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A Brief Review on Evaluation and Exploration of Antioxidant Activity of Mango Ginger

Review Article

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Abstract

Many free radicals are generated during the metabolic processes in the human body and hence antioxidants are utilised to vanish their negative effects. The complex system of natural antioxidant defences or processes, which are mainly enzymatic and non-enzymatic in nature are available in human body. Free radicals are primarily responsible for the development of various diseases and disorders, including cardiovascular, inflammatory, cataract, and cancer. As a result, it is critical to protect the body from free radicals, which can be accomplished by eating a diet rich in antioxidants. And the antioxidants found in nature play a critical role in protecting the body from free radical damage. Antioxidant activity has been reported in a variety of medicinal plants and their preparations. Chemically, Mango ginger reported for the presence of phytoconstituents such as flavonoids, terpenoids, tannins, steroids, alkaloids, glycosides, and essential oils. Because of the large diversity of phytoconstituents present, the plant has a long history of medicinal relevance for a variety of ailments. It efficiently heals skin allergies, digestive issues, high blood cholesterol, and has antioxidant capabilities, according to reports. Various research publications on the antioxidant activity of mango ginger and related curcuma and other species have been collected from various journals, websites, and databases and researched and recorded systematically in this present review work

Key Words: Antioxidant Activity, Free Radicals, Flavonoids, Medicinal Plants, Mango Ginger.

Introduction

Mango Ginger (MG) is biologically known as *Curcuma amada* Roxb belongs to Zingiberaceae family. The Genus name is originated from the word 'Kumkum' in Arabic. This group includes more than 80 rhizomatous herb species that have adapted to settings ranging from sea level to as high as 2000 meters in the Western Ghats and Himalayas. This genus' geographical range includes India, Thailand, Indochina, Malaysia, Indonesia, and northern Australia. *Curcuma amada* Roxb is a rhizomatic aromatic herb popularly known as Mango Ginger that is utilized in ayurvedic medicines. It is known in India by numerous names, including Mango Ginger (English), Amradrakam (Sanskrit), and Amahaldi (Hindi). They are abundantly grown in Gujarat, West Bengal's wild areas, Uttar Pradesh, Karnataka, and Tamil Nadu. *Curcuma amada* Roxb rhizomes are traditionally used to treat skin illnesses, fever, asthma, inflammation, bronchitis, gout, male sex organ ulcers, dyspepsia, wounds, respiratory and rheumatic disorders. And the bioactive chemicals found in the rhizomes of Mango Ginger have been demonstrated to have considerable analgesic, antibacterial, anticancer, and antioxidant properties in numerous studies and researches (1) .

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Morphological characteristics

MG is a perennial herbaceous plant that grows erect to semi-erect. The rootstock, also known as the radical bulb, is ovoid/conical in shape with a buff-colored exterior surface, the rhizome is broad and branching, the flesh is light to pale yellow in color, the sessile tubers grow from the rootstock's base and are thick, cylindrical, meaty and fingered. The leaves are petiolate and big, oblong–lanceolate in shape with an acuminate apex. The leaf's upper side are glabrous and lower side are puberulous. MG bears a central or lateral inflorescence on a long, erect peduncle, which is coated in five to six sheaths and buried by the leaf sheathing bases. A spike/inflorescence with a succession of robust, straw-coloured fertile bracts forms the spike/scape/ inflorescence. A tuft of rose-coloured barren bracts, or leaves, terminates these bracts. The blooms are huge and long, pale yellow, and each bract has four to five blossoms (2).

