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Comparison Study for the Phytochemical Constituents of two *Curcuma* Species by GC-MS Technique

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ABSTRACT

Curcuma, a major Zingiberaceae genus, contains approximately 110 species throughout the Asia-Pacific region. The present work aimed to study the two Indian *Curcuma* species, *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb., whose rhizomes are extracted using ultrasound-assisted extraction (UAE) with chloroform solvent. The extracts are subjected to phytochemical screening and analysed employing gas chromatography-mass spectrometry (GC-MS) procedures. UAE studies of these two *Curcuma* species' rhizomes using chloroform as a solvent have been conducted for the first time. The chloroform extracts of *Curcuma caesia* and *Curcuma angustifolia* contain twenty-six and thirty-two components, respectively. The component with the highest area percentage in both species was 2-cyclohexen-1-one, 4-ethynyl-4-hydroxy-3,5,5-trimethyl (2CEHT), a cyclic unsaturated ketone having anticancer effects. The GC-MS measurement data and phytochemical screening results provide an update on the physiologically active phytoconstituents detected in rhizome extracts, which may be used to standardise crude plant extracts and understand the species' chemical composition and medicinal potential.

Keywords: *Curcuma caesia* Roxb, *Curcuma angustifolia* Roxb, Ultrasound-assisted extraction, GC-MS, Chloroform, Rhizome.

INTRODUCTION

Curcuma caesia Roxb. and *Curcuma angustifolia* Roxb. are two species belonging to the *Curcuma* genus, which is a part of the Zingiberaceae family. *Curcuma angustifolia* Roxb. is distributed in the Northeast, Madhya Pradesh, Uttar Pradesh, and Himachal Pradesh, while *Curcuma caesia* Roxb. is found in the Indian states of West Bengal, Orissa, Uttar Pradesh, Madhya Pradesh, Sikkim, and Chhattisgarh. In terms of importance and use, *Curcuma angustifolia* Roxb.is used in the production of arrowroot powder, and its rhizomes are used to make food. It is also used to treat diarrhoea, fever, and pain, and is a demulcent and blood-clotting agent.[1] *Curcuma caesia* Roxb. is utilised as a folk medicine and has antiasthmatic, anticancer, antiallergy, and anti-inflammatory qualities. The rhizome has been used as a condiment and food preservative.[2,3]

Medicinal plants are appreciated for their therapeutic phytoconstituents, which may lead to the development of new medications. Because of the

phytochemicals found in medicinal plants, as well as the pharmaceutical and cosmetic industries' shift towards organic products, medicinal plant research is just as essential as traditional drug research.[4] Phytoconstituents from plants must be extracted and measured in order to discover novel compounds or use them as a lead molecule in the production of more effective medicinal molecules.[5] Extraction is critical in phytochemical processing for identifying and evaluating bioactive phytoconstituents from plant sources. Common extraction methods include decoction, hot continuous extraction, percolation, maceration, infusion, and others.[6] Modern extraction methods, such as supercritical fluid extraction (SFE), microwave-assisted extraction (MAE), and ultrasound-assisted extraction (UAE), are constantly being developed to improve production while lowering costs.[4] Heat extraction has the potential to destroy thermolabile natural substances. Ultrasound-Assisted Extraction (UAE) accelerates and cools the extraction process. Ultrasound cavitates and ruptures cell walls, accelerating the extraction of active plant components from the matrix and enhancing mass transfer.[7]

Solvent plays a vital part right through the extraction process and the type of solvent to be used is determined based on the nature of phytoconstituents to be extracted. For the extraction of the nonpolar secondary metabolites from plants, non-polar solvents are usually used. The extracts are subjected to GC-MS testing to understand the phytoconstituents present and to uncover information about their mass and structures.[8–11] The use of UAE in chloroform extracts of *Curcuma caesia* Roxb. rhizomes are reported in this study for the first time. There have been no reports of *Curcuma angustifolia* Roxb. rhizome extracts being investigated by the UAE. This study of the phytoconstituents of a UAE rhizome chloroform extract sheds insight on its therapeutic potential The information presented in this study will help reaffirm the usage of *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb. rhizomes as reserves for medicinal phytoconstituents and can provide a pathway for developing herbal products based on the identification of the components and understanding its nature from the present study.

