IJMPR 2022, 6(6), 121-131

International Journal of Modern Pharmaceutical Research
www.ijmpronline.com

ISSN: 2319-5878
IJMPR
Review Article
SJIF Impact Factor: 5.273

FROM TRADITIONAL CLAIM TO FORMULATIONS: AN OVERVIEW OF THE POTENTIAL OF GAMOCHAETA, AN EDIBLE PLANT GENOME

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Received on: 21/05/2022
Revised on: 11/06/2022
Accepted on: 01/07/2022

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ABSTRACT

Gamochaeta (Asteraceae, Gnaphalieae) is a genus of sixty species found predominantly in tropical and semitropical America. Previous molecular biological process investigations have steered the genus' paraphyly but due to insufficient taxonomic category sampling, they have not offered a basis for redefining generic bounds. This plant is supposed to be medicinal and is used to treat diabetes, high blood pressure, stomach ulcers, diarrhoea and other ailments. The Gamochaeta species has a diverse range of bioactive chemicals that are well tolerated as ancient remedies. Gamochaeta species are widely used in various traditional medicinal systems all throughout the world. Due to the wide range of pharmacologic qualities of Gamochaeta species, more complete and inclusive clinical trials are required for the use of Gamochaeta species to treat a variety of disorders. Various additional uses such as food, cosmetics and agriculture may also be examined or explored in the future. Investigation of various species for undiscovered biological potential, isolation and characterization of recent bioactive constituents and finally investigation of new applications and possible commercialization of those bioactive leads are some of the main domains that can be explored at intervals in this genus. There are certainly other viable analytic domains outside those listed above but for this assessment, we will focus on the activities listed here. A review like this one is intended to offer a comprehensive, detailed and careful look at the ethnomedicinal uses, pharmacology, phytochemistry and toxicology of Gamochaeta species as well as to suggest means of planning and executing future preparations, either alone or in combination with commonly used remedies. The review also underlines the importance of encouraging researchers to look into the diverse range of pharmacological applications of the various Gamochaeta species to expand their use and exploration in the future.

KEYWORDS: Gamochaeta, Capitula, Trichomes, Asteraceae, Truncate.

MATERIALS AND METHODS

All relevant data and information on various Gamochaeta species were compiled utilising a variety of databases including PubMed, Science Direct, Springer-link, Google Scholar review and analysis papers from peer-reviewed publications. Some 'grey literature' sources such as ethnobotanical books and chapters, were also looked at.

INTRODUCTION

Gamochaeta are endemic to the America, exclusively from South America; however other appears to be native to North American countries as well as the flora space. Some species are aggressive weeds with wide non-native ranges. Its been difficult to estimate the distribution of the widespread species due to variations in their identification.

Several botanists who have recognised Gamochaeta as a separate genus within the last decade have emphasised its individuality. Small cypselae with minute, mucilage producing papilliform hairs on the faces, concavo-convex post-fruiting receptacles, truncate assembling appendages of favour branches in bisexual florets and pappus bristles basally connate in smooth rings and ejected as single units define the species. Almost all species appears to be largely autogamous as evidenced by the tiny, non-showy heads that scarcely emerge during flowering. This notion is supported by the uniformity of vegetative and floral alternatives in several taxa. Some varieties of *Gamochaeta purpurea* (L.) Cabrera, has traditionally been recognised as variants in

the flora; distinctions are visible in the field, where it's typical to find as many as five species growing in close proximity without intergradation (Hammond *et al*.; Morin *et al*.; Moreno *et al*.).

Gamochaeta species are identified by differences in root type, leaf shape, indument nature and distribution, and phyllary morphology. For a few species, body counts are reportable; however, due to the inaccuracy of identifications, vouchers for those counts should be restudied (Morin *et al*.).

Fig. 2: *Gamochaeta pensylvanica* (Willd.) Cabrera.

