J. Indian bot. Soc. (2022) Vol. 102 (2): 113-122
https://doi: 10.5958/2455-7218.2022.00013.4

e-ISSN:2455-7218, ISSN:0019 - 4468
www.indianbotsoc.org

REVIEW ARTICLE

An overview of the Multi-Utility Potential of a Tropical American Herb: *Ageratum houstonianum* Mill.

[1]Enna Choudhary, [1]Navneet and [2]Nidhan Singh,

Abstract The demand for plant-based metabolites, pharmaceuticals, food supplements, cosmetics etc. keeps on increasing day by day. For that purpose, our quest for finding novel uses of plants is never ending. Among a large number of useful species of plants, some are generally overlooked, or underestimated. In this paper, such a species from the genus *Ageratum* of family Asteraceae is being discussed, which is claimed to have high therapeutic potential to treat various diseases, yet ignored largely as a weed. It is a multipurpose herb with many ethno-medicinal and pharmacological characteristics, with a long history of traditional medicinal use. Extract of young leaves is said to be effective against skin problems, and a study of the literature revealed many other pharmacological activities of this plant. The current review is an attempt to provide pharmacological and biological reports on *A. houstonianum*.

Keywords: *Ageratum houstonianum*, antimicrobial, medicinal plants, phytoconstituents

Introducation

Herbal drug practitioners have been engaged in using traditional or folk medicine from ancient times for treatment of various ailments like irritation, artery diseases, cancer as well as for their antimicrobial activities (Kumar *et al.* 2007). Herbal plants or their uses are less demonstrated and, therefore, scientifically inadequately assessed by the followers of modern medicine for their properties. Herbal medicine has been used extensively in many countries and has become part of primary health care as the herbal products are used to treat various skin conditions, skin irritation, burns, indigestion, infections, lesion, trims, ulcers and swellings. They are also effective as antibacterial, antifungal, antiviral, and antiprotozoal agents (Tennyson *et al.* 2011). In general terms, out of approximately 400,000 species of plants known to exist,bioactivity has been studied in only 6% and around 15% plant compounds have been examined. Phytochemicals are really very useful in protecting humans from various disorders. They generally have curative, protective, or disease preventive properties for the host (Kanase and Shaikh 2018). *Ageratum houstonianum* is herbaceous plant, often known as blue mink. It is very useful in curing fever, paste of leaves is useful in wound healing, essential oil shows cytotoxic effect (Hadidy*et al.* 2019), and it is also examined for antimicrobial and mosquitocidal effects (Tennyson *et al.* 2011). The screening of literature regarding biological assets of *A. houstonianum* revealed negligible data and seems almost silent on this aspect as very fewreports are present on activity of this plant (Chandrekar *et al.* 2020). Oil of this plant is having insecticidal activity (Kurade *et al*. 2010). *A. houstonianum* is widely used as a fodder and to protect soil (Menut and Lamaty 1993). The essential oil has very strong smell and has been tested for different biological activities. Chemical constituents of *A. houstonianum* essential oil include: flavonoids, triterpenoids (Chandra *et al*. 1996), benzofuran derivatives and steroids (Menut and Lamaty 1993).This study is aimed to summarize pharmacological and biological activities of this valuable herb.

✉ [1]Enna Choudhary[1]
ennagujjar198@gmail.com

1 Department of Botany and Microbiology, Gurukula Kangri Vishwavidyalaya, Haridwar, Uttarakhand, 249404 India

2 Department of Botany, I.B. (PG) College, Panipat-132103 *India*

Received : 30 October 2021 Accepted : 02 December 2021 Published online : 30 June 2022

Taxonomical Information

The accepted name of the taxon is *Ageratum houstonianum* Mill (http://powo.science.kew.org/) with native range from Mexico to Central America. As per the same database, it has 19 synonyms. The genus *Ageratum* L. with around 40 species worldwide is included in family *Asteraceae* Bercht. & J. Presl.