MATERIALS AND METHODS

Plant collection

The *Curcuma caesia* Roxb. rhizome was gathered in March 2020 and 2021 from the ICAR-IISR (Indian Institute of Spices Research Kozhikode), located in Kerala. ICAR-IISR authenticated and maintained the rhizome under accession number Acc. 292 (IC 349014).

Curcuma angustifolia Roxb. rhizome was obtained from Jorhat, Assam, in the month of February every year between 2020-2021. Plant authentication with Accession No. was given by CSIR-National Botanical Research Institute (NBRI) Herbarium (LWG) 109910.

Chemicals

Analytical grade chloroform was used for the study. Whatman Filter Paper 41 and MDI 0.45 micron nylon syringe filters were used for the filtration of extracts.

Sample preparation

GC-MS Analysis

The rhizomes underwent a thorough scrubbing with water, followed by division into small pieces and subsequent drying for five days in shade. They were then powdered in a mixer grinder and sifted to obtain a fine powder. The powdered rhizomes were stored in covered jars and used for upcoming experiments. The rhizome powder and the solvent (chloroform) were taken in a ratio of 1:25 and sonicated for 30 min using an ultrasound sonicator water bath.[13] The extraction was performed in a pulsed manner over 11 and 19 min with 2-3 min breaks in between. The temperature was maintained between 25°C and 30°C. Following sonication, ashless filter paper 41 from Whatman was used to sift the extracts, which were then filtered again through a nylon syringe filter of 0.45 micron before being introduced into the GC-MS instrument.

Phytochemical screening

The extracts filtered through Whatman Filter Paper 41 were utilized in the qualitative phytochemical screening studies.

Instrumentation

Sonicator

The Dakshin, 200H sonicator had a stainless steel tank with a capacity of 6.5 litres, an ultrasonic frequency of 36±3 kilohertz (KHz), and an ultrasonic power of 200 watts. It required an electric supply of 230 volts A.C, 50 Hz, and could operate at a maximum temperature of 60°C.

GC-MS

The GC-MS is a Shimadzu GCMS-QP2010 Plus model coupled with the GCMS-QP2010 Ultra Mass Spectrometer.

GC condition

The analysis by GC-MS was carried out on a capillary column, Restek Rtx-5MS, having dimensions measuring 30 metres x 0.25 millimetres ID, 0.25 micron with helium being the carrier gas and pressure as the flow control mode set at 83.5 kilopascals (kPa). The oven was programmed to heat at 80°C during the first 5 min then upstretched to 150°C at a scale of 10°C each minute and kept for 2 min afterwards elevated to 220°C at an amount of 10°C for every minute and placed constant for 2 min and ultimately enhanced to 290°C at the same proportion of 10°C every single minute and stationed for 5 minutes. The entire duration of the run was 35 minutes.[14] The temperature of the injector port was 250°C. The volume injected was 2 microlitres (µL) with a split ratio of 90.0.

MS condition

The ion source and interface were heated to 220°C and 260°C, respectively. The detector gain was set at 1.03 kilovolts (kV). The solvent cut time was maintained at 2.0 min and the scan start time and end time were 2.0 min and 34.0 min respectively, with a start mass to charge (m/z) of 35.0 and an end m/z of 700.0. The scan speed was set at 2500. The data processing of mass spectra and chromatograms was performed using LabSolutions' GCMS Solution Version 2.70 software. The NIST 11 library database was used for identifying the chemical components.

RESULTS

A crucial tool in the bioactive component investigations, phytochemical screening is an easy and rapid process that provides a quick answer to the various types of phytochemicals in the extracts. This screening helps to gain awareness of the types of phytochemicals that are existent in the extracts.[15] The outcomes of the phytochemical diagnosis of both extracts presented in Table 1 reveal the existence of steroids, terpenoids, phenolic compounds, and cardiac glycosides, but tannins, quinones, flavonoids, alkaloids, and amino acids are absent.

