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Antioxidant properties of *Clerodendrum* species found in north east India: A review

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Abstract
The popularity of herbal medicine is increasing very rapidly among the people due to awareness of harmful side effects and adverse reactions caused by synthetic compounds. There are about 580 species of *Clerodendrum* which belongs to the family Verbenaceae. Its widely distributed in the tropical regions of the world mostly in the south east Asia. *Clerodenrum* is an important locally used medicinal plant. It is one of the essential herbs. The leaves *Clerodendrum* species found in North eastern part of India forms an important source of diet. Various plant parts such as root and leaf extracts of *C. phlomidis*, *C. petasites*, *C. serratum*, *C. trichotomum*, *C. chinense* and *C. indicum* have been used for the treatment of hypertension, diabetes, rheumatism, asthma, coughs, skin diseases, vermifuge, febrifuge, malaria, inflammatory diseases etc. *Clerodendrum* genus has also been widely explored for various biological activities to know its potential effect towards pharmaceutics one of which is anti-oxidant property. In the present review the antioxidant property of *Clerodendrum* at different concentrations in the DPPH radical scavenging assay, is studied.

Keywords: *Clerodendrum*, north east India, antioxidant

Introduction
Human beings have depended on plants for survival since ever. Plants are not only the major source of food and shelter but also for the medicine to cure illness [1]. Chemicals extracted from different flora have demonstrated antiseptic, anti-oxidant, anti-fungal, anti-carcinogenic, analgesic, and insecticidal properties [3]. Chemical compounds responsible for therapeutic characteristics are generally called secondary metabolites [2]. Oxidative stress is believed to be a primary factor in various diseases as well as in the normal process of aging [4-5]. Free-radicals and reactive oxygen species are well known for initiating cellular and tissue pathogenesis leading to various human diseases such as cancer, atherosclerosis, inflammatory disorders and cardiovascular diseases. Most common cause of death in the industrialized countries is due to cardiovascular diseases. The beneficial effects of phytochemicals are associated with a multitude of biological activities, which includes antioxidant and free radical scavenging properties [6].

Clerodendrum philippinum which also known as Chinese glory flower is a perennial shrub (50-120 cm) tall. Branchlets are nearly four -angled to round, velvet-hairy when young, becoming hairless. Leaf-stalks are 3-17 cm long, velvet-hairy to woolly; leaf blade broadly relate to somewhat-heart-shaped (9-22 cm x 8-21 cm), below velvet-hairy on veins and with several large glands near base; above bristly; base flat, broadly flat, or somewhat heart-shaped, margin sparsely irregularly toothed and tip tapering. Flowers are born at branch-ends, in dense corymb-like cymes. Flower-cluster-stalk is woolly; bracts lance shaped (1.5-3 cm); velvet-hairy, with several large glands. Flowers are single or double and fragrant. Sepal-cup is (1.5-2.5 cm) deeply five-lobed, velvet-hairy, with several large glands; sepals linear-lance shaped or lance shaped. Flowers are white, pinkish, or red, lobes elliptic or ovate. Chinese glory bower is native to Assam, China, East Himalaya, Jawa, Myanmar, Nepal, Philippines, Sulawesi, Sumatera, Thailand, Vietnam [7].

Various different species from this genus have been used in almost every traditional systems of medicine by different tribes in many countries like China, India, Japan, Korea and Thailand [8]. Different plant parts such as leaf and root extracts of *C. phlomidis*, *C. petasites*, *C. serratum*, *C. trichotomum*, *C. chinense* and *C. indicum* have been used for the treatment of hypertension, diabetes, rheumatism, asthma, coughs, skin diseases, vermifuge, febrifuge, malaria, inflammatory diseases etc. [9, 10-14].

Plant species such as *C. indicum* is used for the treatment of coughs, vermifuge, febrifuge, malaria, venereal infections, skin diseases, elephantiasis, rheumatism, tropical burns etc. [15] *C. phlomidis*, *C. colebrookianum*, *C. calamitosum* and *C. trichotomum* have been used for anti-diabetic, anti-hypertensive and sedative properties [11, 13, 15].