Therapeutic uses

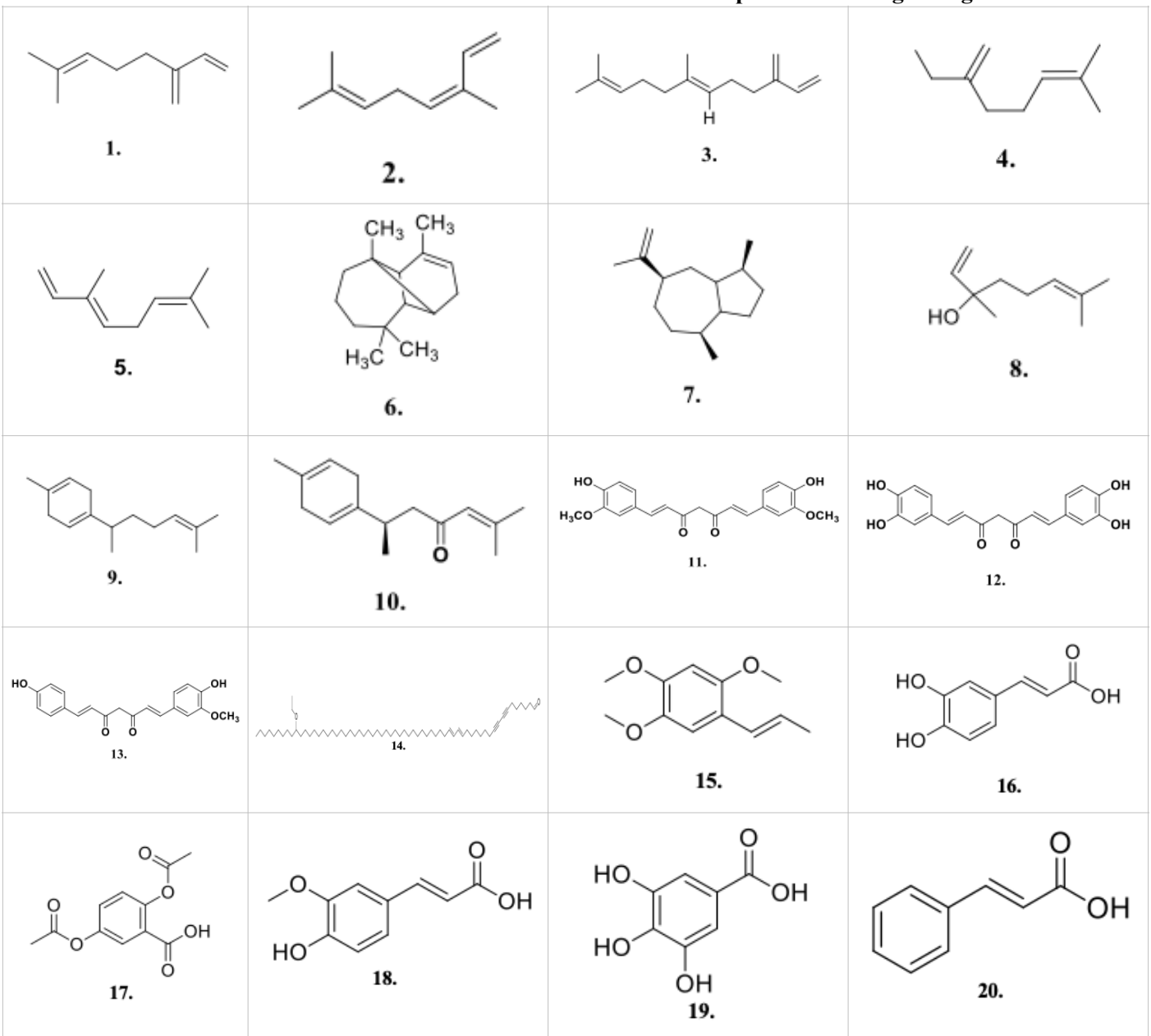
Curcuma amada Roxb (Mango Ginger) offers medicinal properties for a number of diseases. It works

well for skin allergies, digestive issues, and high cholesterol levels. It's also known for its antibacterial and antioxidant properties (1) .

