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GENUS CARALLUMA: PHYTOCHEMICAL DIVERSITY, THERAPEUTIC POTENTIAL, AND EMERGING OPPORTUNITIES FOR DRUG DISCOVERY

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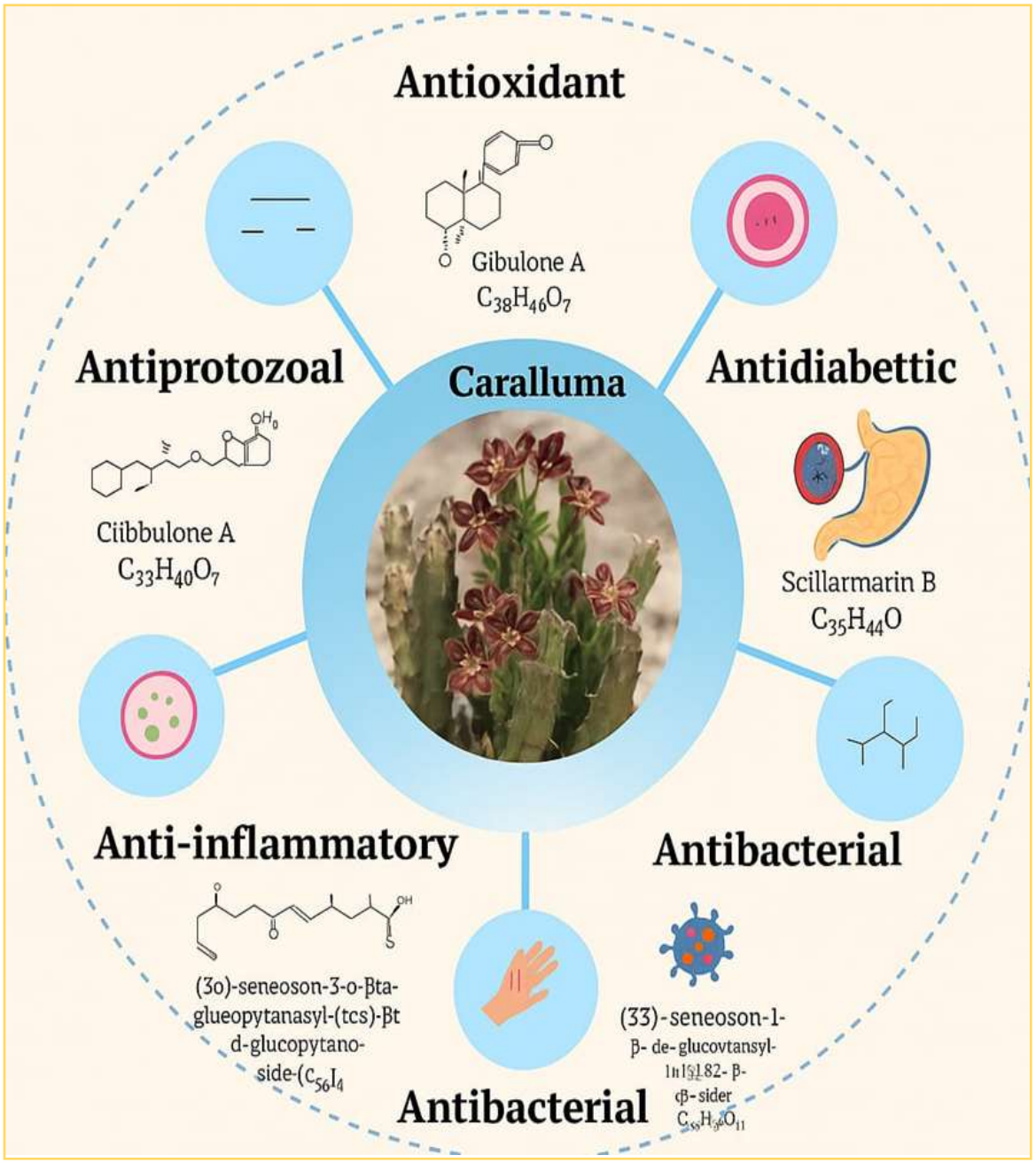
Abstract
The genus Caralluma has generated considerable attention due to its wide ethnomedicinal and phytochemical complexity. Still, lacking a comprehensive and update review that covers ethnomedicinal, phytochemical constituents and biological activitites. This review aims to offer comprehensive and up-to-date information on genus Caralluma associating with its taxonomy, medicinal uses, phytochemical compound classes, anti-microbial properties and toxicology studies to lead future research. Web search engines such as, Science Direct, PubMed, Wiley Online Library, Google scholar and Springer Link were used to conduct an exhaustive examination of the literature. The genus Caralluma belonging from family (Apocynaceae) consists of succulent species that have long been used in traditional medicines across South Asia and the Arabian Peninsula. The results of this review presents a detailed synthesis of the available literature on the Distribution, medicinal uses, phytochemistry, antioxidant, antimicrobial and toxicity profiles of Caralluma species. The species of the Caralluma genus had been widely used to cure diabetes, inflammation, skin issues (freckles and pimples), hypertention, liver disorders, hepatitis B/C, cancer(oral, curvical, brest, lungs, colon, and heptic cancer), rhumetisim, blood disorders, leprosy, peptic ulcers, dysentery, gastric issues, constipation, kidney stones, cysts, cough, asthama, insomnia, urogenital infections, tuberculosis, weight management, malaria, appetite suppressing and microbial infections. It also covers the phytochemical compound classes, including pregnane glycosides, flavonoids, Saponins, gallic acid, rutins, alkaloids, and phenolic compound. These biological activities could be associated with the chemicals present in the species of Caralluma. This review highlights that Genus Caralluma had high medicinal values and also had antioxidant, toxicity, antimicrobial activities with its phytochemical constituents. It also demonstrated the urgent need for the future research on the drug discovery and ethnopharmacological studies of the genus Caralluma.