Anti-oxidant Activity

Oxygen Species which are reactive (ROS) and many of the free radicals are natural by-products, which are constantly generated *in vivo*, both by "accidents of chemistry" and for specific metabolic purposes [16]. ROS has a high reactive potential and is responsible for many of the human diseases like diabetes, cancer, viral infections, cardiovascular diseases, and inflammations, and also damages the biological molecules like DNA, lipids, and proteins [17]. The antioxidants which are present in the medicinal plants minimise the formation of ROS [18]. The ethanolic extract of aerial parts of *Clerodendrum serratum* showed good antioxidant properties against 1,1-diphenyl, 2-picryl hydrazyl (DPPH) and nitric oxide radical whereas *Clerodendrum serratum* roots extract showed considerable antioxidant properties against DPPH [19]. The ethanolic extract of the leaves of *Clerodendrum infortunatum* Linn showed significant antioxidant activity against DPPH-free radical scavenging activity, reducing power assay and scavenging of hydrogen peroxide [20]. The methanolic extract of leaves of *Clerodendrum inerme* showed higher free radical and antioxidant activity [23]. The ethanolic extract of roots of *Clerodendrum viscosum* showed notable scavenging of the cation radical, nitric oxide radical, ferric-ion radical and DPPH. However, the aqueous extract showed moderate antioxidant activity [21]. The ethanolic extract of roots of *Clerodendrum phlomidis* showed best free radical scavenging activity compared to other three extracts *viz.* petroleum ether, chloroform, and ethyl acetate [22].

Chahal and Sarin [24] *et al.*, (2014) described that *Clerodendrum* genus is a valuable source of natural products such as bioactive compounds and antioxidants which are very advantageous for human health. Two conventionally valuable plants of spp. *Clerodendrum* (*C. inerme* and *C. phlomidis*) were tested for their antioxidant potential. *Clerodendrum* is found in various parts of Asia. Three solvents (Ethanol, Water, and Ethyl acetate) were used separately for extraction of dehydrated powder. The extract was separated for its prospective antioxidant potential using DPPH Radical inhibiting potential. The outcomes determined that the inhibiting potential of *C. inerme* shoot is greater than *C. phlomidis* shoot. Ethyl acetate and Ethanol both predicted the better potential for radical inhibiting activity and could be used as original parts of active antioxidant managers.

Khan [25] *et al.*, (2013) stated that *Clerodendrum inerme* also has antioxidant properties. The antioxidant activity of *C. inerme* shoot was measured by calculating whole phenolic, whole flavonoid, DPPH free radical, decreasing control and proportion of linoleic acid peroxidation. Whole phenolic insides and whole flavonoid insides amount were calculated as (0.89-1.89 mg/100 g GAE) and (3.18-5.68 mg/100 g CE) correspondingly. The IC50 and average self-consciousness of linoleic acid peroxidation amount of *C. inerme* remove vary from (24.1-81 µg/mL) and (41-72 %) correspondingly. Peroxide significance, free fatty acid, and *para*-anisidine amounts were also realized by using canola oil as oxidation substrate. Results showed that methanol extract of *C. inerme* shoot gives improved antioxidant activity. The cytotoxicity values were concluded from hemolytic inactivity of plant mines and checked on the human erythrocytes (RBCs) *in vitro*.

Devi [26] *et al.*, (2012) have ascribed the comprehensive study of pharmacognostic on the foliage of *C. inerme* and have revealed its role in Ayurveda and Siddha medication systems. This study was based on its physicochemical, macroscopic and organoleptic characteristics. Polyphenols like phenolic acids, flavonoids etc., triterpenoids, steroids, and sugars are present in *C. inerme*. Isolation of phenolic acid had been done and marker this compound as well as also recognized as Ursolic acid. By estimating free radical scavenging potential, anti-oxidant potential of Ursolic acid, as well as alcoholic extract, had been determined by following the assay of DPPH scavenging assay. Extract of plant presented better antioxidant potential which is analogous to that of Butylated Hydroxy Toluene that had been employed as a standard.