Vernacular Names

Floss flower, Blue mink, Blueweed, Pussyfoot, Mexican paintbrush, Bluebilly goat weed. It is referred to as "Yerba de Zopilote" and "Flor de Garrapata" in Vera Cruz, its native habitat (Johnson, 1971). A few more regional names are being provided below:

Table 1: Showing Vernacular Names

Language	Vernacular Names
English	Floss flower, Mexican paintbrush
Nepali	Nilogandhe, Buko bon, Gandhejhaar
Malayalam	Michanga, Niloappa
Bengali	Nakful, Dochunty, Elamejhar
Kannada	Amanpathri
Arunachal Pradesh	Eehgaarh

Habitat and Distribution

In 1731, Vera Cruz was the first place from where *Ageratum houstonianum* was collected and placed in the tribe Eupatorieae, which is characterized by its tubular flowers. The family Asteraceae includes more than 1650 genera globally, which are distributed across tropical and subtropical regions. This species usually grows wild near habitation on fallow lands, along the sides of roads, in disrupting regions, and banks of the river in Mexico, Central America, the Caribbean, South and East Africa (Hadidy*et al.* 2019, Menut and Lamaty1993). It is present mainly up to 1300 m above sea level.

Botanical description

It is an annual, herb 30-70 cm in height. It emerges from Peru, Mexico, and Central America (Devkota and Sahu 2019). Stems glandular, densely hairy, usually purple to reddish, round. Leaves opposite, ovate to triangular, 2-7 cm long, margins serrated. Bluish-pink, homogamous flower heads or capitulate appear in umbellate clusters. Florets tubular with 5 sepals reduced to pappus. The brown to black 'seeds' (achenes) are topped with five whitish awn-tipped scales resembling short bristles or hairs, which are modified sepals (pappus). Seeds are dispersed with the help of air. According to a study by Lamsal *et al.* (2019) *A. houstonianum* plants are not drought tolerant and grow better in

Figure 1: *Ageratum houstonianum*

neutral to alkaline soil conditions.

Cultivation and General Phenology

Flowering: April-November;
Fruiting: September-December

It is often grown for showy heads, as an ornamental, attracted by a number of butterflies and other insects. For cultivation (not much popular in India), the propagules are seeds, which can be sown from March to September. The preferred soil type is neutral to slightly alkaline, and the shady, moist areas are the habitats which promote its growth well. Being a tropical climate plant, it can flourish at a variety of temperatures. When in cultivation, the removal of dead flowering heads extends its flowering season.

Cytology and Morphology

In *A. houstonianum*, white flower plants have diploid number n=10, whereas tetraploid number (n=20)were reported in plants having blue flowers (Gill and Garg 2016). The cultivated varieties usually include tetraploids as well as hybrids.

Differences between *A. houstonianum* and *A. conyzoides*

A. houstonianum is common in plains while *A. conyzoides* is naturally distributed in high altitude areas. *A. houstonianum* has a better invader strategy due to low LCC resulting in use of energy more effectively (Singh *et al*. 2011). (Table 1).

Pyrrolizidine alkaloids

A. houstonianum was found to inhibit the growth of nematodes. Some *Crotalaria* species are known to be used for inhibiting nematodes, because they produced pyrrolizidine alkaloids. But it is also to be noted that these alkaloids were commonly produced by *A. houstonianum*. Wiedenfeld and Cetto (2001) isolated four Pyrrolizidine alkaloids which were determined with the help of GC–MS and homo- as well as hetero-nuclear 2D NMR spectroscopy. They stated that only one was reported previously that belongs to retronecine-typeO^9-(-)-viridiflorylretronecinewhile other three were characterised by them, which show retronecine-O^9 and retronecine-O^7structure.

Polymethoxy flavones and Benzofuran derivatives

Quijano *et al.* (1982) collected aerial parts of *A. houstonianum*, its petroleum extract resulted in isolation of lucidin dimethyl ether, eupalestin, and agecorynin C that are already known but they demonstrate new flavones that are highly oxygenated, named as agehoustin A and B According to them, it was the first report of these flavones. In Asteraceae family, the first octamethoxyflavone reported was Agehoustin A and the third compound reported from nature.Benzofuran derivatives isolated from *A. houstonianum*roots are of phytochemical and taxonomic interest due to their unusual pattern (Breuer *et al.* 1987).

Table 2: Differences Between *A. houstonianum* and *A. conyzoids*

S. No.	*A. houstonianum*	*A. conyzoides*
1.	Plants more vigorous and grows up to 60 cm in height	Plant less vigorous and grows not above 30 cm in height
2.	Branches more and dense, purple.	Branches few and sparse, green.
3.	Ovate to triangular leaves, simple and opposite	Egg-shaped leaves with the broad end at the base
4.	Leaf base is generally cordate to truncate	Leaf base is obtuse or broadly cuneate
5.	Numerous sticky hairs on the bracts	Few hairs on the bracts
6.	Diameter of capitulum up to 6mm wide	Capitulate up to 4 mm wide
7.	Involucre bracts pubescent	Involucre bracts are less pubescent