Phytochemistry

The phytoconstituents present in plant mainly includes flavonoids, terpenoids, tannins, steroids, alkaloids, and glycosides. It also contains (1) Myrcene, (2) ocimene, (3) β-farnasene, (4) cis-hydro-ocimene, (5) trans-hydro-ocimene, (6) α-longipinene, (7) α-guaiene, (8) linalool, (9) β-curcumene, (10) turmerone (11) curcumin, (12) bis-demethoxycurcumin, (13) demethoxycurcumin, (14) amadaldehyde, (15) beta-asarone, (16) caffeic acid, (17) gentistic acid, (18) ferulic acid, (19) gallic acid, (20) cinnamic acid (Table 1) (3).

Table 1: The chemical structures of various constituents present in Mango Ginger



(1) Myrcene, (2) ocimene, (3) β-farnasene, (4) cis-hydro-ocimene, (5) trans-hydro-ocimene, (6) α-longipinene, (7) α-guaiene, (8) linalool, (9) β-curcumene, (10) turmerone (11) curcumin, (12) bis-demethoxycurcumin, (13) demethoxycurcumin, (14) amadaldehyde, (15) beta-asarone, (16) caffeic acid, (17) gentistic acid, (18) ferulic acid, (19) gallic acid, (20) cinnamic acid

The metabolic processes in human body leads to generation of free radicals which are dangerous to the health. The human body composed of various system of natural enzymatic and non-enzymatic antioxidant mechanisms to fight against the damaging effects of these antioxidants. Cancer, moderate cognitive impairment, cardiovascular disease, alcohol-induced liver illness, neurological disorders, Alzheimer's disease, ulcerative colitis, ageing, Parkinson's disease, and atherosclerosis are just a few of the diseases that are caused by free radicals. As a result, protecting our bodies from free radicals created in the body during various metabolic processes is critical, which can also be accomplished by eating a diet rich in antioxidants.

Antioxidants that occur naturally are very essential, and several in-vitro models can be used to identify these naturally occurring anti-oxidants. Antioxidant properties have been documented in a variety of medicinal plants (4). Mango Ginger is a basic fruit with a unique orange peel and a seed in the middle. It's also the world's most consumed tropical plant, accounting for almost 5% of global production. *Curcuma amada* is the botanical name for it. Roxb is the most well-known of the *Zingiberaceae* family's genera. Many researchers have identified it as one of the most important herbal drugs for its anti-oxidant properties (1).

A search of the literature indicated that no review articles on its antioxidant potential and exploration have been published yet. This encouraged us to begin working on the suggested review exercise. Various research publications published on the antioxidant activity of mango ginger have been collected from various journals, websites, and databases and thoroughly examined in this study. Few other research works related to anti-oxidant activity of extracts from medicinal plants also been reviewed and presented .

Materials and Methods

Collection of Data

The information regarding anti-oxidant effect of MG was reviewed by collecting data from various databases like PubChem, Scopus, Web of Science and other databases were used to collect the information. The reported research work on "Antioxidant activity of MG" were collected and downloaded. In the present review article and the various studies on evaluation of anti-oxidant potentials of MG and also other related medicinal plant species were reported and explored as below:

Angel Gabriel Rajamma *et al.*, have studied the anti-oxidant effect of MG extract. They have evaluated activity with the help of DPPH radical scavenging method. The crude extract of MG was mixed with Tween 20 and DPPH in methanol in the presence of small amount HCL buffer with P^H value of 7.9. The reaction mixture was incubated for twenty minutes and the absorbance was determined (517nm). The results of investigation showed that anti-oxidant potentials of extract (5) .

Dyrairajprema *et al.*, have reported that extract of MG was carried out based upon DPPH method. Different concentration of extracts (25-500 µg/ml) was prepared the 2.0ml of the extract from the extract were collected and added to the 0.5 ml of DPPH radical solution. The reaction mixture was kept for thirty minutes and the absorbance was determined (517nm). And they also carried out the phosphor molybdenum method, ABTS using ethanolic extract of the rhizome which shows potent free radical scavenging activity. And the anti-oxidant activity is also because of the presence of several phytoconstituents in the rhizome and the overall results of investigation showed good anti-oxidant effect (6).

