snake bite
3.	<i>Curcuma aromatica</i> Salisb.	<i>Palua</i>	Wild/ Agricultural	Kuldiha wild life sanctuary and adjoining areas. Cultivated parts of Balasore district.	Mitrapur, Balasore	Rhizome	Dysentery, Diarrhoea, Loose motion, Indigestion, Stomach pain, Leukoderma
4.	<i>Curcuma caesia</i> Roxb.	<i>Gada/ Kala haldi</i>	Ornamental	Home gardens, mostly in the coastal villages of Bhadrak district.	Basudevpur, Bhadrak	Rhizome	Oral infection, Dysentery
5.	<i>Curcuma Longa</i> L.	<i>Haldi</i>	Agricultural	Cultivated throughout the study area.	Remuna, Balasore	Rhizome, Leaf	Diabetes, Worm infection, Skin irritation, Itching, Rashes and burning
6.	<i>Hedychium coronarium</i> Koenig.	<i>Gada/ Torani</i>	Ornamental	Home gardens, mostly in the coastal villages of Bhadrak district.	Bant, Bhadrak	Rhizome	Rheumatism, Diarrhoea, Indigestion
7.	<i>Kaempferia galanga</i> L.	<i>Saprakachu</i>	Agricultural	Cultivated throughout the study area, mostly in home gardens <sup>4</sup>	Bhograi, Balasore	Rhizome	Rashes and Inflammation, Indigestion, Toothache
8.	<i>Zingiber montanum</i>	<i>Gada/ Bana Ada</i>	Ornamental	Home gardens,	Ghanteshwar ,	Rhizome	Constipation, Stomach



	(Koenig.) Link ex A. Dietr.			mostly in the coastal villages of Bhadrak district.	Bhadrak		ache
9.	<i>Zingiber officinale</i> Rosco.	<i>Ada</i>	Agricultura l	Cultivated throughout the study area.	Remuna, Balasore	Rhizome	Cold, Cough, Oral infection
10.	<i>Zingiber zerumbet</i> (L.) Smith.	<i>Sapa Gada</i>	Wild	Kuldiha wild life sanctuary and adjoining areas.	Nilagiri, Balasore	Rhizome	Snake bite, Pulmonary infection

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