Table 3: Showing Phytoconstituents of *A. houstonianum*

Compounds	Class	Source	References
Agerarin	-----	Plant extract	Shin *et al.,* 2017
Precocene I, Precocene II	Chromenes	Plant extract	Lu *et al.*, 2014, Kurade*et al.*, 2010
2,2- dimethyl chromenes	Chromenes	Plant extract, Oil extract	Hadidy*et al.*, 2019
β-caryophyllene	Sesquiterpenes	Plant extract, Oil extract	Lu *et al.*, 2014
β- sesquiphellandrene	Sesquiterpenes	Leaves oil	Menut and Lamaty, 1993
3,7- Dimethyl-2,6-octadienyl acetate	-----	Plant extract	Zeeshan*et al.*, 2012
Ageratochrome (Precocene II)	Chromenes	Oil extract	Adebisi*et al.*, 2019, Lu *et al.*, 2014
Benzofuran derivatives	-----	Roots	Breuer *et al.*, 1987
α-Bisabolo	-----	Leaves oil	Hadidy*et al.*, 2019
Exoticin	Flavones	Aerial parts extract	Quijano*et al.*, 1982.
Geranial	Terpenes	leaves	Chandra *et al.*, 1996
Camphene	Terpenes	leaves	Chandra *et al.*, 1996
Myrcene	Terpenes	Leaves oil	Menut and Lamaty, 1993

Table 4: Showing Traditional Uses of *A. houstonianum*

Countries	Used plant part	Plant properties	References
China	Whole plant	To clear away heat and toxic material	Devkota and Sahu, 2019
Central America	Whole plant	Used as an antiphlogisticto relieve swelling and throat pain	Devkota and Sahu, 2019
Nepal, India, Mexico, Southern America	Whole plant	Used as an ornamental plant	Sharma, 2020
India	Whole plant	Antimicrobial, antifungal, and mosquitocidal activity	Devkota and Sahu, 2019
Mexico, India	Aerial parts	Antimicrobial, antibacterial, antioxidant, antifungal, anti-inflammatory, wound healing	Lu *et al.*, 2014
Mexico	Aerial parts	Plant infusion is given in most of the stomach problems such as diahorrea, dysentery, and indigestionas well as rheumatism and fever	Hadidy*et al.*, 2019
India	Aerial parts	The paste of the leaves is applied to the wound to stop bleeding and quick healing	Wangpan*et al.,* 2019
India	Aerial parts	Treat skin infections and sore throat	Hadidy*et al.*, 2019
India	Leaves extract	Treatment of diabetes	Sharma, 2020
	Leaves extract	Treat conjunctivitis, ophthalmics, and skin problems	Adebisi*et al.*, 2019

Chromenesprecocene I and II

Siebertz*et al.* (1990) separated plants into different organs (leaves, flowers, stems, and roots) to analyze the accumulation of precocene. The most prevalent amounts have been identified in leaves (12.45 µmol per plant) then in flowering heads (9.14 µmol per plant), followed by small concentration in stalks and roots (0.069- 0.63 µmol per plant). Precocene I and II have been found to be present in highest concentration in involucral bracts and in receptacles(34 and 31.5 µmol g^{-1} fresh weight respectively). Precocene aromatic ring biosynthesis wasconducted by feeding stable isotopesand ^{14}C-labelled compound, inhibitors of PAL, to the seedling of *A. houstonianum*. With this study, it was concluded that chromene is the biogenetic precursor of precocene II.