Gokani [27] *et al.*, (2011) had been studied the essence of *Clerodendrum phlomidis* (Verbenaceae) and revealed that Arni/Agnimantha, is its vital constituent. Methanolic extract of the roots was evaluated for its in-vitro antioxidant potential with the anti-radical, superoxide scavenging, anti-lipid peroxidation, hydroxyl radical scavenging and nitric oxide scavenging, assesses. The active part of the plant was consistently found to have anti-oxidant potential. *C. phlomidis* is recognised as a prospective origin of ordinary antioxidant.

Amirtharaj and Saravanan [28] (2010) analyzed the antioxidant potential of aerial extracts of *Clerodendrum inerme which* belongs to the family verbenace. Anti-oxidant potential of chloroform mixture of *Clerodendrum inerme* (CI) aerial portions was examined for its free radical inhibiting possessions in different *in vitro* activities as 1, 1 diphenyl-2-picryl hydrazyl, nitric oxide, decreasing command to examine and hydrogen peroxide radical treatment activity. Various amounts of the chloroform extract of CI were extracted and examined. The IC50 values of the chloroform extract of CI contended with ascorbic acid (Standard) and it was noted that the extract gives important meditation used free radical inhibiting possessions in all the methods. Examined values have chloroform extract of CI hold *in vitro* free radical inhibiting potential. The answers rationalize the presence of this plant in the controlling of antioxidant potential.

Gurudeeban [29] *et al.*, (2010) revealed that *Clerodendrum inerme* is a medicinal plant conventionally used as an abortifacient to cure constipation, odema, bacterial infections, cancer, and diabetes. First phytochemical separation of the plant examined that the occurrence of huge quantity of phenolic compounds and flavonoids. Following quantification showed the existence of 0.74% (m/m) phenolic (calculated as gallic acid) and 0.13% (m/m) flavonoids considered as catechin per each 100 grams of new mass. The existence of phenolic compounds encouraged to lead this work to assess its antioxidant potential. Methanolic shrubberies cutting of *Clerodendrum inerme* was separated to examine its maximum antioxidant and free radical inhibiting potential of shrubberies extract. 2500 mg ml-1 of antioxidants was detected.

Chourasiya [30] *et al.*, (2010) determined the antioxidant levels of methanolic and petroleum ether extract of *Clerodendron inerme.*

The methods used were DPPH (1, 1-diphenyl-2- picryl hydrazyl) examine, hydroxyl inhibiting analysis and the lipid peroxidation analysis. The *Clerodendron inerme* methanol extract (CIME) was most abundant in the DPPH test with an IC50 value of 19.20 ± 0.27 µg/mL. The hydroxyl radical inhibiting potential of the petroleum ether extract disclosed the extreme potential 69.28±2.1% at 100µg/ml. In the lipid

peroxidation analysis, the highest amount was that of methanolic extract *i.e.* 36.38±1.3%.

Gouthamchandra [31] *et al.*, (2010) analyzed three consecutive extracts of *Clerodendrum infortunatum* L shrubberies for their activity as antioxidant 1, 1-diphenyl 2 picrylhydrazyl (DPPH) model. The inhibiting potential of ethanol extract was examined to be maximum when analyzed with petroleum ether and chloroform extracts. So, it was chosen as a standard to test the potential candidates using *in vivo* and *in vitro* methods. The antioxidant properties encouraged oxidative pressure in rats considerably high. Further, to authenticate the conventionally therapeutic claim wound healing potential of plant extract also tested. Between the three extracts used, the petroleum ether and ethanol extract showed the significant results.

Bhujbal [32] *et al.*, (2009) studied the antioxidant activity of ethanolic extract obtained from roots of *Clerodendrum serratum* at different concentrations in the DPPH radical inhibiting methods; FRAP method (Ferric Reducing Antioxidant Power) and the Hydrogen peroxide radical inhibiting method. In the last decade, herbal and Ayurvedic medicines were very popular due to their medicinal and economic advantages. Due to their worldwide acceptance and effectiveness, the use of plant extract throughout the world increased. Over the time, appropriate scientific methods have been developed to become the standards for recognition of herbal health rights.