Angel G R *et al.*, have reported that extract of MG extract showed promising antioxidant activity. In the methodology diluted samples was mixed with sufficient quantity of Tris HCl buffer (P^H 7.9) and DPPH solution in methanol. The solution was incubated for twenty minutes and the absorbance taken at 517 nm. The study concluded MG extract showed promising antioxidant activity (7).

Mariat George *et al.*, have reported that extract of Curcuma species showed the total antioxidant effect of essential oil. They observed that essential oil showed the high dose dependent activity than that of the ascorbic acid (8).

Dipanwitamitra *et al.*, have reported that extract of *Curcuma amada* Roxb **(**Mango ginger) that the assessment of superoxide dismutase and catalase in hepatic and renal tissues was deliberated following standard protocol and the spectroscopic technique can be carried out at the absorbance of 240nm using a spectrometer which concluded mango ginger shows antioxidant activity (9).

Vazhayiisaipriya *et al.*, have reported anti-oxidant effect of extract of MG based upon the $ABTS^+$ method. The $ABTS^+$ radical cation was used to determine the capacity of antioxidant effect of natural extracts. The cationic radical ability of methanol and acetone extracts of C. amada can be taken that shows higher activity with increasing the concentration of standard and sample (10).

Md. Sakhawat Hassain *et al.*, have evaluated and reported that the various fractions such as chloroform, aqueous, petroleum ether of the crude methanolic extract of *Curcuma amada* have good anti-oxidant, antibacterial, thrombolytic and cytotoxic activities. In that the chloroform soluble fraction exhibited very good free radical scavenging activity with IC_{50} value of about 103.09µg/ml (11).

Rohman A *et al.*, have reported that extract of MG has good anti-oxidant effect. They observed that rhizomes are rich in phenolic contents including caffeic acid and ferulic acid, terpenoids contents are difurocumenolol, amadamulon and amadaldehyde. They performed anti-oxidant activity by DPPH free radical method for methanolic extract (12).

R K Gupta *et al.*, have reported antioxidant activity of extract of MG. The antioxidant activity was measured by using various *in vitro* models like DPPH method, Nitric oxide method, and DMPD method, ABTS method, ORAC method, and TBARS assay as well as using few in vivo models in rat and mice (13).

R S Policegoudra et al., have reported the antioxidant activity of the MG by using the chloroform extract of the *Curcuma amada* rhizome and purification was carried out by liquid chromatography using silica bed column to get a pure anti-oxidant moiety and its further analyzed by UV, IR- spectroscopy and LC-MS hyphenated techniques and 2D-NMR HETCOR and compound named as "Amadannulein" and this compound had shown anti-oxidant activity against DPPH free radical scavenging activity, lipid peroxidation inhibition activity, metal chelating activity and super oxide scavenging activity (14).

R S Policegoudra *et al.,* have reported that the MG possessing very good anti-oxidant activity and it was proved by submitting the data on anti-oxidant activity of various extracts of *Curcuma amada* using solvents like chloroform, hexane, ethyl acetate, acetone, water and methanol. Out of which the chloroform extract showed good anti-oxidant activity by inhibiting lipid peroxidation pathway and metal chelating activity while the ethyl acetate extracts showed good anti-oxidant activity by DPPH free radical scavenging activity and superoxide radical scavenging activity along with good platelet aggregation and cytotoxicity activity (15).

P. Jegajeevanram *et al.*, have reported the in-vitro antioxidant activity of MG rhizome via DPPH method, total anti-oxidant assay, metal chelating activity, super peroxide and iron reducing power activity at various concentrations like 20, 40, 60, 80µg/ml and in their study they reported that the flower extract has high antioxidant activity because of presence of bioflavonoids content in the flower part of the MG (16).

