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Phytopharmacological and multi-elemental profiling of potential zingiberaceae species

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ABSTRACT

Zingiberaceae family are used in medicine to treat a variety of human maladies, lessen inflammation, relieve motion sickness, and enhance digestion. In the current study seven Zingiberaceae species, including *Zingiber zerumbet*, *Kaempferia rotunda*, *Kaempferia galanga*, *Curcuma zedeoaria*, *Zingiber rubens*, *Costus speciosus* and *Hedychium flavescens* were assessed for phytochemical and multi-element composition. All seven species showed a considerable variation proving to be superior in many ways when compared to the nutritional worth of near commercial species, such as ginger and turmeric. The outcome emphasizes the phytochemical and elemental value of lesser-known but equally significant plants with strong therapeutic potential, and also indicates the need to encourage cultivation and protect genetic resources.

Keywords: Elemental profiling, ICPMS, Zingiberaceae, Phytochemical.

INTRODUCTION

Zingiberaceae family comprised flowering plants of around 50 genera with about 1600 known species[1] of aromatic perennial herbs with creeping horizontal or tuberous rhizomes distributed throughout tropical Africa, Asia, and America. Many species are important ornamental, spice, or medicinal plants. Ornamental genera include the Shell gingers (*Alpinia* sp.), Siam or summer tulip (*Curcuma alismatifolia*), Globba or ginger lily (*Hedychium* sp.), Torch-ginger (*Etlingera elatior*). Spices include common cultivated in India are Ginger (*Zingiber officinale*), Turmeric (Curcuma longa), Large Cardamom (*Amomum subulatum*), and Cardamom (*Elettaria cardamomum*). Galangal or Thai ginger (*Alpinia galanga*), Melegueta pepper (*Aframomum melegueta*), Myoga (*Zingiber mioga*), and Korarima (*Aframomum corrorima*) are mostly used as spices in the rest of the world.

The Zingiberaceae family is well-known for its use as medicine to treat many human ailments, reduce inflammation, cure motion sickness, and improve digestion. Numerous studies on the traditional uses of herbs by various tribes and their knowledge of plant parts from various Zingiberaceae species have been conducted up to this point. Therefore, it is crucial to understand the distribution and occurrence of phytochemicals about their qualities, particularly the trace and hazardous components in such widely used medicinal plants. Ayurvedic and allopathic medications are produced using a variety of pharmaceutical firms' utilization of several such plants.

Studying trace elements and poisonous heavy metals is crucial because these substances are crucial in synthesizing the chemical compounds that give medicinal plants their therapeutic and hazardous qualities [2]. Even while some metals, including zinc, iron, copper, and cobalt, are necessary nutrients, they are reportedly hazardous at large concentrations, while other metals, like lead and cadmium, are just harmful and have no beneficial effects.

Better quality control procedures must be maintained for these therapeutic plants to safeguard customers against adulteration. Due to the existence of poisonous components, many medicinal plants and their blends can be harmful to health. To ascertain the efficacy of medicinal plants in treating various diseases and comprehend their pharmacological activity, it is crucial to quantify the amounts of several trace elements. Trace element analysis is also employed in medicinal plants to determine the dose of the herbal medicines made from these plant components. To comprehend the nutritional significance of food and associated items, element compositions in such products must be determined [2, 3]. Therefore, it is crucial to comprehend the phytochemical characteristics, particularly the trace and hazardous components in such widely used therapeutic plants.

Keeping in view the increasing trend in using herbal medicines around the world and the importance of testing the trace and toxic elements present especially on those plants commonly consumed orally, the present investigation is planned with the aim of phytochemical and multi-elemental analysis of seven medicinally consumed Zingiberaceae plants, namely *Zingiber zerumbet* (Yaiimu), *Kaempferia rotunda*

(Bhui Champa), *Kaempferia galanga* (Kenchur), *Curcuma zedeoaria* (Kachur), *Zingiber rubens* (Phachang), *Costus speciosus* (Beth Lauro), *Hedychium flavescens* (Kaahili), taking into consideration the rising trend of using herbal medicine.

MATERIALS AND METHODS

Phytochemical Investigation:

The conventional protocols were used to conduct the phytochemical test of the medicinal plant that is ingested orally, with a few minor modifications to identify the various ingredients [4, 5].