Twenty four species of Gamochaeta (Gnaphalieae, Asteraceae) – *Gamochaeta aliena, Gamochaeta alpina, Gamochaeta axillaris, Gamochaeta longipedicellata, Gamochaeta americana, Gamochaeta andina, Gamochaeta chamissonis, Gamochaeta depilata, Gamochaeta deserticola, Gamochaeta falcata, Gamochaeta filaginea, Gamochaeta humilis, Gamochaeta neuquensis, Gamochaeta nivalis, Gamochaeta spiciformis, Gamochaeta oligantha, Gamochaeta procumbens, Gamochaeta ramosa, Gamochaeta serpyllifolia* (Pruski *et al*.), *Gamochaeta simplicicaulis, Gamochaeta spiciformis, Gamochaeta stachydifolia, Gamochaeta subfalcata, Gamochaeta valparadisea* and *Gamochaeta villarroelii* are formally monographed with morphological descriptions, illustrations, geographical distribution and habitat, distribution maps, phenology, lists of representative specimens examined and a comprehensive identification key for each species. A brand new name *Gamochaeta ramosa* S.E. Freire, N. Bayón & C.M. Baeza for *Gnaphalium ramosum* Phil. (1864) non Lam. (1779) necrotizing enterocolitis Sch. Bip. (1845) is proposed. The following taxa are freshly synonymized- *Gamochaeta foliosa* with *Gamochaeta spiciformis*; *Gamochaeta monticola* with *Gamochaeta oligantha*; *Gnaphalium petraeum* with *Gamochaeta andina*; *Gamochaeta suffruticosa* with *Gamochaeta chamissonis*; *Gnaphalium bellidifolium*, *Gamochaeta berteroana* with *Gamochaeta filaginea* and *Gnaphalium agreste* with *Gamochaeta stachydifolia*. Lectotypes are newly selected for *Gnaphalium andinum, G. berteroanum, G. suffruticosum*, and *G. villarroelii*. (Freire *et al*.; Salomón *et al*.; Grossi *et al*.

2.1 Different Species and Their Common Name

Table 1: Common names.

Scientific Name	Common Name
Gamochaeta antillana	Caribbean Purple Everlasting, Delicate Everlasting
Gamochaeta argyrinea	Silvery cudweed
Gamochaeta chionesthes	White – cloaked cudweed
Gamochaeta coarctata	American Everlasting, Elegant cudweed
Gamochaeta pensylvanica	Pennsylvania Everlasting, Pennsylvania cudweed
Gamochaeta purpurea	Spoonleaf Purple Everlasting, Spoonleaf cudweed
Gamochaeta simplicicaulis	Single stem Everlasting, Simple stem cudweed

Fig. 3: Some Species of Gamochaeta.

3.1 Distribution of Plant

This genus' Plants have relatively small heads in spiciform (spike – like) arrays, depressed post-fruiting receptacles, truncate grouping appendages of favour branches in bisexual florets, comparatively small cypselae (fruits) with minute, mucilage – producing outgrowth hairs on the faces and pappus bristles basally connate in sleek rings and free as single units (Freire *et al*.; Salomón *et al*.; Grossi *et al*.).

- *Gamochaeta aliena*: Chile
- *Gamochaeta ambatensis*: Catamarca
- *Gamochaeta americana* (American Everlasting): Lechuguilla, Palomita, Mesoamerica, South America, West Indies
- *Gamochaeta andina*: Chile
- *Gamochaeta antarctica* (Antarctic cudweed) : Tierra del Fuego, Falkland Islands
- *Gamochaeta antillana* : Southeastern US
- *Gamochaeta argentina* : Rio Grande do Sul, Uruguay, Northeastern Argentina
- *Gamochaeta longipedicellata* : Jujuy
- *Gamochaeta lulioana* : Peru, Bolivia
- *Gamochaeta malvinensis* : Tierra del Fuego, Falkland Islands
- *Gamochaeta meridensis* : Venezuela
- *Gamochaeta monticola* : Neuquen, Chile, Bolivia
- *Gamochaeta neuquensis* : Rio Negro, Neuquen, Central and Southern Chile
- *Gamochaeta nigrevestis* : Southeastern Brazil
- *Gamochaeta nivalis* : Chile, Argentina
- *Gamochaeta oligantha* : Santiago, Valparaiso
- *Gamochaeta pennsylvanica* : Mesoamerica, India (Gujarat, Jharkhand) (Horo *et al*.; Patel et al.), Africa, Australia
- *Gamochaeta platensis* – Uruguay, North eastern Argentina, Southern Brazil

Fig. 4: Biodistribution of Gamochaeta species.