Jiten Sutar *et al.,* have reported the antioxidant, antimicrobial, anti-inflammatory, anti-hyperglycemia, anticancer and analgesic activity of the MG because of the presence of the various phytoconstituents like tannins, flavonoids, alkaloids, phenolics, curcumin, dimethoxy curcumin, bis-dimethoxy curcumin etc. out of which tannins, saponins, flavonoids, alkaloids contents were higher in rhizome part and phenolic content was higher in the leaf part hence the anti-oxidant activity of the rhizome part of the *Curcuma amada* is greater than the leaf of the *Curcuma amada* by acetone extract of the rhizome is more than the methanol extract of the rhizome (17).

Prasanthi Donipati *et al.,* reported the anti-oxidant activity if the *Curcuma amada* species by comparing the antioxidant activity of chloroform, hexane and methanolic extract of rhizomes by ferric reducing antioxidant assays and reduction test for iron, DPPH free radical scavenging activity and they have plotted a graph between enzymatic and non-enzymatic antioxidant concentrations and found out that DPPH assays has more antioxidant activities more than the iron reduction test and ferric reducing assays(18).

Yanhang Chen *et al.,* have reported the antioxidant activity of MG by screening and characterizing the composition of organic volatile compounds (OVC) in the fresh rhizome part of the *Curcuma amada* namely (ZO45, ZO89, ZO114) which were originated from thr Myanmar. And they had further analyzed by using head space solid-phase microextraction technique which is coupled with the gas chromatography-mass spectrometry with the time-of-flight analyzer. As a result of this analysis, they have got 112 OVC's out of 373mass spectra of the extracted compounds. And also submitted 10 potent antioxidant and highly available compounds such as alpha-zingiberene, alpha-tumerone, alpha-santelene, cuprene, (E)-gamma-atlantone, teresantol, beta-bisabolene, beta-sesquiphellandrene, gamma-curcumene trans-alpha-bergamotene. And they have found out that the *Curcuma amada* having more accession about (15.707± 5.78[a]) for the ZO89 compound as compared to *Curcuma longa* accession for ZO138 about (0.300± 0.08[a]) (19)

Mamata Yadav *et al.,* reported the *in-vitro* antioxidant activity of MG by using extract of rhizome in methanol against the DPPH assay by utilizing standard protocols. And by phytochemical analysis they also found out the presence of various constituents such as flavonoids, phenols, saponins, tannins and alkaloids, and the quantity of flavonoids in methanolic rhizome extract of the *curcuma amada* was detected to be 2.920mg/1000mg while as the *curcuma longa* was obtained to be 2.752mg/100mg, and this was concentration dependent with the IC50 value of ascorbic acid and extracts around 14.11 and 63.67µg/ml respectively (20)

Devi P.A.V *et al.,* have reported the antioxidant activity of the MG by carrying out the *in-vitro* cytotoxicity and free radical scavenging antioxidant activity of ethanolic extract of *Curcuma amada*. The results obtained from the rhizome extract were indicated the potent scavenging of the free radical like DPPH radicals, superoxide, hydroxyl, nitric acid, ferric reducing, and lipid peroxidation pathway inhibiting activity and metal chelating activity (21).

Rajeshwari Sahu *et al.,* have reported the antioxidant activity of the MG by means of screening the total phenolic and flavonoid content in curcuma species using conventional and non-conventional methods. The amount of total phenolic content in the extract was detected using Folin-Ciocalteu reagent. And they have used gallic acid as standard for this purpose and expressed in 92.30±0.05 to 260 ± 0.025 mg/g of gallic acid. This work was done using UV-visible spectroscopy by calibration curve method with the various concentrations of 0.01-0.05 mg/ml in methanol. And 0.1 and 1mg/ml concentrations of extract of *Curcuma amada* were prepared using methanol. And 0.5ml of all the above samples were mixed with the 2.5ml of Folin-Ciocalteu reagent and 2ml of sodium carbonate (7.5%) and solutions were allowed to stand for 30 minutes at room temp. and absorbance was recorded at 760nm (22).