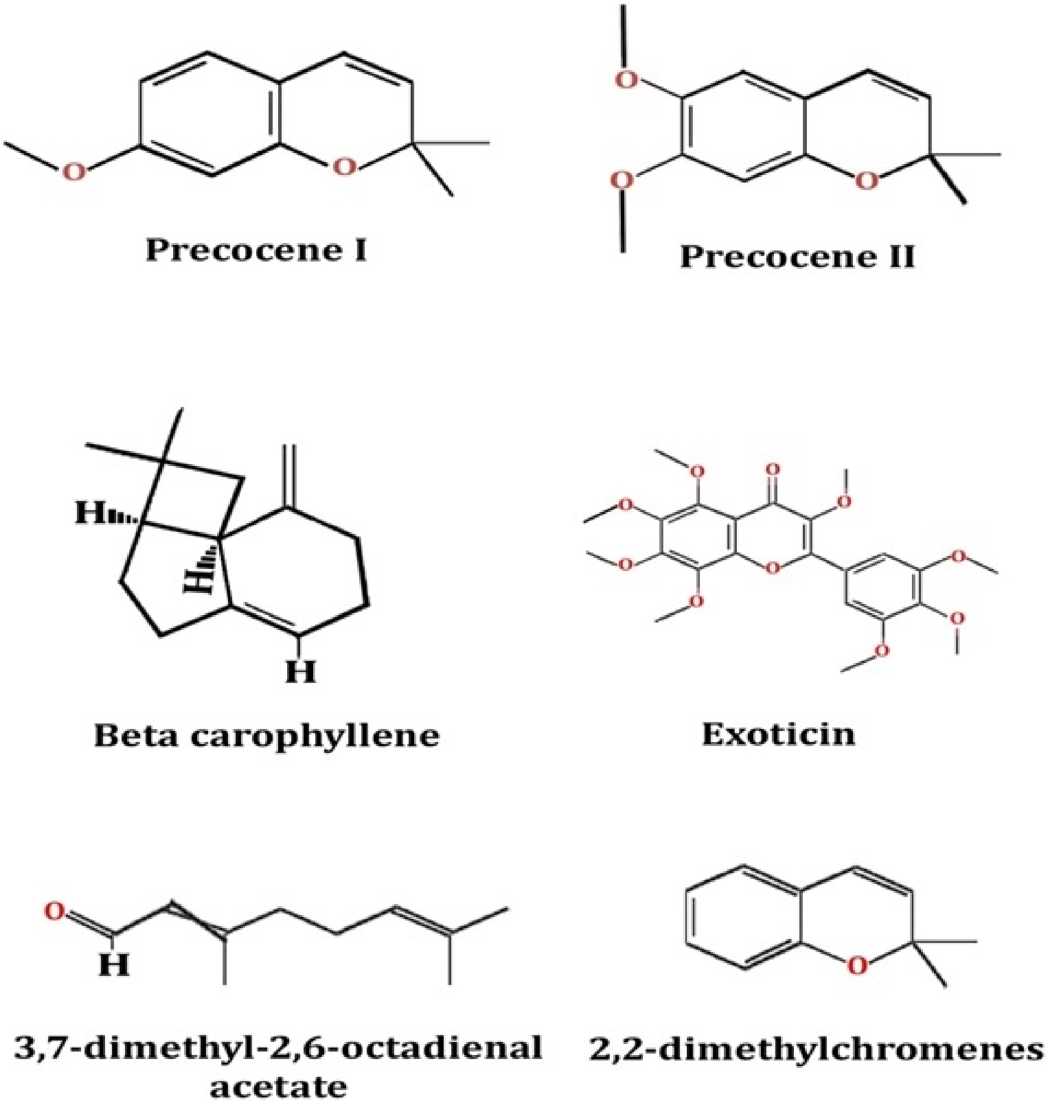

Figure 2: Phytoconstituents structure found in major amount in *A. houstonianum*

Ethnopharmacological Activities (Table 3)

a. Adulticidal activity and Antidiabetic activity

The absorption of the different levels of plant extract was recorded by the α-amylase inhibition activity. The results demonstrate that extracts of plant found to be a potent α-amylase enzyme inhibitor similar to standard acarbose.A dose dependent increase in α-amylase inhibitory activity of plant extract is reported by Sharma (2020). Reddy *et al.* (2012)conducted an experiment in alloxane-induced diabetic rats and regular rats to monitor blood glucose levels at two doses 200 and 400 mg/kg. It was shown that hydro-alcoholic extract of *A. houstonianum* with 400 mg/kg was more impactful than 200 mg/kg in the treatment of diabetes as this dose was found to reduce blood glucose concentration between 2-4 hours.

b. Antimicrobial activity

Tennyson *et al.* (2011) studied the *A. houstonianum* leaf extracts to analyse the antimicrobial effect with different solvents (hexane, ethyl acetate and methanol) by disc diffusion method. Test organisms included *Staphylococcus aureus, Pseudomonas aeruginosa, Vibrio fischeri, Klebsiella pneumoniae, Yersinia enterocolitica,* *Erwinia amylovora, Salmonella typhi, Enterobactera erogens, Proteus vulgaris* and *Candida albicans*.The highest activity (19 mm) against *P. aeruginosa* was given by ethyl acetate extract followed by *S. typhi*(18 mm). *P. aeroginosa* was inhibited by all three extracts but *E. aerogens* was not inhibited by any of the solvent extracts.