4.1 Morphology and Micromorphology

Habitat and Stems: Most Chilean species of Gamochaeta are perennial herbs, more rarely biennials or annuals, i.e. *Gamochaeta oligantha, Gamochaeta ramosa, Gamochaeta simplicicaulis*. Stems start from a few cm (e.g. *Gamochaeta andina, Gamochaeta oligantha, Gamochaeta deserticola*) to 60-70 cm tall (e.g. *Gamochaeta americana, Gamochaeta simplicicaulis*) or more sometimes with primary stem branching at ground level only and ascending normally branchless stems (branched stems in *Gamochaeta ramosa*) from an accumbent base.

Pubescense: The thickness of the wool on the leaves can be used alone or combined with other features to distinguish species (e.g. *Gamochaeta aliena* from *Gamochaeta filaginea* by woolly loosely woolly or lanuginose respectively. Others include *Gamochaeta serpyllifolia* from *Gamochaeta depilate* by woolly and subglabrous or lanuginose respectively). Puberty in Chilean Gamochaeta species as well as Pseudognaphalium species is comprised of two fundamental trichome kinds found on stems, leaves and phyllaries. In contrast to Chilean Pseudognaphalium species, glandular trichomes are scarcely depicted in Gamochaeta.

Taproot or fibrous – rooted (subrhizomatous) annuals, biennials or perennials, 5-65 centimetres. Stems occasionally upright, usually climbing decumbently. Blades mostly linear to spatulate or straightforward, base unsubdivided to cordate, edges whole, occasionally sinuate, abaxial faces ordinarily white or grey and tomentose or pannose – tomentose, adaxial green and glabrescent or glabrous or greyish and arachnose, loosely tomentose or subpannose. Disciform heads, generally in glomerules, borne in continuous or interrupted arrays, usually spiciform and occasionally paniculiform (reduced to terminal glomerules in depauperate individuals), 2.5-5 mm involucres, narrowly to loosely campanulate. Phyllaries in 3-7 series, uneven, mainly chromatic to stramineous, occasionally purple, hyaline to lustrous, eglandular, distally stuff to scarious with flat (concave in fruit), glabrous, epaleate receptacles. Corollas are entirely yellow or purplish – tipped, pistillate florets are 50-130 with more variety than bisexual florets; golden or distally purple corollas. Cypselae oblong, slightly flattened faces with process hairs (myxogenic).

All of the species in the Gamochaeta genus are endemic to the Americas (Morin *et al*.; Nesom *et al*.) with around 50 species. The majority are only known from South America; however some appears to be endemic to Mexico and therefore the flora space. Some species are aggressive weeds with wide non-native ranges. It is proven difficult to estimate the overall ranges of the widespread species due to variations in their identifications.

Phenology: From January to March, the plant blooms. Sometimes in October also.

Relationship: In terms of habit, capitula preparation and leaf form, *Gamochaeta aliena* is quite similar to *Gamochaeta filaginea*. *Gamochaeta aliena – V*, on the other hand, is identified by its whitish – woolly leaves on each surface against whitish – lanuginose above and whitish woolly below in Gamochaeta filaginea. *Gamochaeta aliena* has a habit and capitula arrangement similar to *Gamochaeta falcata*. *Gamochaeta aliena – V*, on the other hand, is distinguished by its straight cauline leaves.

5.1 Ethnopharmacology Uses Of Gamochaeta

- Species might belong to the "Lamiaceae" (Labiatae or Mint) family and be a multiregional genus. Gamochaeta species are a valuable component of traditional medicines. They are widely used, particularly in India's mountainous regions (Uttarakhand, Himachal Pradesh, Jammu and Kashmir, Leh-Ladakh), Asia (Khyber Pakhtunkhwa, Pakistan), Nepal (Baglung district), China and the mountainous regions of Turkey and Iran.
- Chicken pox, TB, malaria, pneumonia, influenza, measles, abdominal disorders, eye complaints, metabolism disorders, asthma, cold and cough and other diseases and conditions are all treated using Gamochaeta species (De-la-Cruz *et al*.; Ramirez *et al*.).
- This plant is considered medicinal and is used to treat diabetes, high blood pressure, stomach ulcers, diarrhoea and gastrointestinal infections among other ailments (Ramirez *et al*.).
- Leaves and immature flowering shoot terminals are edible and are commonly used to obtain medical benefits. So, locals usually gather those plant additions and any seasonally available greens and boil them into a greens saag.
- The nutritional value of many wild edible leafy greens consumed by the "Ho" tribes was studied. *Gamochaeta pennsylvanica*, *Gnaphalium indicum* and *Gnaphalium luteo* are among the Gamochaeta species found in Jharkhand's W. Singhbhum area. The plant is known among the "Ho" tribes as "Putam aa" which is a herb that is used to prepare vegetables (Horo *et al*.).