Anita Tamata *et al.,* have reported the antioxidant activity of MG by carrying out the investigation on chemical composition and in-vitro antioxidant activity of the essential oil content and rhizome extract of *Curcuma amada* Roxb. They have carried out the distillation and obtained the hydro-distilled essential of rhizome part of the *Curcuma amada* and obtained 19 compounds containing the total essential oil about 77.31% and further identification was carried out by using gas chromatography and gas chromatography with mass spectrometry hyphenated technique. And extraction fractions were collected using various solvents and petroleum fraction of the extract showed very antioxidant activity via DPPH radical scavenging activities with the IC_{50} value of 18.98±0.05µg/ml with the reducing power of A_{700}=0.861±0.0001. and ethyl acetate fraction showed antioxidant activity via nitric oxide radical clearance with IC_{50} value of 5.97±0.09µg/ml higher than that of

the standard ascorbic acid IC_{50} value of 6.05±0.02µg/ml. and the essential oil showed good superoxide clearance activity IC_{50} value of 15.30±0.03µg/ml as compared to the ascorbic acid as standard IC_{50} value of 15.28±0.01µg/ml (23).

Anil Kamboj *et al.*, have reported the antioxidant activity of MG by conducting studies on Phytochemical investigation and reporting the Antioxidant and Analgesic activity by extracting *Curcuma amada* Roxb rhizome part with acetone by carrying out both *in-vitro* DPPH and nitic oxide free radical scavenging activity and *in-vivo* analgesic activity by using tail flick method and pain induced in Wistar rats using formalin 100, 200, 400mg/kg and showed both antioxidant and analgesic activity at all the three doses in all experimental animals (24).

Vishnupriya M *et al.*, have reported the antioxidant activity of MG by carrying out investigating antioxidant activity and how can we protect our body from DNA damage caused by the Hydroxyl radical using *Curcuma amada* Roxb aqueous extract. And mainly antioxidant activity was done by using iron chelating capacity and hydroxyl group radical scavenging activity. They have also studied DNA damage protection in herring fish sperm DNA damage induced by (H_2O_2) using aqueous extract of MG. results displayed that the antioxidant activity via iron reducing power with IC_{50} value 297.3µg/ml and hydroxyl ion reducing activity with IC_{50} value of 323.8µg/ml of aq. Extract of *Curcuma amada* Roxb (25).

Mahadevi R *et al.*, have reported the antioxidant activity of MG by quoting a review on phytochemical and pharmacological investigation of *Curcuma amada* Roxb. In this review they mentioned about the formulated a bread containing MG powder (3%) showed the doubled antioxidant activity as compared to the control bread and also reported regarding the antioxidant activity of the soup sticks containing 10% MG increased activity about 26.83-48.06% (3).

Dhan Prakash *et al.*, have reported the antioxidant activity of MG by conduction studies on total phenolic content and antioxidant activity by free radical scavenging activities of certain medicinal plants such as *Curcuma amada* Roxb leaves and rhizome extracts with antioxidant activity 51.9%, 45.3% and total phenolic compound equivalent to gallic acid is 13.4mg/g, 32.4mg/g respectively (26).

The summary of research work conducted antioxidant activity of Mango Ginger were presented in Table 2.