c. Antioxidant and Antifungal activity

Hadidy*et al.* (2019) revealed potential cosmetic and medicinal uses of *A.houstonianum*. The herb is very useful source of naturally occurring antioxidants. The free radical scavenging action against radicals of DPPH and hydroxyl was assessed using methanolic leaf extracts, ethyl acetate and hexane. Ethyl acetate gave better results as compared to hexane and extract of methanol (Tennyson *et al.* 2012). If compared with the standard ascorbic acid IC_{50} 5.38 µg/mlthe plant showed mild antioxidant potential with IC_{50}123.67 µg/ml (Sharma, 2020).Devkota and Sahu (2019)have demonstrated high fungicidal potential of *A. houstonianum* against five strains *Sclerotium rolfsii, Phytophthora capsici, Alternaria brassicae, Fusarium oxysporum* and *Botrytis cinerea*. Highest antifungal activity had been shown by methanolic extracts against *P. capsici, S. rolfsii,* and *F. oxysporum* at various concentrations. At higher concentrations of about 150-250 mg/mL, the plant extracts might have better fungicidal properties as they were more efficient than the chemical fungicides.

d. Wound healing

Panicke r*et al.* (2017) performed wound healing experiment on wistar rats with leaf extract of *A. houstonianum* by using methanol as a solvent. *A. houstonianum* treated group was recovered more quickly and the wound width was considerably reduced in comparison with control. Moreover, microscopic examination of rat's scar tissue showed reduction when medicated with 10% to 20% concentration of extract in a dose dependent manner. The reason behind this is the presence of antioxidant molecule i.e., flavonoids which scavenge free radicals and thereby contributing in wound healing property of the extract.

e. Oviposition deterrent activity

Tennyson *et al.* (2012) have shown the impact of *A. houstonianum* leaf extract against oviposition activity of *Anopheles stephensi, Aedes aegypti,* and *Culex quinquefasciatus*. They conducted site analysis, planning, ovitraps placement, field observation, and finally natural breeding monitoring at the study site. They concluded that *A. houstonianum* leaf extract has the potential of oviposition deterrent property that is observed in both field and laboratory results.

***f. In vitro* organogenesis**

The combination of Auxin and IAA activates the root and shoot regeneration for *A. houstonianum*. Various concentrations of Kin and IAA (0.4-0.4, 1-1, 2-2, 4-4, 0.4, 1-0.4, 2-4, 4-2) (mg L^{-1}) were used in induction of callus shoot, root multiplication, and plantlet formation. At 2-4 (mg L^{-1}) concentration, the maximum results for root and shoot formation in epicotyl explants were observed. Shoot apical meristems were found to be responding best for regeneration of plantlets at 4- 2 (mg L^{-1}) Kin-IAA combination (Mohammadi, 2017).

g. Heavy metal stress tolerant

Cadmium (Cd) is causing high toxicity as it is a heavy metal pollutant of the environment. Milusheva *et al*. (2019) performed experiments to examine the Cd stress physiological response, shown by ornamental *A.houstonianum*. The stress effect was assessed by examining different indicators like changes in height and width of the plant, diameter and length of roots, biomass, and the electrolyte discharge of micro plant. Visual observations, including delayed growth and necrosis, leaf chlorosis and root tip browning, withering and severe stress effect death were observed as symptoms of toxicity. The effects of Cd toxicity on the plant's development and explant height were more severe in young plants according to biometrical indices of *in vitro* cultivated *A. houstonianum*. In the presence of Cd up to 10 mg l^{-1}, the height of explants remained unaffected as compared to control (non-treated) (5x MPC). The height of 20-day-old explants was found to have decreased significantly. They claim that using *in vitro* models of ornamental plants is a reliable method for analysing and predicting yearly tolerance to Cd and other heavy metal.

Essential oil

In the plant essential oil, almost 35 components were identified. Precocene II (62.68%), Precocene I (13.21%), and β-caryophyllene (7.92%) were present in major amount. Oil and its constituents have better ability to develop insecticides and resist stored grain insects (Lu *et al.* 2014). According to Kurade *et al.* (2010), precocene-II (43.99%), precocene-I (23.34%), and β-caryophyllene (9.16%) were the main constituents. Flavonoids, triterpenoids, steroids and benzofuran derivatives were present (Chandra *et al.* 1996).

