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A review on the medicinal plant *Zingiber zerumbet* phytochemical composition, traditional uses, and potential health benefits

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Abstract
Zingiber zerumbet, commonly known as pinecone ginger or shampoo ginger, is a perennial herbaceous plant belonging to the Zingiberaceae family. This review aims to provide a comprehensive overview on entire plant along with phytochemical composition, traditional uses, and potential health benefits. *Z. zerumbet* has a rich phytochemical profile, with various bioactive compounds identified in its rhizomes, leaves, and flowers. These include gingerols, paradols, terpenoids, flavonoids, and phenolic compounds. The rhizomes are particularly abundant in bioactive constituents, which contribute to the plant's medicinal properties. In traditional medicine, *Z. zerumbet* has been used for centuries in different parts of the world to address various health conditions. The plant has been attributed with anti-inflammatory, antimicrobial, antioxidant, analgesic, and anti-diabetic properties. It has also been used to alleviate digestive disorders, respiratory ailments, and as a remedy for skin diseases. The plant has shown potential in the management of conditions such as arthritis, diabetes, cardiovascular diseases, and cancer. Moreover, *Z. zerumbet* exhibits antimicrobial properties against a range of pathogens, including bacteria, fungi, and viruses. Additionally, studies have highlighted its ability to modulate immune responses and enhance the body's defense mechanisms against infections. However, despite the promising findings, further research is warranted to fully elucidate the mechanisms of action and therapeutic potential of *Z. zerumbet*. Standardization of plant extracts, identification of active compounds, and clinical trials are essential steps for establishing its efficacy, safety, and dosage recommendations.

Keywords: *Zingiber zerumbet*, standardization, efficacy, safety, Phytochemical profile

1. Introduction
The name zingiber, actually derived from sanskrit word that refer's to bull's horn. It is a perennial, aromatic and tuberose plant that grows in humid conditions. The family Zingiberaceae consists of versatile group of plants known as gingers which come in a wide range of shapes, sizes and colours. The species widely used as favoring for food is *the Z. officinale*. However, a few species basal inforescences and occasional terminal spikes augment the beauty. Where it is widely used in foods, beverages and for ornamental purposes. The viscous juice present in the inflorescence of the plant is rich in surfactants and is also known as "ginger shampoo".
These species are widely distributed throughout the tropics and subtropics, and are especially abundant in Southeast Asia. Zingiberaceae comprising more than 1300 species is divided into about 52 genera of aromatic perennial herbs with creeping horizontal or tuberous rhizomes. India is one of the richest and diverse regions for Zingiberaceae, having 20 genera and around more than 200 species.The genus Zingiber, another important group which belongs to the family is represented by 141 species, distributed mainly in tropical Asia. In India, the genus is represented by 12 species and among this ginger (*Zingiber officinale*) is an important spice and medicinal plant known since time immemorial. In *Z. zerumbet* the rhizome is the part that is most used for medicinal purposes. These folk medicines are generally prepared by maceration and infusion of fresh rhizome, but tinctures, poultices and even the plant in natura are other therapeutic uses. The cone-shaped flowers are long-lasting and are employed in craft arrangements for ornamental purpose. The rhizome is used as a tonic and as a stimulant The rhizome serves as a seasoning in foods, while the floral buds are consumed as vegetables.
The rhizome of ginger has been extensively used with remarkable therapeutic effects for the treatment of inflammation, diarrhea, stomach cramps, bacterial infections, fever, flatulence,

allergies and poisoning. Powdered rhizome is used to treat ear infections, toothache and, in the form of tea, to treat stomach disease. The leaves are also used in therapies for joint pain. The juice of cooked rhizome was reported to be effective in combating worms in children. The creamy substance present in the mature inflorescence, is rich in surfactants and serves as a natural shampoo.

Plant profile

Synonyms

Zingiber spurium, Zingiber aromaticum, Amomum zerumbet Linn, *Amomum sylvestre*

International common names

- English: Bitter ginger, pinecone ginger, lily shampoo, wild ginger, Shampoo ginger
- Spanish: Jengibre.
- French: Gingembre, blancgingembre.
- Arabic: Zerunbadzurunbah.
- Chinese: Hong qui jiang.
- Malaysia and Indonesia: Lempoyang.
- India: Ghatian and Yaiimu.
- Bangladesh: Jangli adha.
- Northern Thailand: Haeo dam or Haio dam.
- Hawaii: Awapuhi.