Collection and Authentication of Medicinal Plants

The fresh sample of rhizomes of different plants (Zingiberaceae) was collected from cultivated and naturally grown areas of Rishop, Lava, and Kafer of Kalimpong district, of West Bengal, India. Selected plant samples were identified at Regional Research Station, Hill Zone, Uttar Banga Krishi Viswavidyalaya (UBKV), Kalimpong and where it was maintained in the field gene bank.

Drying of Sample

The rhizomes from the gathered plant samples were carefully washed twice with tap water, dried by air, thinly sliced, and oven-dried for two days at 40°C before being crushed into a homogeneous powder with a Philips Mixer Grinder.

Preparation of Plant Extracts:

Following drying, aqueous and ethanol extraction were performed on the samples of powdered plants. An aqueous extract was made from the dry powder sample for the qualitative examination of alkaloids, anthraquinones, tannins, and terpenoids. Each sample was precisely weighed at 10 g using an automated balance. Samples were weighed and then put into a beaker with 100 ml of distilled water. Sample-containing beakers were appropriately foil-sealed and kept at room temperature for 12 hours [4].

A dry powder sample was made into an ethanol extract for flavonoids, glycosides, saponin, and steroids. On an electronic weighing balance, each sample was carefully weighed at 2 g. Samples were weighed and then put into a beaker with 20 ccs of ethanol. After being carefully sealed with aluminum foil, the beakers containing the samples were kept at room temperature for 72 hours [5].

Phytochemical Analysis

Qualitative tests used for the identification of phytoconstituents are described in (Table 1).

Multi elemental profiling:

The Anton Par Multi-wave 3000, an Indian company, was used to microwave-digest dried materials under the following conditions: power: 1200 W; IR: 190°C; rate: 0.3 bar/sec; ramp: 5 min; hold: 7 min; sample size: 0.1 g; acids utilized: HNO_3: 5 ml and HCl: 1 ml. After being digested, the samples were cooled, and DDW was used to increase the volume to 50 ml. The samples were analyzed using an Inductively Coupled Plasma Mass Spectrometry (ICP-MS) system with a cross-flow nebulizer (Perkin Elmer, Nex ION 300 X, USA). Utilizing accepted reference material, the device was calibrated (Peach leaves- NIST 1547). The ionic composition of the digested samples was examined using a multi-element standards solution. Data were statistically analyzed using JMP Pro 11 for all experiments performed in triplicate and with a randomized design. The experimental results were evaluated using a one-way analysis of variance (ANOVA). The residual plots were examined to ensure that the data were consistent with normality. At p 0.05, the significance of mean differences was determined.

RESULTS AND DISCUSSION

Phytochemicals Analysis

Plants are known to contain a wide range of secondary metabolites, including volatile oils, tannins, terpenoids, alkaloids, flavonoids, phenols, steroids, glycosides, and glycoside analogs. Identification of the phytochemical elements used by herbalists in the treatment of ailments is important [6]. Some of the biological activity of specific plant extracts may be explained by the presence or lack of specific phytochemicals. For instance, saponins, a particular type of glycoside with soap-like properties, are effective antifungal agents. Numerous tannins, flavonoids, and alkaloids have been found to have antimicrobial effects [7].

The present study analyzed the presence and absence of Alkaloids, Anthraquinones, Flavonoids, Glycosides, Tannins, Terpenoids, Saponins, and Steroids in these above-mentioned seven species of Zingiberaceae in aqueous and ethanolic extracts.

The phytochemical characteristics of the seven plants investigated are summarized in Table 2. In aqueous extracts, alkaloids were abundantly present in *Zingiber zerumbet*, *Kaempferia rotunda*, *Kaempferia galanga,* and *Curcuma zedeoaria* which corroborated with the results of earlier studies [8, 9, 10, 11]. It showed moderate presence in *Hedychium flavescens* and *Zingiber rubens with* a completely absent in *Costus speciosus* Smith [7]. The aqueous extracts of Anthraquinones in all plant species considered in the present study showed negative results. Three species of the Zingiberaceae family *Zingiber zerumbet, Kaempferia galanga,* and *Hedychium flavescens* exhibit abundant Flavonoids, which was contradictory to the study by [11] Prakash *et. al.* in *Zingiber zerumbet* showing its absence. Its moderate presence in *Curcuma zedeoaria* and completely absent in *Zingiber rubens, Kaempferia rotunda* and *Costus speciosus* is in contrast to the results of other studies [7, 9]. Glycosides were abundantly present in *Zingiber rubens,* and fairly present in *Curcuma zedeoaria with negative results in Zingiber zerumbet*, *Kaempferia rotunda*, *Kaempferia galanga*, *Costus speciosus*, *Hedychium flavescens*.