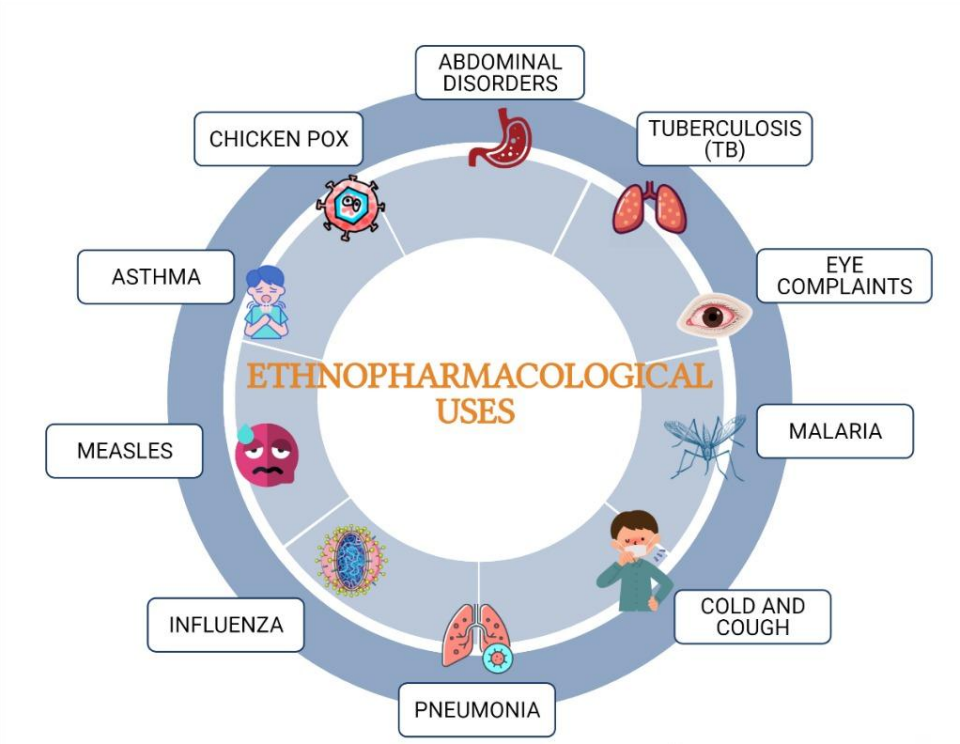


Fig. 5: Ethnopharmacological uses of the Gamochaeta genus.

6.1 Pharmacological Uses Of Gamochaeta

- **As an antioxidant:** Navarro Soto AJ studied the number of polyphenolic components and in vitro antioxidant activity of the hydroalcoholic extracts of *Gamochaeta purpurea* (L.) Cabrera (whole plant). The antioxidant activity was assessed using the DPPH and ABTS technique and the polyphenolic compounds were quantified using the spectrophotometric method devised by Folin and Ciocalteau which used gallic acid as a reference. *Gamochaeta purpurea* (L.) Cabrera was found to have a more significant amount of polyphenolic compounds with antioxidant activity.
- **As antiviral:** *Gamochaeta simplicicaulis* (Willd.) Cabr, according to E. Mongelli *et al*., has antiviral activity and can be used to treat pox, measles, and varicella. It is used to wash away wounds and blemishes on the outside.
- **Activity against HIV I Reverse Transcriptase :** Some Argentine Plant Extracts were shown to be

active against Polymerase and Ribonuclease H Activities of HIV-1 Reverse Transcriptase, according to Hnatyszyn *et al*. Methanol extracts of *Gamochaeta simplicaulis* (Willd.) Cabr. exhibited minor action but extracts of *Achyrocline flaccida* (Weinm.) DC. and *Phyllanthus sellowianus* (Klotzsch) Muell. Arg. showed activity in inhibiting DNA-polymerase activity in wild and mutant types and ribonuclease activity. Furthermore, these fractions were non-cytotoxic and effective inhibitors of viral replication.