Sannigrahi [33] *et al.*, (2009) evaluated the antioxidant activity of methanolic extract *Clerodendrum infortunatum* Linn. (MECI), used in the Indian native medicine for wide uses, was examined. The antioxidant activity was calculated using various organized *in vitro* antioxidant tests. MECI was found to have a lot of polyphenolics and it holds important free radical inhibiting potential. The greater potential was probably due to the highest quantity of polyphenolics and flavonoids in it.

Chae [34] *et al.*, (2007) studied the antioxidant activity of isoacteoside, separated from *Clerodendron trichotomum* (Verbenaceae), This compound inhibited intracellular sensitive oxygen species (ROS) and 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical, and prohibited lipid peroxidation. This radical inhibiting potential of isoacteoside sheltered cell viability of Chinese hamster lung fibroblast (V79-4) cells exposed to hydrogen peroxide (H2O2). Furthermore, isoacteoside decreased the cell apoptosis caused by H2O2. However, isoacteoside amplified the cellular antioxidant enzyme action including superoxide dismutase (SOD) and catalase (CAT). Altogether these results examined that isoacteoside, separated from *C. trichotomum*, have antioxidant potentials.

Methods

Antioxidant activity

The antioxidant activity of samples were determined using standard methods. VC and BHT were used as positive standards in the radical-scavenging assays. Gallic acid was considered as a standard in the ferric reducing power assay. Ethylene diamine-tetra acetic acid (EDTA) was used as a standard for the ferrous ion-chelating activity assay.

DPPH radical-scavenging activity: The DPPH radical scavenging activity was estimated by mixing 0.1 ml of the extract with 3.9 ml of 60 µM solution of DPPH in ethanol. After 30 min of reaction in the dark condition the absorbance was measured at 517 nm. The inhibition percent and 50% inhibition (IC_{50}) values of DPPH radicals were calculated [34].

ABTS radical-scavenging activity: [34]. This method was used to determine the ABTS radical-scavenging capacity. An small portion of extract (0.1 ml) was added to 3.9 ml of ABTS radical solution. The mixture was reacted for 30 min in dark condition and absorbance at 734 nm was measured. The inhibition percent and IC_{50} values of the extracts for ABTS radical were calculated.

Superoxide radical-scavenging activity: The superoxide radical scavenging effects were examined [35]. About, 1 ml of the extract was taken and added to 1 ml of 50 µM NBT solution, 1 ml of 468 µM NADH, and a 1 ml of the portion of 60 µM PMS reaction mixture. After 5 min, the absorbance was read at 560 nm. The inhibition percent and IC_{50} values were calculated.

Hydroxyl radical-scavenging activity: The scavenging of hydroxyl radicals was determined following the method of Guo *et al*. [35]. The reactions were performed with 0.3 ml of 20 mM sodium salicylate, 2.0 ml of 1.5 nM $FeSO_4$, 1.0 ml of sample, and 1.0 ml of 6 mM H_2O_2. The reaction mixture was incubated for 1 hour at 37˚C. Then absorbance was measured at 510 nm. The inhibition percent and 50% of absorbance (EC_{50}) were calculated.

Reducing power: The reducing power of the samples were assayed using the method of Guo *et al*. [36]. Briefly, 1 ml of extract solution was added to 2.5 ml of phosphate buffer (0.2 M, pH 6.6) and 1%,2.5ml potassium ferri-cyanide. After 20 min, 2.5 ml of 10% tri-chloro acetic acid (TCA) was added, and after that the mixture was centrifuged at 2800-3000 rpm for about 10 min. The upper layer was mixed with 2.5 ml of distilled water and 0.5 ml of 0.1% ferric chloride, and after 10 min, the absorbance was measured at 700nm. The EC_{50} values were calculated from the graph of inhibition percentage against extract concentration.

Ferrous ion-chelating activity: About 1 ml portion of extract was added to a solution of 100 µL of $FeCl_3$ (2.0 mM), 3.7 ml of distilled water and 200 µL of ferrozine (5.0 mM). After 20 min, the absorbance was checked and recorded at 562 nm. The inhibition percent and IC_{50} values were calculated.