Table 1: Phytochemicals screening data for *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb. chloroform extracts

Phytochemical Constituents	Test	Observation		Inference		References
		C. caesia	*C. angustifolia*	*C. caesia*	*C. angustifolia*	
Terpenoids	Extract+1 mL $CHCl_3$+few drops of concentrated. H_2SO_4	Reddish brown colour interface appears	Reddish brown colour interface appears	Positive	Positive	16
Steroids	Extract+5 mL $CHCl_3$+5 mL concentrated. H_2SO_4	Reddish top layer, sulphuric acid layer changed to yellowish	Reddish top layer, sulphuric acid layer changed to yellowish	Positive	Positive	
Tannins	Extract+1 mL of 5% $FeCl_3$	Two layers observed. upper red and lower yellow	Two layers observed. upper red and lower yellow	Negative	Negative	
Amino acid	Extract+3 drops of 5% lead acetate and heat the resulted solution	No blue/purple colour was observed	No blue/purple colour was observed	Negative	Negative	
Flavonoids	Extract+2 mL of 10% lead acetate	Two layers observed. and lower yellow and upper layer colourless	Two layers observed. and lower yellow and upper layer colourless	Negative	Negative	
Alkaloids	Extract+few drops of picric acid solution (in alcohol)	No yellow-coloured precipitate observed	No yellow-coloured precipitate observed	Negative	Negative	
Phenolic compounds	Extract+few drops of diluted Iodine solution	Transient reddish colour observed	Transient reddish colour observed	Positive	Positive	17
Quinone	Extract+4 drops of Isopropyl alcohol+1 mL of concentrated. H_2SO_4	Wine red colour observed	Wine red colour observed	Positive	Positive	
Cardiac Glycosides	Extract+1 mL glacial acetic acid+ 1 mL $FeCl_3$+4 drops of concentrated. H_2SO_4	Slight greenish blue colour observed	Slight greenish blue colour observed	Positive	Positive	

The assessment of phytoconstituents encompassed in the prepared extract from *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb. rhizomes were carried out, and the results obtained were shown in Figures 1 and 2, respectively,

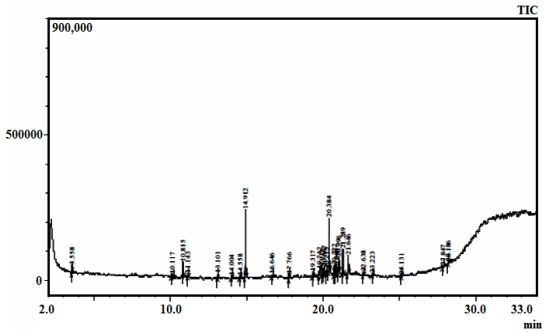

Fig. 1. GC-MS spectrum of *Curcuma caesia* Roxb. rhizome extract

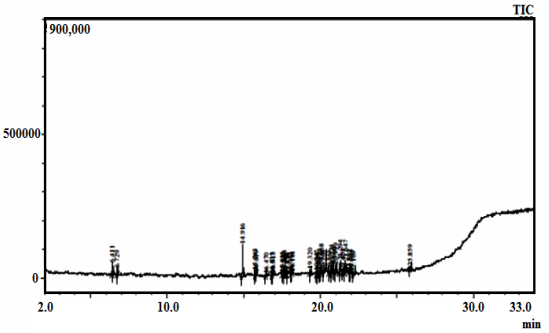

Fig. 2. GC-MS spectrum of *Curcuma angustifolia* Roxb. rhizome extract

The GC-MS spectrum for *Curcuma caesia* Roxb. rhizome extract showed 26 peaks with different retention times, and peak areas with molecular weights for each identified compound, as shown in Table 2.