- **As anti-human immunodeficiency virus type-1 (HIV-1) :** As documented by H. Salomón *et al*., the anti-human immunodeficiency virus type-1 (HIV-1) activity of two South American plant extracts was examined in vitro. Aqueous extracts of *Achyrocline flaccida* (Weinm.) DC and *Gamochaeta simplicicaulis* (Willd.) Cabrera inhibited 50% of viral generation at doses of 3 and 5 mg/mL respectively. Concentrations of 400 and 600 mg/mL were shown to impede cellular proliferation. There was non-virucidal action found. The findings showed that both *Achyrocline flaccida* (Weinm.) DC and *Gamochaeta simplicicaulis* (Willd.) Cabrera extracts have significant anti-HIV-1 actions which might occur at an early stage of viral replication on lymphocytes from a primary source.
- **As anti-herpes:** Aqueous extracts of *Gamochaeta simplicicaulis* (Willd.) Cabrera has been shown to exhibit actual antiviral activity in vitro against several members of the herpesvirus family (herpes simplex virus types 1 and 2, human cytomegalovirus, bovine herpes virus, and reduced activity with pseudorabies virus), according to L. Cavallaro *et al*. Some RNA (naked and enclosed) viruses and adenoviruses were unaffected by the extract. The extract was not virucidal but it had a high enough antiviral index (AI) to warrant further investigation. Different experimental techniques suggest that the antiviral action was mediated at an early stage of viral replication, at least the adsorption phase.

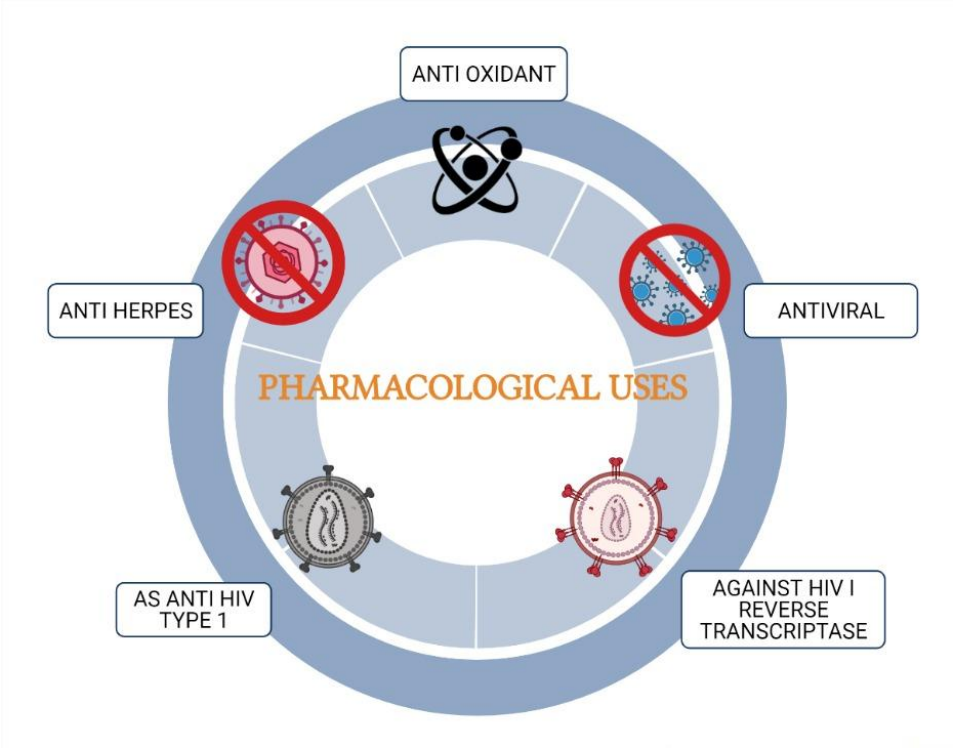


Fig. 6: Pharmacological uses.