Table 2: Antioxidant Activity of Mango Ginger

Sl. No.	Authors Name	Title of the Work	Reference Number
1	Angel Gabriel Rajamma *et al.*,	Antioxidant and antibacterial activities of oleoresins isolated from nine Curcuma species.	5
2	Dyrairajprema *et al.*,	In vitro antioxidant and cytotoxicity studies of *Curcuma amada* Roxb (Mango ginger).	6
3	Angel G R *et al.*,	Essential oil composition of eight starchy Curcuma species.	7
4	Mariat George *et al.*,	"Phytochemical, antioxidant and antibacterial studies on the essential oil of the rhizome of *Curcuma amada* Roxb".	8
5	Dipanwitamitra *et al.*,	Antidiabetic and antioxidative efficacy of the constituents present in the fraction solvents of *Curcuma amada* rhizomes an experimental study on the diabetic rat model.	9
6	Vazhayiisaipriya *et al.*,	Studies on total phenolic content and antioxidant activities of aqueous acetone and methanolic extracts from raw and boiled rhizomes of *Maranta arudinaceae* L. and *Curcuma amada* Roxb.	10
7	Md. Sakhawat Hassain *et al.*,	Phytochemical and Biological Investigation of *Curcuma amada* Leaves.	11
8	Rohman A *et al.*,	A. Review on in-vitro antioxidant activities of Curcuma species commonly used as herbal components in Indonesia.	12
9	R K Gupta *et al.*,	Evaluation of antioxidant potential of different extracts of mango ginger (*Curcuma amada* Roxb) rhizome.	13
10	R S Policegoudra et al.,	Isolation and characterization of antioxidant and antibacterial compound from mango ginger (*Curcuma amada* Roxb) rhizome.	14
11	R S Policegoudra et al.,	Cytotoxicity, platelet aggregation inhibitory and antioxidant activity of *Curcuma amada* Roxb extracts.	15
12	P. Jegajeevanram *et al.*,	In vitro antioxidant activity of mango ginger rhizome.	16
13	Jiten Sutar *et al.*,	Qualitative and quantitative phytochemical analysis and antioxidant activity of *Curcuma amada* Roxb an important medicinal plant.	17
14	Prasanthi Donipati *et al.*,	In Vitro Bio Evaluation and Correlation of Antioxidant Activity of Different Extracts of *Curcuma amada*.	18
15	Yanhang Chen *et al.*,	Characterization of volatile organic compounds in mango ginger (*Curcuma amada* Roxb.) from Myanmar.	19

16	Mamata Yadav *et al.,*	Phytochemical analysis and antioxidant potential of rhizome extracts of *Curcuma amada* Roxb and *Curcuma caesia* Roxb.	20
17	Devi P.A.V *et al.,*	In vitro cytotoxicity, free radical scavenging and antioxidant activity of ethanol extract of *Curcuma amada.*	21
18	Rajeshwari Sahu *et al.,*	Screening of total phenolic and flavonoid content in conventional and non-conventional species of curcuma.	22
19	Anita Tamata *et al.,*	Chemical composition and in vitro antioxidant potential of essential oil and rhizome extracts of *Curcuma amada* Roxb.	23
20	Anil Kamboj *et al.,*	Phytochemical analysis, Antioxidant and Analgesic Activity of Acetone Extract of *Curcuma amada* Roxb Rhizome.	24
21	Vishnupriya M *et al.,*	Antioxidant Activity and Hydroxyl Radical Induced DNA Damage Protection Effect of Aqueous Extract of Curcuma amada Roxb.	25
22	Mahadevi R *et al.,*	Phytochemical and pharmacological properties of *Curcuma amada* A Review.	3
23	Dhan Prakash *et al.,*	Total phenol, antioxidant and free radical scavenging activities of some medicinal plants.	26

Conclusion

Mango Ginger is the most important genera come under the *Zingiberaceae* family. Chemically it has reported for the presence of wide range of phytoconstituents which include the flavonoids, terpenoids, tannins, steroids, alkaloids, glycosides and essential oils. Due to presence of these wide variety of phytoconstituents plant possess very well-known traditional values reported for pharmacological significance for a variety of ailments and also the plant has extensively explored for its potential anti-oxidant activity.

Abbreviations

MG: Mango Ginger, DPPH: Diphenyl-1-picrylhydrazyl, DMSO: dimethyl sulfoxide, PMR: Proton magnetic resonance, BHT: butylated hydroxytoluene, TLC: thin layer chromatography, HETCOR: Hetero Nuclear Correlation Spectroscopy.

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