Table 2: Phytoconstituents in *Curcuma caesia* Roxb. rhizome chloroform extract

Peak No	Name	Retention Time(min)	Area%	Molecular weight	Molecular formula
1	Eucalyptol	3.558	2.15	154	$C_{10}H_{18}O$
2	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-,[1R-(1R*,4Z,9S*)]-	10.117	2.91	204	$C_{15}H_{24}$
3	(-)-Aristolene	10.815	6.50	204	$C_{15}H_{24}$
4	n-Tridecan-1-ol	11.143	1.73	200	$C_{13}H_{28}O$
5	Phenol, 2,4-bis(1,1-dimethylethyl)-	13.101	1.40	206	$C_{14}H_{22}O$
6	2H-3,9a-Methano-1-benzoxepin, octahydro-2,2,5a,9-tetramethyl-, [3R-(3.alpha.,5a.alpha.,9.alpha.,9a.alpha.)]-	14.004	1.10	222	$C_{15}H_{26}O$
7	1-Pentadecene	14.558	1.22	210	$C_{15}H_{30}$
8	2-Cyclohexen-1-one, 4-ethynyl-4-hydroxy-3,5,5-trimethyl-	14.912	24.42	178	$C_{11}H_{14}O_2$
9	Bufa-20,22-dienolide, 3-hydroxy-15-oxo-, (3.beta.,5.beta.,14.alpha.)-	16.646	0.91	384	$C_{24}H_{32}O_4$
10	1-Nonadecene	17.766	1.56	266	$C_{19}H_{38}$
11	Cyclohexane, 1,1-bis(5-methyl-2-furyl)-	19.317	2.20	244	$C_{16}H_{20}O_2$
12	1,6-Dimethyl-9-(1-methylethylidene)-5,12-dioxatricyclo[9.1.0.0(4,6)]dodecan-8-one	19.742	1.84	250	$C_{15}H_{22}O_3$
13	n-Hexadecanoic acid	19.913	0.74	256	$C_{16}H_{32}O_2$
14	2,11-Dioxatetracyclo[4.3.1.1(3,10).0(6,9)] undec-4-ene, 3,7,7,10-tetramethyl-	20.067	2.16	206	$C_{13}H_{18}O_2$
15	n-Tetracosanol-1	20.215	1.30	354	$C_{24}H_{50}O$
16	2,2,7,7-Tetramethyltricyclo[6.2.1.0(1,6)] undec-4-en-3-one	20.384	15.59	218	$C_{15}H_{22}O$
17	1,2-Dimethyl-5-nitroadamantane	20.722	3.05	209	$C_{12}H_{19}NO_2$
18	Phenol, 3-ethyl-, acetate	20.860	1.48	164	$C_{10}H_{12}O_2$
19	2-(1-(Beta-d-glucopyranosyloxy)-1-methylethyl) -2,3-dihydro-7-oxo-7H-furo(3,2-g)chromene, (R)-	20.996	5.72	408	$C_{20}H_{24}O_9$
20	Pregn-4-ene-1,20-dione, 12-hydroxy-16,17-dimethyl-	21.289	9.04	358	$C_{23}H_{34}O_3$
21	2-Propenal, 3-(2,6,6-trimethyl-1-cyclohexen-1-yl)-	21.646	8.93	178	$C_{12}H_{18}O$
22	Cyclopropa[c,d]pentalene-1,3-dione, hexahydro-4-(2-methyl-2-propenyl)-2,2,4-trimethyl-	22.638	1.23	232	$C_{15}H_{20}O_2$
23	Cyclohex-2-enone, 3-(N',N'-dimethylhydrazino)-5-(3-methoxyphenyl)-	23.223	1.27	260	$C_{15}H_{20}N_2O_2$
24	1-Nonadecene	25.131	0.62	266	$C_{19}H_{38}$
25	Purine-2,6-dione, 8-(3-ethoxypropylamino)-1,3-dimethyl-3,9-dihydro-	27.847	0.42	281	$C_{12}H_{19}N_5O_3$
26	1,10-Diazacyclooctadecane	28.186	0.51	254	$C_{16}H_{34}N_2$

The chromatographic sketching showed the presence of phenolic compounds, terpenoids, steroid and aromatic compounds. 2-Cyclohexen-1-one, 4-ethynyl-4-hydroxy-3,5,5-trimethyl- referred as 2CEHT was the component with the highest area concentration with 24.42%, followed by 2,2,7,7-Tetramethyltricyclo[6.2.1.0(1,6)]undec-4-en-3-one with 15.59%, Pregn-4-ene-1,20-dione, 12-hydroxy-16,17-dimethyl- with 9.04%, 2-Propenal, 3-(2,6,6-trimethyl-1-cyclohexen-1-yl)- with 8.93%, and (-)-Aristolene with 6.50% were the other major components detected. Eleven components had an area concentration greater than 2%.