a. Antimicrobial activity

Agar well diffusion method was assessed for the antimicrobial effect of leaves and flowers essential oil of *A. houstonianum* (Hadidy*et al.* 2019). Both Gram positive and negative strains of bacteria including *Staphylococcus aureus*, *Bacillus subtilis* and Methylene resistance *Stapylococcusaureus* clinical isolate, *Klebsiellapneumoniae*, *Salmonella typhimurium,* and *Escherichia coli* were used. In comparison with Gentamycin, the flower oil sample was shown to be highly efficient against *B. subtilis* and *S. aureus* having 50% potency. The antibacterial effect of essential oils was observed and better results were shown against gram positive bacteria as compared to gram negative bacteria. They suggested that due to the presence of chromenes the essential oil of the flowers of *A. houstonianum* showed the antibacterial effect.

b. Acaricidal activity

Leaf essential oil of *A.houstonianum* containing foam soap shown the acaricidal properties against *Rhipicephalus lunulatus.* Four replications of different doses ranging from0.00, 0.02, 0.025, and 0.03 ml/g were observed *in vitro* and 10 ticks were placed in each of the petriplate having different concentration with the foam soap on the bottom. Mortality rates observed *in vitro* vary from 0 to 50% when treated with control and when compared 95% with the lowest dose on 8^{th} day and 100% on the 3^{rd} day after treatment. The result indicates the high efficiency of this medicated oil soap as it is highly toxic to *R. lunulatus* (Pamo *et al.* 2004).
]

c. Repellent Activity and Contact Toxicity

Aerial part essential oil of *A. houstonianum* evaluated for booklice to commercial repellent dimethyl phthalate, at a concentration of 0.8 nL/cm^2 after 4 hours of exposure. Results showed that essential oil exhibited strong repellent activity.Furthermore, the essential oil bioactive constituents also showed contact cytotoxityagainst *L. bostrychophila* with an LC_{50} value of 50.8 μg/cm^2.Stronger acute toxicity was shown by Precocene II than precocene I (Lu *et al.* 2014).

d. Insecticidal activity

Fresh *A. houstonianum*aerial parts were extracted by steam distillation and characterized by GCMS analysis. Main compounds were precocene I and Precocene II and beta- caryophyllene. The isolated constituentswere agetochrome and 1- heptadecene. *Plutellaxylostella* and *Aphiscraccivora* were used against essential oil, hexane/methanol fractions. Hexane fraction, essential oil, agetochrome and 1-heptadecenewas toxic to P. *xylostella* larvae whileagainst *A. craccivora* methanol fraction was effective. Essential oil showed repellent activity against *P. xylostella* (Adebisi *et al.* 2019).

e. Antifungal effect

Seven fungal species *viz.*, *Aspergillus flavus, A. fumigatus, A. niger, Candida albicans, Epidermophyton floccosum, Fusarium oxysporous, Trichophyton rubrum* were isolated from infected human nails. There was co-dominance of *Candida* and *Trichophyton* and these were seen to be present in both sterilized as well as unsterilized infected nails. *A. houstonianum* essential oil was found as most potent toxicant as it inhibits the mycelialgrowth at 500 ppm against the test fungi. For both *Candida albicans* and *Trichophyton rubrum* the minimal inhibitory concentration was 400 ppm, and it was fungicidal at 500 ppm for both the test fungi (Kumar 2014).

f. Anticancerous activity

Hadidy *et al.* (2019) performed an experiment using three cancer cell lines HepG-2, HCT-116 and MCF-7 to assess cytotoxicity test on *A. houstonianum* essential oil. For leaves and flower oil sensitivity of human cancer cell was performed with the help of MTT assay test. The principle behind the MTT assay depend on the fact that, a compound of yellow colour is converted into purple derivative i.e. formazan by viable cells. Flowers and leaves derived oil showed *in vitro* cytotoxicity against colon (HCT-116) carcinoma cell line with IC_{50} (11.1 %, 14.2 %) μg/ml sample, respectively. According to them, it may be due to the presence of β-caryophyllene as it is a major constituent in leaves derived oil and exerted significant cytotoxicity.

g. Anti-Dermatophytic activity

The oil was obtained from the leaves of *A. houstonianum* by hydro distillation method and the test was performed against two clinical dermatophytic isolates *Microsporum gypseum* and *Trichophyton mentagrophytes*. The potentization of griseofulvin's activity with essential oil has been assessed. For testing essential oil/griseofulvin were taken in the ratio 8:2 and 10:1 respectively. On guinea pigs (*Cavia porcellus*), oil dermal toxicity was assessed by using the Agar dilution method used for anti-dermatophytic tests. When compared with the control group, no diarrhoea, change in treated skin, and appearance of fur was observed by the workers. On the contrary, with the increase in the dose concentration, noise sensitivity, pinch reaction, locomotion and reactivity decreased. The LD_{50} was 5g kg-1 body weight. These results suggested that *A. houstonianum* leaves oil when used topically may not be toxic and having anti-dermatophytic compounds (Njateng*et al*. 2010).