7.1 Miscellaneous

Some of the local community has utilised 138 weed species from 35 houses and 111 genera for various purposes. The majority of weeds were either medicinal (58 species) or fodder (23 species) or both medicinal and fodder (19 species). Fifteen species were utilised as green leafy vegetables or salad, six were toxic, 6 were decorative and five were employed as medications and non-woody hay fuel respectively. The remaining species are used for a variety of purposes including broom making (2 species), washing (1 species), rope and basket making (1 species), insecticide (1 species) and perfume production (1 species) (De-la-Cruz *et al*.).

8.1 Formulations

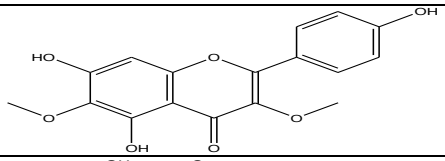
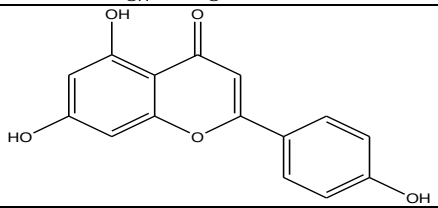
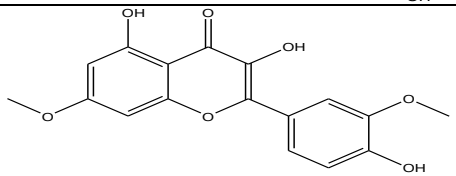
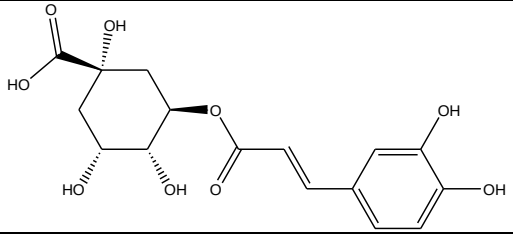
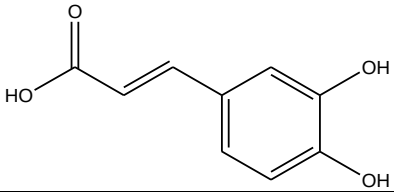
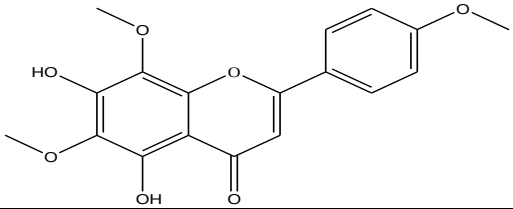
Treatments for various ailments were primarily structured through infusion, decoction and mixture and were administered orally or topically to the skin. These therapies have been utilised to treat a variety of fitness difficulties including respiratory problems, gastrointestinal problems, skeletal-muscular aches, skin problems and cardiovascular problems among others. Out of 138 weeds, ninety-eight plant species were found