Total phenolic content (TPC): The Total Phenolic Contents in the samples was determined by colorimetric method, Zhou *et al*. [34]. Folin-Ciocalteu reagent (2 ml) was added to 2 ml of diluted extract. After 3 min, 750 µL of sodium carbonate anhydrous solution (7.5%, w/v) was added, and the mixture was adjusted to 10 ml with distilled water. After 2 h, the absorbance was checked at 765 nm. Calibration curves were constructed with gallic acid as the standard at concentrations ranging from 0–100 µg/ml.

Total flavonoid content (TFC): The reaction mixture consisted of 1.0 ml of extract, 0.3 ml of 5% sodium nitrite and 4 ml of 60% ethanol. About 6 min later, 0.3 ml of 10% aluminium nitrite was added. 6 mins later, 4 ml of 1M sodium hydroxide solution was added. Then, the volume was brought to 10 ml using distilled water, and the absorbance was measured at 510 nm. The TFC was calculated and is expressed as rutin equivalents (RE). A calibration curve was

constructed with different concentrations of rutin (15– 75 µg/ml) as a standard [35].

Conclusion

Clerodendrum forms an precious part of traditional/folk medicine in many countries like India, Japan, Korea, China and Thailand. A few works conducted on the anti-oxidant potential of *Clerodendrum* by various researchers reflects its huge potential as ethnomedicine, although deep investigation through scientific validation and experimentation is still scarce. *Clerodendrum* spp. Possesses multiple pharmacological and therapeutical activities such as anti-microbial, anti-inflammatory, anti-malarial, anti-diabetic, anti-cancer, analgesic. However, there are limited numbers of studies describing the bioactivities of *Clerodendrum* and this opens up new horizon for researchers working in this filed to explore this raw material as potent nutraceutical and pharmaceutical product.

DPPH (1,1-diphenyl-2-picryl-hydrazil) is a free radical which is stable and that accepts an electron or hydrogen radical to form a stable diamagnetic molecule. The model of scavenging the stable DPPH radical is widely used for relatively rapid evaluation of antioxidant activities compared to different other methods [32]. The reduction capability of the DPPH radical is calculated by its absorbance decrease at 517 nm, as induced by natural antioxidants [29].

Scavenging of H2O2 by antioxidants may be due to donation of electrons to H_2O_2, thus neutralizing it to water [30]. According to phytochemical investigation it is observed that the ethanolic extract of CSR contains phenolic compounds such as flavonoids, tannins. It has been recently shown that quercetin and its glycosides exert inhibitory activity against lipid peroxidation [28]. Since luteolin and its derivate, along with quercetin and rutin, belong to the same group of compounds – flavonoids, the following antioxidative mechanism can be proposed: conjugation of the double bound in position 2,3 with C4- -carbonyl group, and also the existence of a free OH group on C5 and C7, enable the formation of chelate complexes with d-elements (Fe2+, Cu2+, Zn2+). The formation of a complex with Fe2+ prevents the production of OH_ radicals (Fenton's reaction), which was used to evaluate the inhibitory effects. The antioxidant activity of this extract can be linked up to the high polyphenols and flavonoids content. Divers studies mentioned an implication of the polyphenols and flavonoids in the antioxidant occupation of different plants extracts [31-32]. Phenols have been shown to possess an important antioxidant job toward these radicals, which is mainly based on the redox properties of their phenolic hydroxyl groups and the structural relationships between different parts of their chemical structure.

It have been established a highly good relationship between total phenols and antioxidant activity in many plant species. antioxidant activity through the DPPH free radical scavenging action, reducing power assay and scavenging of hydrogen peroxide. The initial phytochemical study indicates the presence of flavonoids in the plant. Polyphenols such as flavonoids and tannins are the well known natural antioxidants [32]. So, the antioxidant potential of the plant may be attributed to the presence of flavonoids. The separation and identification of flavonoids present in the roots can help scholars to find new molecules which can be used as natural antioxidants. Further studies are currently infact underway to isolate and characterize the active constituents responsible for its antioxidant activity.