Conclusion

A. houstonianum is very useful in pathogenic infection treatment. The research has shown that *A. houstonianum* have antioxidant, analgesic, antimicrobial, mosquitocidal, insecticidal, wound healing, and antifungal activity. The chemical constituents such as phenolic acids, flavonoids, phenolic compounds, and some other active compounds are responsible for these activities. A literature review found that *A. houstonianum*is rightly recognised as a useful natural herbal plant.

Acknowledgement

The author is grateful to the CSIR-UGC, Government of India for providing the financial support for my Ph.D. research work as a Junior Research Fellow.

References

Adebisi O, Dolma SK, Verma PK, Singh B and Reddy SGE 2019 Volatile, non-volatile composition and biological activities of *Ageratum houstonianum* Mill.against diamondback moth, *Plutellaxylostella* (L.) and aphid, *Aphis craccivora* Koch. *Indian Journal of Experimental Biology*. 57 908-915.

Breuer M, Budzikiewicz H, Siebertz R and Prokosch P 1987 Benzofuran derivatives from *Ageratum houstonianum. Pergamon Journals Limited.* **26(11)** 3055-3057.

Chandra S, Shahi A K, Dutt P and Tava A 1996 Essential oil composition of *Ageratum houstonianum* Mill. from Jammu region of India. *Journal of Essential Oil Research*. **8(2**) 129-134.

Chandrekar S K, Lal M, Ghosh M K, Tiwari V, Ghorai TK and Shukla R 2020 Green synthesis of copper nanoparticles using leaf extract of *Ageratum houstonianum*Mill. and study of their photocatalytic and antimicrobial activities. *Nano Express*. **1(1)** 010033

Devkota A and Sahu A 2019 Evaluation of *Ageratum houstonianum* Mill leaves extracts against phytopathogenic fungi. *Indian Journal of Natural Products and Resources*. **10(3)** 181-187.

Gill A and Garg P 2016 Cytomorphological diversity of *Ageratum* species from North-West India. *Annals of Plant Sciences* **5(5.3)** 1289- 1295.

Hadidy DE, Sayed A M E, Tantawy ME and Alfy TE 2019 Phytochemical analysis and biological activities of essential oils of the leaves and flowers of *Ageratum houstonianum* Mill. cultivated in Egypt. *Journal of Essential Oil-Bearing Plants*. **22(5)** 1241-1251.
http://www.plantsoftheworldonline.org/

Johnson MF 1971 A monograph of the genus Ageratum L. (Compositae-Eupatorieae). *Annals of the Missouri Botanical Garden*.6-88.

Kanase V and Shaikh S 2018 A pharmacognostic and pharmacological review on *Chromolaenaodorata* (L.)RM King and H. Rob. (Siam weed). *Asian Journal of Pharmceutical and Clinical Research*, **11(10)** 34-38.

Kumar B, Vijayakumar M, Govindarajan R and Pushpangadan P 2007 Ethnopharmacological approaches to wound healing-exploring medicinal plants of India.*Journal of Ethnopharmacology* **114** 103-113.

Kumar N 2014.Inhibition of nail infecting fungi of peoples of northeastern U.P causing *Tineaunguinum* through leaf essential oil of *Ageratum houstonianum* Mill.*Journal of Pharmacy*. **4(6)** 36-42.

Kurade NP, Jaitak V, Kaul VK and Sharma OP 2010 Chemical composition and antibacterial activity of essential oils of *Lantana camara*, *Ageratum houstonianum,* and *Eupatorium adenophorum*. *Pharmaceutical Biology.* **48(5)** 539-544.

Lamsal A, Devkota MP, ShresthaDS, Joshi S and Shrestha A 2019 Seed germination ecology of *Ageratum houstonianum*: a major invasive weed in Nepal. **14(11)** e0225430

Lu XN, Liu XC, Liu QZ and Lie ZL 2014 Isolation of insecticidal constituents from the essential oil of *Ageratum houstonianum* Mill.against*Liposcelisbostrychophila*Badonnel. *Journal of Chemistry*.

Menut C and Lamaty G 1993 Aromatic plants of tropical central Africa.part X chemical composition of the essential oils of*Ageratum houstonianum* Mill. and*Ageratum conyzoids* L. from Cameron. *Flavour and Fragrance Journal*.**8**1-4.