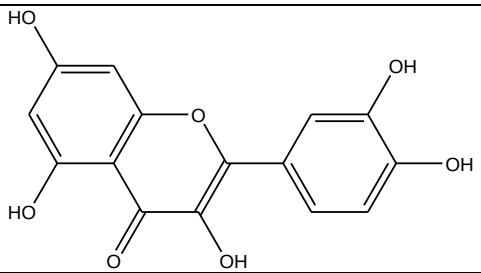
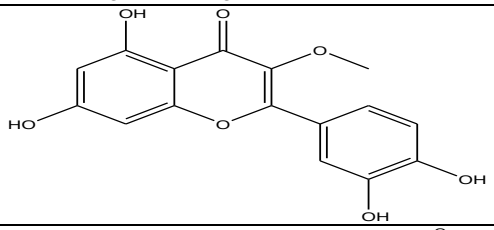
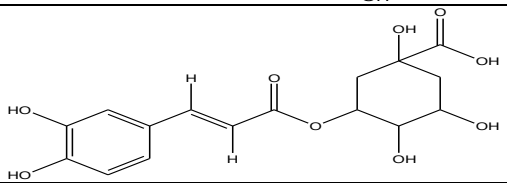
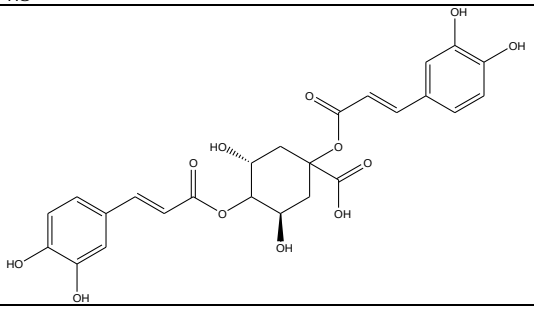
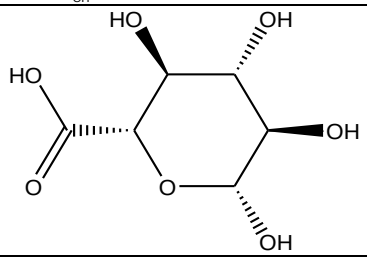
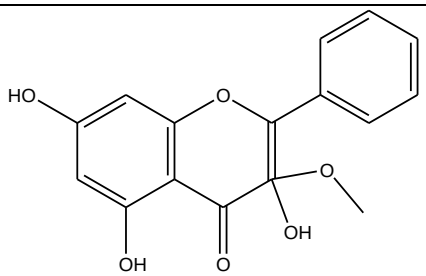
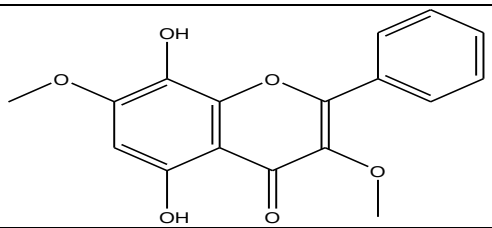
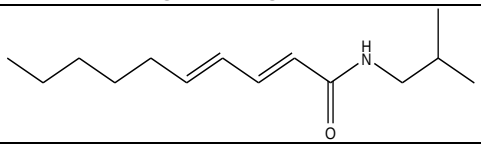
to have the whole plant body utilisable, while the other species had been given one or more components to be used by local people. Plants have a survival rate for man on our planet, even weeds, the so-called unwanted plants inside the crop field. As a result, specific conservative measures and strategies are essential for the survival of the vegetation within the area's lives (De-la-Cruz *et al*.).

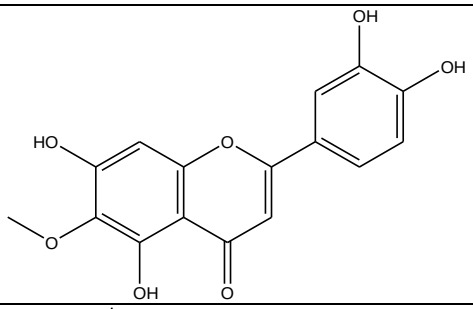
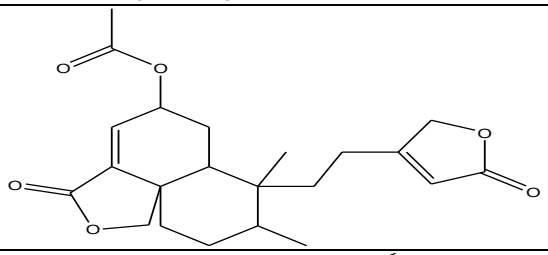
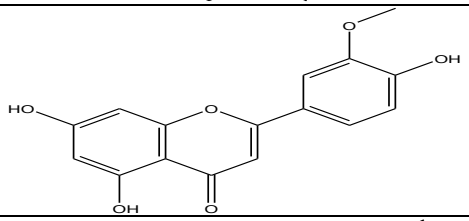
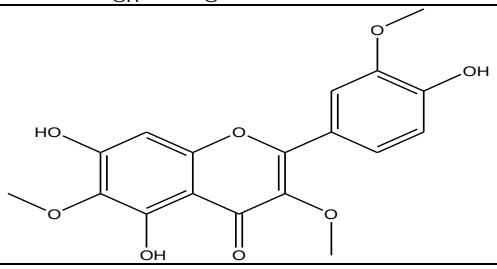
8.1 Phytoconstituents