Vernacular names

- Telugu: Kaarallamu
- Hindi: Banadrak
- Assamese: gathian
- Bengali: kulanjan, mahabari bach, narkachur
- Kannada: agale shunti
- Malayalam: kathu-inshi-kua
- Manipuri: Yaimu
- Marathi: Kaali halad, narakchora
- Oriya: viranam
- Sanskrit: ahava, avanti, karpuraharidra

Plant description

This plant is characterized by the presence of stems approximately 1–2 m tall, which are erect, oblique, round and covered by sheaths of flat leaves. The leaves and inflorescences grow from a thick rhizome or underground stem. The sheets are thin and are approximately 25–35 cm (about 1.15 ft) long, with a centrally raised midrib which strongly raised on the lower surface. The sheets are arranged alternately along the stem.

Plant type

Herbaceous, Perennial, Broadleaved. The inflorescence, which is green when young, becomes red when old and reaches 6–12 cm (about 4.72 in) in height. It is supported on a separate pseudo stem from the leaves by a narrow overlap that forms an open pouch, from which the flowers arise. An important botanical feature of *Z. zerumbet* is that the yarn is connected to a long curved beak. The fruit is white, glabrous, thin-walled and is approximately 1.5 cm (about 0.59 in) long. The seeds are ellipsoids and black. The rhizome is perennial, thick, aromatic and yellow.

Stem

Usually flowers and fruits as a shrubby plant about 1-2 m tall but it should be noted that only the leaves are above ground level. The true stem is below the soil surface which is green in colour.

Leaves

Leaf blades sessile or shortly petiolate (petioles about 0.4-0.5 cm) lanceolate, about 14- 40 x 3-8 cm, glabrous on the upper surface but pubescent on the lower surface at least when young, ligule about 1-3 cm long, pubescent when young, apex obtuse.

Foliage

1. Leaf arrangement: alternate
2. Leaf type: simple
3. Leaf margin: entire
4. Leaf shape: lanceolate
5. Leaf venation: pinnate Current year stem/twig thickness: very thick
6. Leaf type and persistence: semi-evergreen
7. Leaf blade length: 8 to 12 inches
8. Leaf color: variegated
9. Fall color: no fall color change
10. Fall characteristic: not showy.

Flowers

Inflorescence is produced from the base of the plant. Inflorescence about 7 cm long, on a peduncle about 20-50 cm long. Bracts red, about 1.5-4 x 1.2-4 cm. Flowers smell like ginger (*Zingiber officinale*). Calyx about 13-17 mm long. Corolla tube about 20-30 mm long, lobes variable in size and shape, largest one about 15-25 x 10-20 mm. Labellum ovate or orbicular, about 12-20 x 15-20 mm. Anther about 8-10 mm long, crest or connective about 7 mm. Two gland-like stylodes (about 5 mm long) present on top of the ovary.
Flower characteristic: summer flowering.

Fruit

Fruits produced in a reddish cone about 12-13 x 4 cm. Capsules enclosed in the persistent inflorescence bracts, capsules about 12 x 8 mm. Seeds about 4-5 x 2.5 mm. Aril translucent, fimbriate at the apex. Embryo about 3.5 mm long, one end globular.
Fruit shape: unknown
Fruit length: unknown
Fruit cover: dry or hard
Fruit color: red

Fruit characteristic: persists on the plant.
Trunk and Branches
Trunk/bark/branches: typically multi-trunked or clumping.

Seedlings

Features not available.

Spread: 4 to 6 feet
Plant habit: upright; spreading
Plant density: open

Growth rate: moderate
Texture: coarse.

Scientific classification
- Kingdom: Plantae
- Clade: Tracheophytes
- Clade: Monocots
- Clade: Commelinids
- Order: Zingiberales
- Family: Zingiberaceae
- Subfamily Zingiberoideae
- Tribe: Zingiberoideae
- Genus: Zingiber Mill.
- Binomial name: *Zingiber zerumbet*.