Key words: Caralluma, Phytochemical Diversity, Drug.

GRAPHICAL ABSTRACT



INTRODUCTION

There are 120 species in the xerophytic genus Caralluma R. Br., which belongs to the Apocynaceae family. The Arabic expression "qarh al-luhum," which indicates an abscess or a cut in the flesh, is where the word "Caralluma" originates. The arrangement of floral components is the only difference between the two taxa, thus Caralluma and Boucerosia are likewise regarded as synonyms (Stewart.,1972; abdel-sattar et al.,2025). The majority of Caralluma plant species are succulent perennial herbs with small, caducous leaves; some of these species have been found to be edible. (Naik and Krishnamurthy.,2012). A vast genus of the Asclepiadoideae subfamily (order: Ceropegieae), Caralluma R. Br. (syn. Ceropegia L.) has a variety of uses in traditional medicine (Karale and Karale .2017).

Many species of Caralluma contain large amounts of megastigmane glycosides, flavones, and PGs (Bader et al.,200; Braca et al.,2002; Abdel-sattar et al.,2007; abdel-sattar et al.,2025). Furthermore, some Caralluma extracts have shown antifungal, antibacterial, anti-eczemic, anticancer, antidiabetic, anti-inflammatory, and antimalarial properties (Waheed et al., 2011; Rauf et al., 2013; Anwar et al., 2022; Ansari et al., 2022; Amrati et al., 2021; abdel-sattar et al., 2025). In Pakistan, Caralluma tuberculata and Caralluma edulis were formerly classified as Boucerosia edulis and Boucerosia tuberculata, but they have since been recognized as Caralluma species (Rauf et al., 2013). It needs to be mentioned that C. tuberculata and C. edulis are currently recognized as Caralluma species, while they were

formerly classified as B. tuberculata and B. edulis in Pakistan. (Jayawardena et al., 2021; Zarei et al., 2020; Mounika et al., 2016)

Caralluma is a genus that is widely distributed over different regions. Asia and Africa (especially Pakistan, India, Afghanistan, Iran and Srilanka), These plants can be found in the Canary Islands, South Africa, Southeast Europe, and the Arabian Peninsula. This wide range illustrates the adaptability and resilience of Caralluma species in diverse environments (Gabali and Al-Gifri., 1990).

The genus Caralluma belongs to the class Magnoliopsida, subclass Asteridae, order Gentianales, and superorder Gentiananae (14). Caralluma was formerly a member of the Asclepiadaceae family, which is commonly referred to as milkweed. Asclepiadaceae should be categorized as a subfamily Asclepiadoideae within the Apocynaceae family (BENSUSAN.,1913) and tribe Ceropetegieae (Kamel et al., 2014), according to recent molecular and genetic research. With over 200 species, one of the main genera of the Asclepiadoideae subfamily is Caralluma.It is found in arid parts of tropical Asia, the southern Mediterranean, the near east and north, and central and eastern Africa (Gilbert.,1990; Albers and Meve.,2012).