The ethanolic extraction process of rhizomes was used to evaluate the tannins, terpenoids, saponins, and steroids in all seven species of the Zingiberaceae family. The present study reiterates the absence of Tannins in all species of the Zingiberaceae family studied.

Terpenoids was abundantly present in *Curcuma zedeoaria*, *Zingiber rubens* and with moderation in *Kaempferia galanga* and *Kaempferia rotunda.* The other three species, Zingiber zerumbet, Costus speciosus, and Hedychium flavescens, showed negative results. Only *Costus speciosus* exhibit an abundant amount of Saponins in the extracts of rhizome with negative results shown by *Zingiber zerumbet, Kaempferia rotunda*, and *Zingiber rubens*. The presence of flavonoids and phenols makes the plant species a strong candidate for the study of antioxidants [12]. The presence of phenolic compounds also serves as the foundation for the antioxidant potential. Saponins are present in both the tubers and the roots. It has been claimed that saponins have hypotensive and plasmolytic effects. Saponins are a unique family of glycosides resembling soap and reportedly effective antifungal agents [7]. Similarly, *Kaempferia galanga*, *Curcuma zedeoaria*, and *Hedychium flavescens* showed possession of Saponins in moderation. Overall, all species selected under the present study shown to exhibit varying levels of steroids, with a maximum in *Kaempferia rotunda*, *Zingiber rubens*, and *Hedychium flavescens*, moderate to fairly in *Costus speciosus Zingiber zerumbet, Kaempferia galanga, and Curcuma zedeoaria.* All of the plants under study were found to contain steroids and phlobatannins. Some of these plants under investigation were found to possess steroidal chemicals. It should be mentioned that steroidal chemicals are significant and of interest to the pharmaceutical field because of their interactions with substances like sex hormones [13, 14]. The medicinal effect of these plant species may be due to the presence of phytochemicals such as alkaloids, flavonoids, saponins, and phenols that have demonstrated therapeutic actions.

Multi-elemental profiling

Data of multi-elemental profiling is presented in Table 3 for the species under along with rhizomes of *Zingiber officinale* and *Curcuma longa* [15].

The seven species showed higher amounts of Mg, Cu and Na compared to their cultivated relatives while Ca and Zn were found to be lower in the species in our study. Each of these species showed a higher amount of the essential element. Most of the non-essential elements were found to be higher in these species *Zingiber zerumbet* (Cu, Zn), *Kaempferia galanga* (Mg, I), *Curcuma zedeoaria* (Mo), *Zingiber rubens* (S, B), *Costus speciosus* (Co), *Hedychium flavescens* (Ca). Because of its role in the structural, catalytic, and regulatory processes of the body's immunity, brain function, and fetal growth and development, zinc (Zn), of all the investigated elements of the human diet, is the least hazardous and a necessary element in humans which was found in the the the comparable quantity needed in the plant species studied. Copper is required as a cofactor in several crucial enzymes, including cytochrome P450 oxidase and superoxide dismutase in people [16]. Along with Fe, Zn, Ca, and Mg, Cu is a mineral element that is deficient in the average person's diet [17]. All the species had a considerable quantity of copper, ranging from 5.91 to 12.03 mg/100g dry weight. Al was abundant and others in descending order by quantity were Si, Na, Ba, Ce, Li, Hg, Pb, Ag, and Cs. All of the species were reported to be good and abundant sources of all of the macro elements as well as microelements, indicating that these species may be possible sources of minerals in areas where malnutrition, hunger, and their use in medicinal and nutraceutical purposes [18].