Geographical Distribution
Shampoo ginger is contemplated to be subtropical atmospheric conditions and native to Southeast Asia, and brought by men across the Polynesian Islands and all over the Pacifc. In Asia, it is found in India, Bangladesh, Malaysia, Nepal, and Sri Lanka, and it is cultivated as a home garden plant across the South-East. It grows naturally as scattered plants along the edges of the forest or mountain slopes, in the village, thickest in the partial shade, and on the roadside. More often, it occurs and grows near rivers, cascades, and other water areas.

Cultivation & Collection
Zingiber zerumbet is a perennial. From autumn until spring it goes dormant above ground as the leafy stems shrivel and die away, leaving the pale brown, creeping stems (rhizomes) at ground level. In the spring, the plant springs up anew. The 10–12 blade-shaped leaves 15–20 cm long grow in an alternate arrangement on thin, upright stem to 1.2 m (3.9 ft) tall. Among the leafy stems, the conical or club-shaped flower heads burst forth on separate and shorter stalks. These appear in the summer, after the leafy stems have been growing for a while. The flower heads are initially green and are 3 to 10 cm (1.2 to 3.9 in) long with overlapping scales, enclosing small yellowish-white flowers that poke out a few at a time. As the flower heads mature, they gradually fill with an aromatic, slimy liquid and turn a brighter red color. The flower stalks usually remain hidden beneath the leaf stalks. *Zingiber zerumbet* is very sensitive to dry soil, so choose a potting soil that retains moisture. A good soil will still drain well and contain lots of organic matter such as coco coir or sphagnum moss. *Zingiber zerumbet* should be repotted after it doubles in size or once a year, whichever comes first. The ideal planting site is in partial shade to partial sun, with moist, fertile soil. Shampoo ginger is moderately salt and drought tolerant. Pests and diseases are rarely an issue, but you may encounter mites. Shampoo ginger makes an excellent pass along plant since it is propagated by division. This species reproduces asexually by multiplying rhizome fragments. Shampoo Ginger may have difficulty thriving, and will drop leaves, without ample sunlight. Place it less than 3 feet from a south-facing window to maximize the potential for growth. Select your region to see how the current weather in your area affects the placement of Shampoo Ginger in your home 65°F to 85°F.
Shampoo Ginger plants are picky eaters when it comes to soil. They crave a mix that retains moisture without becoming a swampy mess. Look for a blend rich in organic matter like coco coir or sphagnum moss, which keeps things damp yet breathable Inflorescence produced from the base of the plant. Inflorescence about 7 cm long, on a peduncle about 20-50 cm long. Bracts red, about 1.5-4 x 1.2-4 cm. Flowers smell like ginger Begin fertilization as the growing season starts, typically in spring. A high- nitrogen fertilizer supports lush foliage, setting the stage for later blooms. Apply it when your plant reaches about 8-12 inches in height, signaling it's ready for more nutrients. The planting season for ginger is from March-April, with the onset of the monsoon. The crop duration is generally around 8-9 months (April/May to December/ January). Ginger is planted in rows, 30 cm apart at distances of 20-25 cm within the row. Ideal pH range of ginger is 5– 7.5. It grows well in humid climate and is cultivated from sea level up to an altitudes of about 1500 m above MSL. However, the optimum elevation for its successful cultivation is in the range of 300-900 m. Ginger can be grown both, under rainfed and irrigated conditions.
Zingiber zerumbet, commonly known as shampoo ginger or pinecone ginger, is a tropical plant prized for its fragrant rhizomes and ornamental qualities. Here's a summary of its cultivation.

Climate
- Thrives in warm, humid climates (USDA zones 8-10).
- Prefers temperatures between 68-86°F (20-30°C).
- Can tolerate light frost but not prolonged freezing temperatures.

Climate type	Preferred or tolerated
Af - Tropical rainforest climate - > 60 mm precipitation per month	Preferred
Am - Tropical monsoon climate - Tropical monsoon climate (< 60 mm precipitation driest month but > (100 - [total annual Precipitation (mm}/25])	Preferred
Cf - Warm temperate climate, wet all year - Warm average temp. > 10 °C, Cold average temp. > 0 °C, wet all year	Tolerated
Cw - Warm temperate climate with dry winter - Warm temperate climate with dry winter (Warm average temp. > 10 °C, Cold average temp. > 0 °C, dry winters)	Tolerated

Soil
- Prefers well-draining, fertile soil rich in organic matter.
- Sandy loam or potting mix with added compost is ideal.
- Avoid waterlogged conditions.