Milusheva D I, Atanassova B Y and Iakimova E T 2019 Application of in vitro test system for evaluating the tolerance of *Ageratum houstonianum*and *Petunia x hybrida*to cadmium toxicity. *Bulgarian Journal of Agricultural Science*, **25(2)** 300-309.

Mohammadi, M 2017*In vitro* organogenesis of *Ageratum houstonianum*(Asteraceae).*International Journal of Biosciences.***10(5)** 85-96.

Njateng G S S, Kuiate J R, Gatsing D, Tamokou J D, Mouokeu R S and Kuete V 2010 Antidermatophytic activity and dermal toxicity of essential oil from the leaves of *Ageratum houstonianum* (Asteraceae). J*ournal of Biological Sciences*, **10(5)** 448-454.

Pamo T E, Tendonkeng F, Kana J R, Tenekeu G, Tapondjou L A and Payne V K 2004 The acaricidal effect of the essential oil of *Ageratum houstonianum* Mill. flowers on ticks (*Rhipicephaluslunulatus*) in Cameroon. *South African Journal of Animal Science*. 244-247.

Panicker V P, Haidas P, Jayavardhan K K and John B 2017 Evaluation of wound healing properties of methanolic extract of *Ageratum houstonianum*Mill. *Journal of Livestock Sciences*. **8** 201-203.

Quijano L, Calderon J S, Gomez F and Rios T 1982 Two polymethoxyflavones from *Ageratum houstonianum*.*Journal of Phytochemistry*. **21(12)** 2965-2967.

Reddy K S, Kumar A S and Ganapaty S 2012 Evaluation of *Ageratum houstonianum*whole plant for its anti-diabetic activity. *Journal of Advanced Scientific Research,* **3(2)** 67-70.

Sharma K R 2020 In-vitro antioxidant, antidiabetic and toxic effect of *Ageratum houstonianum* from Chitwan district Nepal. *Journal of Balkumari College*. **9(1)** 48-51.

Shin S Y, Gil H N, Kim B S, Choe J S, Kim J B, Lee Y H and Lim Y 2017 Agerarin, identified from *Ageratum houstonianum*, stimulates circadian CLOCK-mediated aquaporin-3 gene expression in HaCaT keratinocytes. *Scientific Reports*, **7(1)** 1-13.

Siebertz R, Proksch P and Witte L 1990 Accumulation and biosynthesis of the chromenesprecocene I and II in *Ageratum houstonianum*. *Phytochemistry*, **29(7)** 2135-2138.

Singh V, Singh H, Sharma GP and Raghubanshi AS 2011 Eco-physiological performance of two invasive weed congeners (*Ageratum conyzoides L*. and *Ageratum houstonianum* Mill.) in the Indo-Gangetic plains of India. Environmental Monitoring and Assessment. **178** 415-422.

Tennyson S, Balaraju K, Park K, Raja A, Ravindran K J, Eapen and William S J 2011 In vitro antimicrobial activity of *Ageratum houstonianum* Mill. (Asteraceae).*Elixir International Journal*. 35(2011):2897-2900.

Tennyson S, Balaraju K, Park K, Raja A K, Ravindran K J, Eapen A and William SJ 2012 In vitro antioxidant activity of *Ageratum houstonianum* Mill. (Asteraceae). *Asian Pacific Journal of Tropical Disease*. **2** S712-S714.

Tennyson S, Ravindran K J, Eapen A and William SJ 2012 Effect of *Ageratum houstonianum* Mill. (Asteraceae) leaf extracts on the oviposition activity of *Anopheles stephensi*, *Aedesaegypti* and *Culexquinquefasciatus* (Diptera: Culicidae). *Parasitology research*, **111(6)** 2295-2299.

Wangpan T, Tasar J, Taka T, Giba J, Tesia P and Tangjan S 2019 Traditional use of plants as medicine and poison by Tagin and Galo tribe of

Arunachal Pradesh. *Journal of Applied Pharmaceutical Science*. **9(09)** 98-104.

Wiedenfeld H and Cetto A A 2001 Pyrrolizidine alkaloids from *Ageratum houstonianum* Mill.*Pergamon*. **57(2001)** 1269-1271.

Zeeshan M, Rizvi S M D, Khan M S and Kumar A 2012 Isolation, partial purification and evaluation of bioactive compounds from leaves of *Ageratum houstonianum*. *EXCLI Journal.* **11** 78-88.