Table 1: Qualitative Phytochemical screening in aqueous and ethanolic extract

S. No	Phytochemicals	TEST	Inference
1.	Alkaloids	Mayer's test	Cream coloured precipitate
2.	Anthraquinones	-	Pink colour precipitate
3.	Flavonoids	Lead acetate test	Yellow precipitate
4.	Glycosides	Benedict test	Brown or red Precipitate
5.	Tannins	Ferric chloride test	Brownish green or blue-black colour
6.	Terpenoids	Salkowski's test	Reddish brown colouration of the inter face
7.	Saponins	Foam test	Persistent foam for ten minutes
8.	Steroids	Salkowski's test	Red colour

Table 2: Phytochemicals analysis of seven species of Zingiberaceae

S No	Scientific Name	Aqueous Extract				Ethanolic Extract			
		Alkaloids	Anthraquinones	Flavonoids	Glycosides	Tannins	Terpenoids	Saponins	Steroids
1.	*Zingiber zerumbet*	+++	-	+++	-	-	-	-	+
2.	*Kaempferia rotunda*	+++	-	-	-	-	+	-	+++
3.	*Kaempferia galanga*	+++	-	+++	-	-	++	+	+
4.	*Curcuma zedeoaria*	+++	-	++	+	-	+++	+	+
5.	*Zingiber rubens*	+	-	-	+++	-	+++	-	+++
6.	*Costus speciosus*	-	-	-	-	-	-	+++	++
7.	*Hedychium flavescens*	++	-	+++	-	-	-	+	+++

Table 3: Multi-elemental profile of the seven species of Zingiberaceae (mg/100 g of dry weight)

	Zingiber zerumbet	*Kaempferia rotunda*	*Kaempferia galanga*	*Curcuma zedeoaria*	*Zingiber rubens*	*Costus speciosus*	*Hedychium flavescens*	*Zingiber officinale*	*Curcuma longa*
Essential elements									
S	20.35	19.82	19.78	19.94	20.26	24.39	14.24	-	-
Ca	12.96	6.77	16.48	14.41	14.63	17.38	22.25	114	168
Mg	694.92	375.38	860.23	761.55	550.28	720.00	385.29	-	208
Na	31.73	9.11	23.93	21.44	21.42	29.56	19.94	27	27
B	1.04	0.93	1.44	0.85	6.32	0.97	1.04	-	-
Cu	12.03	9.71	8.65	9.91	8.04	9.32	5.19	0.48	1.3
Zn	2.51	1.90	2.48	2.29	1.89	1.80	1.00	3.64	4.5
Mo	1.8	3.16	7.76	8.67	2.82	1.86	0.59	-	-
Co	0.28	0.15	0.28	0.29	0.13	0.39	0.16	-	-
I	ND	ND	0.11	0.09	ND	ND	ND	-	-
Non - Essential elements									

Ba	26.94	12.02	25.45	22.24	28.01	19.47	24.22	-	-
Pb	0.92	0.61	0.54	0.53	0.47	0.66	0.27	-	-
Ag	0.22	0.08	0.60	0.51	0.41	ND	0.02	-	-
Al	71.40	9.16	136.53	135.39	31.87	89.84	47.52	-	-
Cd	0.49	0.55	1.68	1.73	0.35	0.25	0.06	-	-
Cs	0.41	0.24	0.30	0.31	0.42	0.40	0.16	-	-
Li	1.17	0.67	1.70	1.90	0.81	1.35	0.82	-	-
U	0.03	0.01	0.06	0.05	0.01	0.03	0.01	-	-
Hg	0.35	0.61	1.68	1.63	0.24	0.68	0.35	-	-
Si	27.61	18.15	18.19	20.34	34.64	15.00	4.41	-	-
Ce	1.07	0.33	2.35	2.10	0.41	0.91	0.77	-	-

CONCLUSION

The variation in phytochemical and mineral contents in the species depends on a variety of factors, such as soil availability, soil compositions, and interactions between the environment and genetics (GxE), causing discrepancies between our results and those of others. The seven plants in the Zingiberaceae family showed the presence of alkaloids, anthraquinones, terpenoids, flavonoids, glycosides, saponins, tannins, and steroids in aqueous and ethanolic extracts, which can be separated and subsequently tested for various biological activities depending on their medicinal uses. These plants mineral analyses revealed that they are reliable sources of Mg, Cu, Zn, Mo, and Na.

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Conflict of Interest

None declared.

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