Light
- Enjoys partial shade to full sun.
- Too much shade can hinder flowering.

Propagation
- Propagated by dividing rhizomes in spring or early summer.
- Choose healthy, mature rhizomes with at least 2-3 buds (eyes).
- Plant rhizome pieces 1-2 inches deep, with the eyes facing upwards.

Watering
- Water regularly, keeping the soil consistently moist but not soggy.
- Reduce watering during dormancy (usually winter)

Fertilizers
- Apply a balanced fertilizer monthly during the growing season.
- Avoid over-fertilizing, which can encourage foliage growth at the expense of flowers.

Harvesting
- Rhizomes can be harvested after 10-12 months, when the plant reaches maturity.
- Dig carefully and wash the rhizomes thoroughly before using.

Additional tips
- Mulch around the plant to retain moisture and suppress weeds.
- Bring potted plants indoors or protect them with mulch during winter in colder climates.

Collection
Zingiber zerumbet rhizomes are typically harvested when the plant reaches maturity, around 8-12 months after planting. The harvesting process involves carefully digging up the rhizomes, ensuring minimal damage to the plant.

Processing
- After harvesting, the rhizomes are thoroughly washed to remove dirt and debris. They are then sliced or diced into smaller pieces to facilitate drying.
- Drying is a crucial step in processing, as it helps preserve the rhizomes and prevent spoilage. Sun drying or mechanical drying methods can be used.
- Once dried, the rhizomes are further processed by grinding them into a powder or leaving them whole, depending on the intended use.

Macroscopic Evaluation:
Rhizome

Size	Shape	Colour	Odour	Taste
1.5 cm long & 1-2.5 cm broad	Node and Internodes	Light grey & Light yellow	Fragrant, Aromatic	Bitter taste

- Fleshy, irregularly shaped, and laterally flattened, with a knobby appearance.
- Light brown to pale yellow in color, with a smooth and waxy texture.
- Strong, pungent, and slightly camphoraceous aroma. Bitter and slightly spicy taste.

Leaves

Size	Shape	Colour
15 cm – 20 cm	Blade (or) Scale leaves	Green

- Bilaterally flattened, elongated, and lanceolate in shape.
- Green to dark green in color, with a smooth surface and prominent veins running lengthwise. Arranged alternately on the stem.

Stem

Size	Shape	Colour
1 – 2 M tall	Erect, Oblique, Round	Green to light green

- Aerial stem is pseudostem, formed by the tightly packed leaf sheaths.

Flower

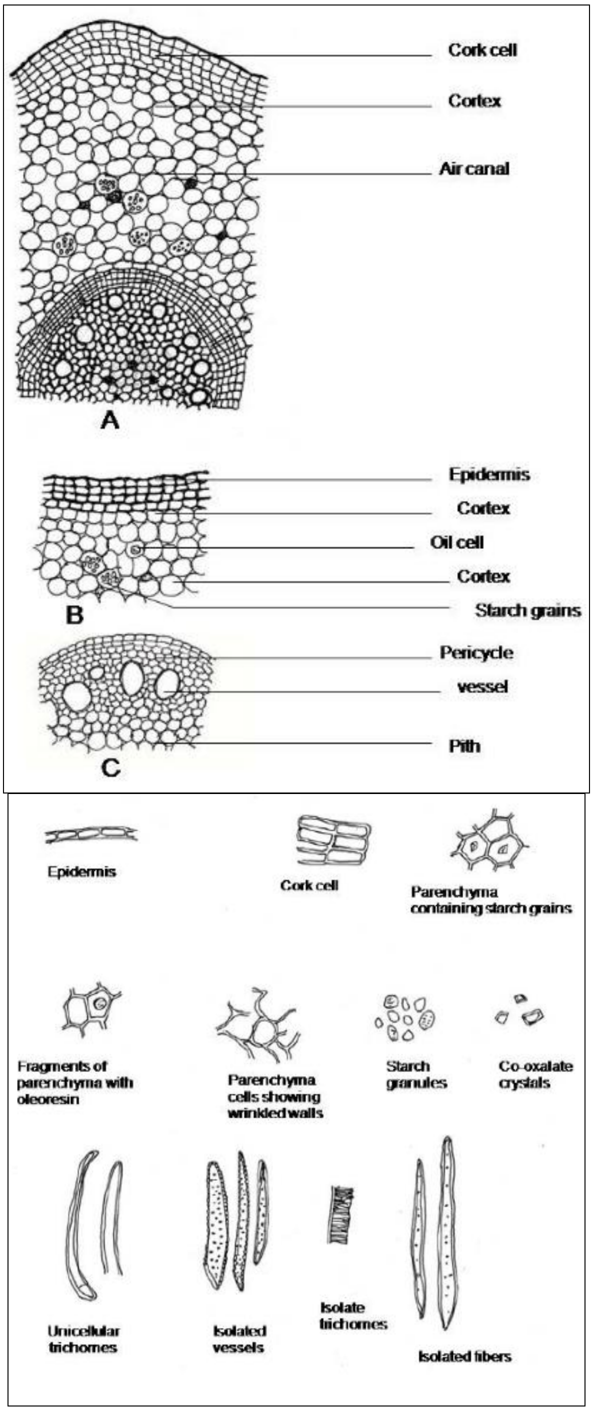
Size	Shape	Colour
3 cm – 10 cm	Conical (or) club shaped	Green & reddish, Yellow