The results also indicate 32 peaks in the GC-MS spectra for *Curcuma angustifolia* Roxb. rhizome extract with different retention times, and peak areas, with molecular weights for each identified compound as shown in Table 3.

Table 3: Phytoconstituents in *Curcuma angustifolia* Roxb. rhizome chloroform extract

Peak No	Name	Retention Time(min)	Area%	Molecular weight	Molecular formula
1	(+)-2-Bornanone	6.411	6.62	152	$C_{10}H_{16}O$
2	Isoborneol	6.729	4.67	154	$C_{10}H_{18}O$
3	2-Cyclohexen-1-one, 4-ethynyl--4-hydroxy-3,5,5-trimethyl	14.916	20.55	178	$C_{11}H_{14}O_2$
4	2-Naphthalenemethanol, decahydro-.alpha.,.alpha.,4a-trimethyl-8-methylene-, [2R-(2.alpha.,4a.alpha.,8a.beta.)]-	15.743	2.98	222	$C_{15}H_{26}O$
5	1-Naphthalenol, decahydro-1,4a-dimethyl-7-(1-methylethylidene)-, [1R-(1.alpha.,4a.beta.,8a.alpha.)]-	15.819	1.49	222	$C_{15}H_{26}O$
6	3,7-Cyclodecadien-1-one, 3,7-dimethyl-10-(1-methylethylidene)-, (E,E)-	16.470	1.34	218	$C_{15}H_{22}O$
7	dl-Phenylephrine	16.835	0.52	167	$C_9H_{13}NO_2$
8	Tricyclo[4.3.1.1(3,8)]undecane-1-carboxylic acid	16.915	1.75	194	$C_{12}H_{18}O_2$
9	Acetic acid, trifluoro-, octahydro-4-hydroxy-1,5-methano-1H-inden-1-yl ester (1.alpha.,3a.beta.,4.beta.,5.beta.,7a.beta.)-	17.515	1.41	264	$C_{12}H_{15}F_3O_3$
10	Propanoic acid, 2-[(1-cyclohexylethyl) carbamoyl]-, ethyl ester	17.590	0.47	255	$C_{14}H_{25}NO_3$
11	(-)-Spathulenol	17.644	1.78	220	$C_{15}H_{24}O$
12	2-Methyl-6,7-dihydro-5H-benzofuran-4-one	17.796	0.31	150	$C_9H_{10}O_2$
13	1-(3,5-Dimethyl-1-adamantanoyl) semicarbazide	17.834	0.11	265	$C_{14}H_{23}N_3O_2$
14	2-Propen-1-amine, N, N-di-2-propenyl-	18.042	0.36	137	$C_9H_{15}N$
15	1-Indolinecarboxaldehyde, 2-hydroxy-5-methoxy-	18.181	0.37	193	$C_{10}H_{11}NO_3$
16	2,11-Dioxatetracyclo [4.3.1.1(3,10).0(6,9)] undec-4-ene, 3,7,7,10-tetramethyl	19.320	2.84	206	$C_{13}H_{18}O_2$
17	1,6-Dimethyl-9-(1-methylethylidene)-5,12-dioxatricyclo [9.1.0.0(4,6)] dodecan-8-one	19.747	2.36	250	$C_{15}H_{22}O_3$
18	Columbin	19.820	0.41	358	$C_{20}H_{22}O_6$
19	n-Hexadecanoic acid	19.924	3.69	256	$C_{16}H_{32}O$
20	2,11-Dioxatetracyclo [4.3.1.1(3,10).0(6,9)] undec-4-ene, 3,7,7,10-tetramethyl	20.068	3.65	206	$C_{13}H_{18}O_2$
21	6-(1-Hydroxymethylvinyl)-4,8a-dimethyl-3,5,6,7,8,8a-hexahydro-1H-naphthalen-2-one	20.209	1.77	234	$C_{15}H_{22}O_2$
22	Androst-5-en-7-one, 3-(acetyloxy)-4,4-dimethyl-, (3.beta.)-	20.563	0.85	358	$C_{23}H_{34}O_3$
23	1,2-Dimethyl-5-nitroadamantane	20.724	4.75	209	$C_{12}H_{19}NO_2$
24	4-Isopropyl-3,4-dimethylcyclohexa-2,5-dienone	20.860	1.65	164	$C_{11}H_{16}O$
25	2-(1-(Beta-d-glucopyranosyloxy)-1-methylethyl)-2,3-dihydro-7-oxo-7H-furo(3,2-g)chromene, (R)-	20.999	6.21	408	$C_{20}H_{24}O_9$
26	Spiro[2,4,5,6,7,7a-hexahydro-2-oxo-4,4,7a-trimethylbenzofuran]-7,2'-(oxirane)	21.294	7.52	208	$C_{12}H_{16}O_3$
27	Diethylmalonic acid, 2-methoxyethyl tetradecyl ester	21.451	2.09	414	$C_{24}H_{46}O_5$
28	4H-1,3,2-Dioxaborin, 4,6-diethenyl-2-ethyl-4-methyl-	21.647	10.00	178	$C_{10}H_{15}BO_2$
29	Oxacyclopentadecan-2-one, 15-methyl-	21.892	0.87	240	$C_{15}H_{28}O_2$
30	Diisooctyl maleate	22.005	1.71	340	$C_{20}H_{36}O_4$
31	Octadecanoic acid	22.169	2.51	284	$C_{18}H_{36}O_2$
32	Isoxazole, 5-chloro-4-(2-phenylethyl)-	25.859	2.37	207	$C_{11}H_{10}ClNO$