References

1. Tipu MA, Akhtar MS, Anjum MI, Raja ML. New dimension of medicinal plants as Animal Feed. Pakistan Vet J 2006;26(3):144-148.
2. Zhang HK, Dev Y, Immunol C. Isolation of defenses of secondary metabolite, show antifungal activity. J Agri Food Chem 2003;27:499-503.
3. Khan SA, Shahid S, Ahmad W, Ullah S. Pharmacological Importance of *Clerodendrum* Genus: A Current Review. International Journal of Pharmaceutical Science and Research 2017;2(2):22-30.
4. Austin MA, Hokanson JE, Brunzell JD. Characterization of low density lipoprotein subclasses: methodologic approaches and clinical relevance. Current Opinion in Lipidology 1994;5:395-403.
5. Liao L, Starzyk RM, Granger DN. Molecular determinants of oxidized low-density lipoprotein-induced leukocyte adhesion and microvascular dysfunction. Arterioscler. Thromb. Vasc. Biol 1997;17:437-44.
6. Bhujbal SS, Kewatkar SMK, More LS, Patil MJ. Antioxidant Effects of Roots of *Clerodendrum serratum* Linn., Pharmacognosy Research 2009;1(5):294-298.
7. https://www.flowersofindia.net/catalog/slides/Chinese%20Glory%20Bower.html 10 Aug 2021.
8. Shrivastava N, Patel T. Clerodendrum and heathcare: An overview. Med Aromat Plant Sci Biotechnol 2007;1:142-50.
9. Singh MK, Khare G, Iyer SK, Sharwan G, Tripathi DK. *Clerodendrum serratum*: A clinical approach. J Appl Pharm Sci 2012;2:11-5.
10. Hazekamp A, Verpoorte R, Panthong A. Isolation of a bronchodilator flavonoid from the Thai medicinal plant *Clerodendrum petasites*. J Ethnopharmacol 2001;78:45-9.
11. Kang DG, Lee YS, Kim HJ, Lee YM, Lee HS. Angiotensin converting enzyme inhibitory phenylpropanoid glycosides from *Clerodendron trichotomum*. J Ethnopharmacol 2003;89:151-4.
12. Panthong A, Kanjanapothi D, Taesotikul T, Wongcome T, Reutrakul V. Anti-inflammatory and antipyretic properties of *Clerodendrum petasites* S. Moore. J Ethnopharmacol 2003;85:151-6.
13. Choi JH, Whang WK, Kim HJ. Studies on the anti-inflammatory effects of *Clerodendron trichotomum* Thunberg leaves. Arch Pharm Res 2004;27:189-93.
14. Kanchanapoom T, Chumsri P, Kasai R, Otsuka H, Yamasaki K. A new iridoid diglycoside from *Clerodendrum chinense*. J Asian Nat Prod Res 2005;7:269-72.
15. Kar P, Goyal AK, Das AP, Sen A. Antioxidant and pharmaceutical potential of *Clerodendrum* L.: An overview. International Journal of Green Pharmacy 2014, 210-216.
16. Goyal AK, Basistha BC, Sen A, Middha SK. Antioxidant profiling of *Hippophae salicifolia* growing in sacred forests of Sikkim, India. Funct Plant Biol 2011;38:697-701.
17. Halliwell B. Free radicals and antioxidants: A personal view. Nutr Rev 1994;52:253-65.
18. Mishra T, Goyal AK, Middha SK, Sen A. Antioxidative properties of *Canna edulis* Ker-Gawl. Indian J Nat Prod Res 2011;2:315-21.
19. Ismail Shareef M, Leelavathi S. Evaluation of antioxidant activity of *Anisolmeles malabarica* R Br and