- Inflorescence borne on a separate stalk arising from the base of the plant.
- Spikes with yellow or orange bracts and small, yellow flowers.

Microscopic characters of *Zingiber zerumbet*:
Rhizome

The rhizome is circular with epidermis, cortex, endodermis and closed, collateral vascular bundle. Transverse section of the rhizome showed outer single layered epidermis having rectangular and elongated cells, followed by thin walled cork cells of 6-10 layers, irregularly elongated. Cortex consists of several layers of parenchymatous cells with intercellular air spaces and contains starch. Oil cells are present in cortex. The central cylinder region contains yellow to orange coloured oleoresin. Endodermis consists of a single layer of cells. Stele consists of a broad central zone of ordinary parenchymatous cells. Closed, collateral vascular bundles are found in a circle in the region just inside the epidermis. The starch grains are abundant in the cortex and mostly globose, ovoid and irregularly rounded. The tracheids are non- lignified and have reticulate, spiral or scalariform thickening on the walls. The rhizome powder was studied under different magnifications, which showed the presence of epidermal fragments, cork cell, parenchyma containing starch grains, fragments of parenchyma with oleoresin, parenchyma cells showing wrinkled walls, starch granules, co-oxalate crystals, unicellular trichomes, isolated vessels, isolated trichomes, and isolated fibers. The transverse section of the rhizomes was circular in outline with epidermis and cortex. There were closed, collateral vascular bundles. Epidermal cells were irregular followed by cork cells which were 6-10 layers. Just beneath the cork layers, there was parenchymatous cortex with intercellular air space and starch grains. Many oil cells were present in the cortex. Centre cells were with yellow to orange coloured oleoresin. Endodermis was single layer and stele consisted of central parenchymatous zone. The tracheids had reticulate spiral or scaliriform thickening on the walls.

Chemical constituents
The methanolic extracts of rhizomes of *Zingiber zerumbet* (L) Smith. gave positive tests for alkaloids, saponin, tannin, amino acid, proteins, starch, flavonoids and reducing sugar. In the study of histochemical localization, it was found that alkaloids were present in a few cortical cells, xylem and periderm. Reducing sugar was present in the parenchymatous cells and also in xylem. Protein and amino acids were also present in parenchymatous cortex and tracheids. Tannin was present in only parenchymatous cells. Starch, flavonoids and saponines were distributed throughout the rhizome except periderm. *Z. zerumbet* is a rich source of different classes of compounds that belong to a wide variety of chemical metabolites, such as polyphenols, alkaloids and terpene (Zerumbone).



"Microscopic evaluation for stem, leaf, Root and flower were not reported".

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Preliminary phytochemical screening of *Z. zerumbet*:

The phytochemical analysis of the extracts (aqueous and ethanol) of bitter ginger (*Z. zerumbet*) revealed the presence of a significant number of secondary metabolites. Table 1 lists the tests used and the different solvent extracts of bitter ginger (*Z. zerumbet*), assessed qualitatively, through a phytochemical analysis, respectively.