The components class detected comprises of sesquiterpenoid alcohols, terpenoids, fatty acids and phenolic compounds. 2CEHT with 20.55%, was the component with the highest area concentration. 4H-1,3,2-Dioxaborin, 4,6-diethenyl-2-ethyl-4-methyl- with 10.00%, Spiro[2,4,5,6,7,7a-hexahydro-2-oxo-4,4,7a-trimethylbenzofuran]-7,2'-(oxirane) with 7.52 %, (+)-2-Bornanone with 6.62, 2-(1-(beta-d-glucopyranosyloxy)-1-methylethyl)-2,3-dihydro-7-oxo-7H-furo(3,2-g) chromene, (R)-denoted as 2BGDFC with 6.21, 1,2-dimethyl-5- nitroadamantane with 4.75%, and isoborneol with 4.67% were some of the other major components detected. Fifteen components had an area concentration greater than 2%.

DISCUSSION

GC-MS method conditions

By carefully establishing the analysis method conditions, the extracts underwent GC-MS screening in order to achieve uniform peak responses, optimal peak separation, and peak resolution. The detectable peaks were identified by name, mass, and structure. A nonpolar column, Restek Rtx-5MS, with an optimum length of 30 m, a moderate ID of 0.25 mm, and a thin film thickness of 0.25 micron, was used for the study. Helium was used as the carrier gas due to its inertness, safety, and its ability to provide good separations.

A gradient temperature programme was finalised for faster elution of components from the column. A constant pressure mode was used for reduced consumption of carrier gas.[18] The initial column oven temperature was 100 degrees lower than the injection surface temperature, as this difference encouraged the analyte concentration to reach the column head at the earliest.[19] Direct injection was used for injecting the sample, as the heat at the injection interface vaporised the sample mixture before it entered the column.

To minimise the quantity of plant extract entering the column, a split ratio of 90 was used, resulting in narrow and sharp peaks. Ion source temperatures of 220°C were vital for EI ionisation.

GC-MS assessment findings

Six components were found to be common in the GC-MS data of both curcuma species. The area percentages of these phytoconstituents were equated graphically for better understanding in Figure 3.