The plant family Asteraceae contains the most significant number of therapeutic species, accounting for more than 39% of Argentina's total medicinal flora. Baccharis, Senecio and Eupatorium were the most commonly reported genera. On the other hand, the majority of phytochemical research was focused on the essential oil content of Senecio (Zhao *et al*.) and Eupatorium species (Zunino *et al*.). 5-7-4'-trihydroxy-3-6-dimethoxyflavone, Apigenin, Rhamnazin, Chlorogenic acid, Caffeic acid, Nevadensin, Quercetin, 3-0-methyl quercetin, Isochlorogenic acid, 1,4-dicaffeoyl quinic acid, Glucuronic acid, 3-methoxy galangin and 3,7-dimethoxy-5,8-dihydroxyflavone, Pellitorine (Alkamide), Eupafolin, Articulin acetate, Chrysoeriol and Jaceidin are the main phytoconstituents (Broussalis *et al*.; Zunino *et al*.). Asteraceae is a plant family with a high number of species utilised in traditional medicine according to a huge number of ethnobotanical research. Only a few species, such as those of the genera Gamochaeta or Heterosperma have been studied to determine their chemical composition or to assess their biological or pharmacological effects.

Table 2: Table of phytoconstituents.

SL. NO	IUPAC name	Mol. Wt. (g/mol)	Structures	Reference
1.	5-7-4'-trihydroxy-3-6-dimethoxyflavone	330.29		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
2.	Apigenin (5,7-Dihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one)	270.24		(Alvarez *et al*.; Barboza et al.; Broussalis *et al*.; Zunino *et al*.)
3.	Rhamnazin (3,5-Dihydroxy-2-(4-hydroxy-3-methoxyphenyl)-7-methoxy-4H-1-benzopyran-4-one)	330.29		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
4.	Chlorogenic acid {(1S,3R,4R,5R)-3-[(E)-3-(3,4-dihydroxyphenyl)prop-2-enoyl]oxy-1,4,5-trihydroxycyclohexane-1-carboxylic acid}	354.31		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
5.	Caffeic acid {(E)-3-(3,4-dihydroxyphenyl)prop-2-enoic acid}	180.16		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
6.	Nevadensin (5,7-hydroxy-4',6,8-trimethoxyflavone)	344.3		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)

7.	Quercetin {2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxychromen-4-one}	302.23		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
8.	3-O-methyl quercetin	316.26		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
9.	Isochlorogenic acid (5-O-caffeoyl quinic acid)	354.31		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
10.	1,4-dicaffeoyl quinic acid	516.4		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
11.	Glucoronic acid {(2S,3S,4S,5R,6R)-3,4,5,6-Tetrahydroxyoxane-2-carboxylic acid}	194.14		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
12.	3-methoxy galangin	285.27		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
13.	3,7-dimethoxy-5,8-dihydroxyflavone	314.29		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
14.	Pellitorine (Alkamide)	223.35		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)

15.	Eupafolin (6-Methoxyluteolin)	316.26		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al.*)
16.	Articulin acetate	388.5		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)
17.	Chrysoeriol (4′,5,7-Trihydroxy-3′-methoxyflavone)	300.26		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al.*)
18.	Jaceidin	360.3		(Alvarez *et al*.; Barboza *et al*.; Broussalis *et al*.; Zunino *et al*.)

9.1 New Records For Two Alien Asteraceae Species In The United Arab Emirates

Gamochaeta pensylvanica and *Verbesina encelioides*, two Asteraceae family species endemic to the Americas are found in numerous parts of the United Arab Emirates. Each of the species is a first for the country's flora with *Gamochaeta pensylvanica* having never been seen before in any region of the Arabian Peninsula. The reported 2 taxa are thought to be invasive in nature and will become issues for the native flora and agriculture in the future.

Both *Gamochaeta pensylvanica* and golden crownbeard are not native to the UAE and while their numbers are now tiny, their variation may expand in the future making them invasive in nature. The plant species, notably the genus *Verbesina encelioides* are invasive and pose a danger to native flora, farms, and grazing animals. Currently, manual management strategies are being used to remove them before they become a danger (Byalt *et al*.; Shahid *et al*.).

10.1 CONCLUSION

This review aims to depict the world of the Gamochaeta genus and how it is used in traditional ways. Gamochaeta is commonly consumed as food in Asian tribal cultures as we have seen throughout this analysis. Many significant phytochemical components are found in the plant and they are responsible for a variety of functions. As a result of this research, we would like to conclude that due to its various therapeutic benefits, the Gamochaeta genus may be employed as a single component medication in herbal medicines as well as in a variety of appropriate polyherbal formulations.

Conflicts of Interest

The authors report no conflicts of interest. The authors alone are responsible foe the content and writing of this article.

Funding

This publishing is not funded.

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