A preliminary phytochemical examination was performed using the standard protocols, to test for the existence of glycosides, tannins, alkaloids, flavonoids, terpenoids, and quinones, qualitatively [28]. To determine the presence of alkaloids, Wagner's test was used. To check for saponins, in six test tubes, 5 mg of the powdered extract was added, followed by 20 mL of 95% ethanol. The mixture was subjected to stirring for 12–15 min. The soapy appearance of the sample indicated the presence of saponin. To test for the presence of tannins, six tubes were loaded with 5 mg of the powdered extract and 5 mL of 95% ethanol, followed by the addition of 5% ferric chloride. The appearance of blue or a dark colour was indicative of the presence of tannins. Then, 3 mL of sodium hydroxide solution was added to each tube containing flavonoids extracted with six different solvents. A gentle stirring produced the colour, and its absence showed flavonoids. For the terpenoids test, 5 mg of the extracts were dissolved in 2 mL of pure chloroform and 5M H_2SO_4 was added to it. A red-brown precipitate suggested terpenoids [29]. To test for glycosides, 5 mg of powdered extracts were placed in six tubes (separately) with 5 mL of six different solvents, 2 mL of glacial acetic acid, 2% ferric chloride, and 1 mL of H_2SO_4. At the interface of the two liquids, glycosides produce a brown or violet ring [30]. Quinone was extracted six times with concentrated H_2SO_4. Red precipitates indicated the presence of quinones [31].

Preliminary phytochemical analysis of extracts of *Zingiber zerumbet* Rhizome

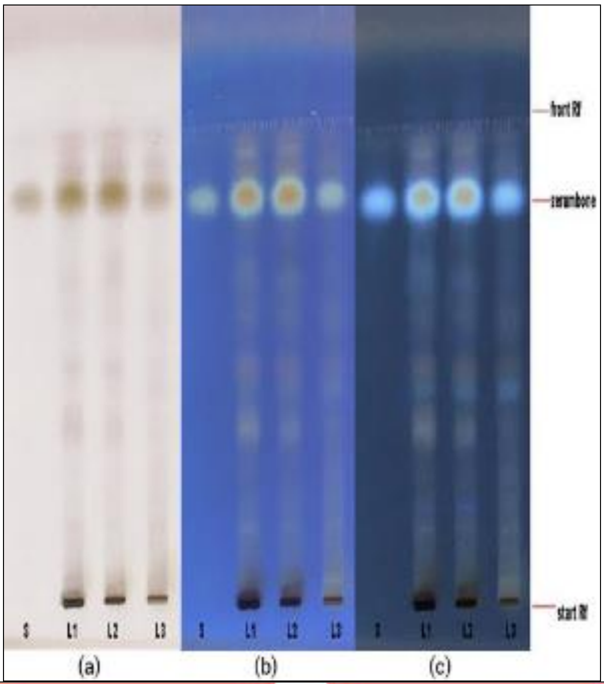
S. NO	Test	Petroleum ether extract	Chloroform Extract	Ethanolic extract	Aqueous extract
1	Alkaloids	-	-	-	-
2	Glycosides	-	-	+	+
3	Flavonoids	-	-	-	-
4	Carbohydrates	-	-	+	+
5	Steroids	+	+	-	-
6	Triterpenes	-	+	+	+
7	saponins	-	-	+	+
8	Tannins	-	-	+	+
9	Proteins	-	-	+	+
10	Amino acids	-	-	+	+
11	Volatile oils	+	-	-	-