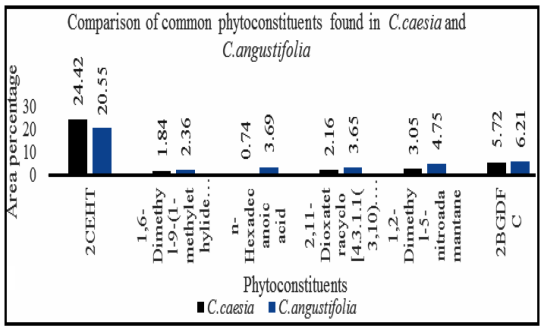

Fig. 3. Graphical comparison of area percentages of common phytoconstituents found in *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb. chloroform extracts

From the graphical representation, it is evident that the area concentration of 2CEHT is present in higher amounts as compared to other phytoconstituents in both species. This phytoconstituent is reported to be present in the essential oil of a plant species that demonstrates anticancer activity.[20]

The data from GC-MS examination of the rhizome chloroform extract of *Curcuma caesia* Roxb. prepared by UAE from this investigation were judged with the GC-MS statistics of the chloroform extract generated by Soxhlet extraction by Atom *et al.,*[12] In contrast to the twenty-six components discovered in the GC-MS study of the of *Curcuma caesia* Roxb. rhizome chloroform extract prepared by the UAE, twenty components were detected in the chloroform extract of *Curcuma caesia* Roxb. rhizomes prepared by Soxhlet extraction. Phenol, 2,4-bis(1,1-dimethylethyl)-, a phenolic component, was found common in both studies.

The ability of plants or herbs to treat disease depends on the phytochemical makeup of those substances, which displays a variety of intriguing and unique biological functions. It has been found that the various phytochemicals identified in this study have a wide range of biologic functions.[21] Table 4 lists the bioactivities reported for the phytoconstituents detected in the GC-MS evaluation of *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb. rhizomes extracted in chloroform by UAE.

As certain phytoconstituents detected in *Curcuma caesia* Roxb. and *Curcuma angustifolia*

Roxb. rhizomes demonstrate biological activity, the chloroform extracts of both these species can be standardised further and used as herbal medications for reported ailments. These phytoconstituents can be used as marker compounds and quality control tools in the standardisation of plant extracts. The data presented in this study gives scientists the chance to investigate phytoconstituents that have not yet been linked to any biological activity.

Table 4: Biological activities reported for some phytoconstituents detected in GC-MS analysis

Peak No	Retention Time	Name	Area%	Activity	References
		Curcuma caesia Roxb. rhizomes			
1	3.558	Eucalyptol	2.15	anti-inflammatory	22
3	10.815	(-)-Aristolene	6.50	Insecticidal	23
5	13.101	Phenol, 2,4-bis(1,1-dimethylethyl)-	1.40	larvicidal, repellent, acaricidal	24
8	14.912	2CEHT	24.42	anticancer	20
13	19.913	n-Hexadecanoic acid	0.74	antibacterial	25
15	20.215	n-Tetracosanol-1	1.30	antimutagenic	26
19	20.996	2BGDFC	5.72	Improving working memory dysfunction	27
		Curcuma angustifolia Roxb. rhizomes			
1	6.411	(+)-2-Bornanone	6.62	Antineoplastic, pain reliever, microbicidal, Inflammation reducer, antimycotic	28
2	6.729	Isoborneol	4.67	use against atherosclerotic disease	29
3	14.916	2CEHT	20.55	anticancer	20
11	17.644	(-)-Spathulenol	1.78	anti-inflammatory,antimicrobial, anti-proliferative,antioxidant, antifungal, antibacterial	30–32
19	19.924	n-Hexadecanoic acid	3.69	antibacterial	25
25	20.999	2BGDFC	6.21	Improving working memory dysfunction	27

Additionally, UAE had previously been utilised to unearth metabolites, ecological pigments, and bioactive compounds from other curcuma species.[33–40] The detection of bioactive phytoconstituents in the GC-MS examination of rhizome chloroform extracts of *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb. extracted by UAE defines a straightforward approach for the extraction of phytoconstituents from different plant parts with minimal processing time.

CONCLUSION

The study assessed chloroform ultrasonic-assisted extracts of *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb. rhizomes by GC-MS analysis and phytochemical screening. Results showed significant phytoconstituent extraction, highlighting the need for recurring usage of UAE in plant standardisation studies. The extracts exhibited potential therapeutic use that can be converted to prospective novel medications by performing further studies for the isolation and separation of the bioactive components found in the study. Overall, *Curcuma caesia* Roxb. and *Curcuma angustifolia* Roxb. could be crucial sources of medicine in contemporary treatment.

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Conflict of interest

The authors state that they have no competing interests to declare.

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