Clerodendrum serratum L. Extractsagainst rheumatism. Res J Pharm Biol Chem Sci 2011;2:488-95.
20. Modi AJ, Khadabadi SS, Deore SL, Kubde MS. Antioxidant effects of leaves of *Clerodendrum infortunatum* (Linn.). Int J Pharm Sci Res 2010;1:67-72.
21. Priyesh P, Narayanasamy VB, Manjunatha Setty M, shirwaikar A. Antioxidant potential *of Clerodendron viscosum* vent. Roots. Pharmacol Online 2007;2:226-35.
22. Sathish M, Tharani CB, Niraimathi V. Free radical scavenging activity of various extracts from root of *Clerodendrum phlomidis* (Linn.) evaluated by three *in vitro* methods. Res J Pharm Biol Chem Sci 2011;2:752-61.
23. Gurudeeban S, Satyavani K, Ramanathan T, Umamaheshwari G, Shanmugapriya R. Antioxidant and radical scavenging effect of *Clerodendrum inerme* (L). World J Fish Mar Sci 2010;2:66-9.
24. Chahal JK, Sarin R. Comparison of antioxidant activity with different solvents in two medicinally important species of *Clerodendrum*. World J Pharm Pharm Sci 2014;3:1100-1105.
25. Khan SA, Rasool N, Riaz M, Nadeem R, Rashid U, Rizwan K *et al.* Evaluation of antioxidant and cytotoxicity of *Clerodendrum inerme*. Asian J chem 2013;25:7457-7462.
26. Devi VG, Vijayan C, Johan A, Goupakumar K. Pharmacognostic and antioxidant studies on *Clerodendrum inerme* and identification of ursolic acid as marker compound. Int J Pharm Pharm Sci 2012;4(2):145-148.
27. Gokani RH, Rachchh MA, Patel TP, Lahiri SK, Santani DD, Shah MB. Evolution of anti-oxidant activity (*in vitro*) of *Clerodendrum phlomidis*. J Herb Med Toxicol 2011;5(1):47-53.
28. Amirtharaj, Saravanan. *In vitro* Antioxidant Activity of Chloroform Extract of Aerial Parts of *Clerodendrum inerme* (L) Gaertn. J Pharm Res 2010;3(11):2709-2711.
29. Gurudeeban S, Satyavani K, Ramanathan T, Umamaheswari G, Shanmugapriya R. Word J fish Mar Sci 2010;2(1):66-69.
30. Chourasiya KR, Jain KP, Jain KS, Nayak SS, Agrawal RK. *In vitro* antioxidant activity of *Clerodendron inerme* (L.) Gareth leaves. Pharmacol Res 2010;1:119-127.
31. Gouthamchandra K, Mahmood R, Manjunatha H. Free radical scavenging, antioxidant enzymes and wound healing activities of leaves extracts from *Clerodendrum infortunatum* L. Environ Toxicol Pharmacol 2010;30:11-18.
32. Bhujbal SS, Kewatkar KMS, More SL, Patil JM. Antioxidant Effects of Roots of *Clerodendrum serratum* Linn. Pharmacognosy Res 2009;1(5):294-298.
33. Sannigrahi S, Mazumder UK, Pal DK, Parida S. *In vitro* anti-oxidant activity of methanol extracts of *Clerodendrum infortunatum* Linn. Orient Pharm Exp Med 2008;9(2):128-134.
34. Chae SW, Kang KA, Kim JS, Kim HK, Lee EJ, Hyun JW. Antioxidant activities of acetylmartynosides from Clerodendron trichotomum. J Appl Biol Chem 2007;50:270.
35. Zhou J, Zheng X, Yang Q, Liang ZY, Li DH, Yang XB, *et al*. Optimization of ultrasonic-assisted extraction and radical-scavenging capacity of phenols and flavonoids from *Clerodendrum cyrtophyllum* Turcz leaves. PloS ONE 2013;8:e68392. https://doi.org/10.1371/journal.pone.0068392 PMID: 23874607
36. Guo T, Wei L, Sun J, Hou CL, Fan L. Antioxidant activities of extract and fractions from *Tuber indicum* Cooke & Massee. Food Chem 2011;127:1634-1640.
37. Jing Z, Qi Y, Xiaochen Z, Tong L, Dongdong H, Jing X. Antioxidant activities of *Clerodendrum cyrtophyllum* Turcz leaf extracts and their major components. Plos One 2020, 1-15.