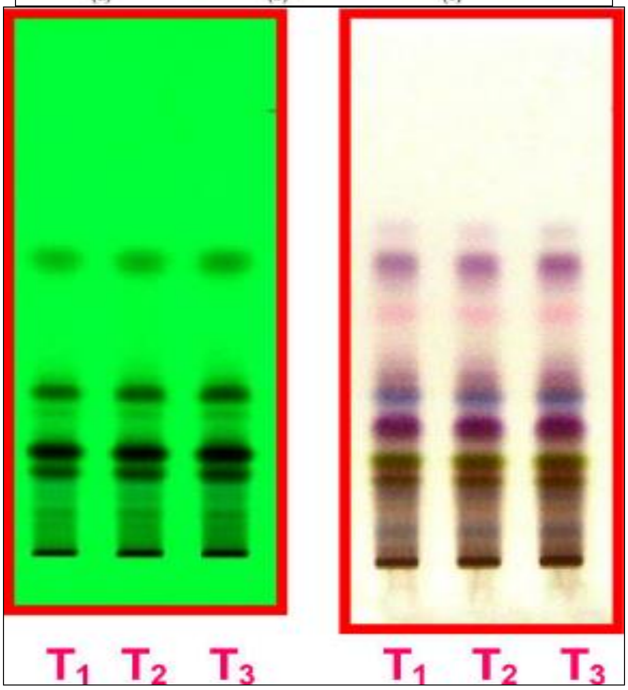
"Phytochemical screening of other parts of plants were not reported".

Thin layer chromatography

Colour tests:

HCL (conc.)	Brown
5% NaOH	Light brown
25% NH4OH	Light brown





TLC profiles of zerumbone (Rf: 0.84) (S) and ethanol extract of *Z. zerumbet* dried rhizome powder (L1, L2, L3) observed under (a) visible light (b) UV at 254 nm and (c) UV at 366 nm after spray with 10% methanolic sulphuric acid solution. The thin Layer Chromatogram of the chloroform extract under UV 254 nm showed five fluorescent spots at Rf 0.06, 0.18, 0.24, 0.33 & 0.63 (fluorescent green). After derivitisation with anisaldehyde sulphuric acid reagent, it showed seven major spots at Rf 0.06 (blue), 0.18 (brown), 0.24 (green), 0.33 (pink), 0.52(orange) and 0.63 (violet).

Uses

Inflorescence

The viscous juice present in the inflorescence of the plant is rich in surfactants and is also known as "ginger shampoo". Where it is widely used in foods, beverages and ornamental purposes.

Rhizome

The rhizome can be macerated in ethanol and used as a tonic and a stimulant. Some of the traditional usages as botanical medicine include the treatment of inflammation, fever, toothache, indigestion, constipation, diarrhea, severe sprains, and to relieve pain, as well as antispasmodic, antirheumatic, and diuretic agents. In India, the rhizome powder is mixed with ripe Morinda citrifolia for the treatment of severe pain, the cooked and softened rhizome is used to treat toothache, cough, asthma, worms, leprosy, and other skin diseases, and the ground and strained rhizome is mixed with water and drank to treat stomach ache.

Test Solutions	Weigh about 5 g of *Z. zerumbet* dried rhizome powder in a 50 mL screw cap conical flask and add 25 mL of ethanol (99.4%). Sonicate the mixture for 15 min at room temperature. Filter and collect the mixture in round bottom flask. Evaporate the filtrate using rotary evaporator at 60 °C. Reconstitute the residue with 20 mL of methanol. Filter the solution and use the filtrate as test solution.
Standard solution	Dissolve 1.0 mg of zerumbone standard [CAS no.: 471-05-6] in 1 mL methanol to produce 1000 µg/mL solution.
Stationary Phase	HPTLC glass silica gel 60 F254, 10 x 10 cm (pre-heated in oven at 100°C for 20 minutes)
Mobile Phase	Hexane: ethyl acetate (9.0:2.0) (v/v)
Application	A. Zerumbone standard (S); 5 µL, 8 mm as a band B. Ethanol (99.4%) extract of *Z. zerumbet* dried rhizome powder collected from different locations (L1, L2 and L3) (3 µL, 8 mm as a band)
Development distance	8 cm
Drying	Air drying
Detection	A. Visible light; B. UV at 254nm; C. Ethanol (99.4%) extract of *Z. zerumbet* dried rhizome powder collected from different locations (L1, L2 and L3) (3 µL, 8 mm as a band)

Conclusion

In conclusion, *Zingiber zerumbet* is a plant with significant phytochemical diversity and a wide range of traditional uses. Its bioactive constituents contribute to its potential health benefits, including anti-inflammatory, antimicrobial, antioxidant, and anti-diabetic properties. Z, zerumbet has evaluated the microscopic & macroscopic evaluation, chemical evaluation also reported for the future study reference. Although further research is needed, *Z. zerumbet* holds promise as a natural resource for the development of novel therapeutic agents and functional foods.

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