Wight and Arnott divided the genus Caralluma into the new genera Boucerosia and Hutchinia in 1834 (Albers and Meve.,2012; abdel-sattar et al.,2025). However, Brown regrouped all the genera into Caralluma in 1892, adding multiple identical succulents to the same genus, which increased dispute. Based on stem and flower morphology, Gilbert separated Caralluma into four subgenera once more in 1990: Boucerosia, Caralluma, Desmidorchis, and Urmalcala. Plowes (1995) later recognized 17 genera and roughly 70 species after further subdividing the genus according to different morphological principles (Albers and Meve.,2012; abdel-sattar et al.,2025). Caralluma was classified into six subgenera by Meve and Liede in 2002: Apteranthes, Boucerosia, Caralluma, Caudanthera, Desmidorchis, and Monolluma. Taxonomists have made multiple attempts to categorize the various Caralluma taxa, but ambiguity persists. Apocynoideae, Asclepiadoideae, Periplocoideae, Rauvolfioideae, and Secamonoideae are the five subfamilies that make up the Apocynaceae family. One of the most important sources of C21 pregnane derivatives is Asclepiadoideae, formerly known as the Asclepiadaceae family (de Souza et al.,2024; abdel-sattar et al.,2025).
The genus Caralluma is primarily abundant in pregnane glycosides, with several newly isolated including six novel pregnane glycosides (quadrangulosides A-F from Caralluma quadrangular (Ismail et al.,2023). Caralluma quadrangula produces flavone glycosides in addition to pregnane glycosides, which add to its range of bioactivity (Ismail et al.,2023). Glycosides, flavonoids, Alkaloids steroids, phenols, tannins and saponins, were found in several solvent extracts during the initial screening of Caralluma stalagmifera (veerabhadraiah et al.,2024). According to GC-MS analysis, the maximum concentration of flavonoids, alkaloids, phenolics and terpenoids was found in methanolic extracts of Caralluma edulis (Khan et al.,2022).
Hydroethanolic extracts of Caralluma europaea showed notable flavonoid and polyphenols concentrations as determined by HPLC, along with flavonoids like, myricetin, and hesperetin and quercetin (Amrati et al., 2020). It has been demonstrated that the stems of Caralluma speciosa contain a combination of fatty acids, hydrocarbons, β-sitosterol, megastigmane glycosides, flavones, and pregnane derivatives in both volatile and nonvolatile fractions. (Kiros et al.,2023).
High levels of phenolic and flavonoid compounds are found in Caralluma tuberculata; rutin and gallic acid have been found in methanol-based extracts, as well as, flavonoid glycosides, pregnane glycosides saponins, and triterpenes. (Baig et al., 2021; Mudrikah et al., 2021).
Through GC-MS analysis 30+ phytochemical compounds were reported in the Caralluma indica's seed extract which also includes, esters and fatty acids. These compounds have antioxidant, antibacterial and cyto toxicty effects (Vidivu and Velavan, 2020). All over Mediterranean regions, Asia and Africa species of the genus caralluma are used in traditional medicines. Various species have been used as shortage foods, appetite suppressants, and treatments for a wide range of illnesses, such as gastrointestinal (dyspepsia, ulcers), metabolic (diabetes, obesity), febrile, inflammatory, and rheumatic conditions. (Adnan et al., 2014) In Yamen Caralluma is widely used for the treatment of gastrointestinal disorders, diabetes, obesity arthritis and inflammation (Abdel-sattar et al., 2025).

3.1. Review Methodology

An investigation was conducted on the available literature of genus Caralluma to evaluate the Phytochemical constituents, ethnomedicinal uses, antioxidant, anti-microbial properties and toxicity activities. A thorough search was conducted using Web of Science (https://mjl.clarivate.com), Science Direct, Wiley Online Library, Google Scholar, and Pub Med in accordance with the preferred reporting item PRISMA for Systematic Assessments and Meta-Analyses) recommendations. Important keyword searches include: genus Caralluma, species of the genus Caralluma, phytochemical contents, toxicological activities, antioxidant and antimicrobial properties, and phytochemicals of different Caralluma species. To ensure a thorough and accurate research, I employed a systematic filtering process to include and remove papers, as showed in Fig. 1. My first search screening yielded 2440 entries

from five sources: Google Scholar (n = 1924), PubMed (n = 43), Science direct (n = 178), Wiley online library (n=120) and Web Science (n = 175).

After removing 1503 duplicate items, I looked at 937 articles grounded on their abstracts and titles. During this initial screening step, 696 records were eliminated, including 347 publication categories deemed inappropriate (such as publications with unique elements) and 349 studies deemed unrelated to our emphasis on the genus Caralluma (such as studies of adjacent species). The remaining 241 full-text papers were carefully assessed using predetermined inclusion requirements that gave priority to research explicitly examining Genus Caralluma in terms of ethnomedicinal applications, phytochemical ingredients, toxicological activities, antioxidant, and anti-microbial capabilities. 137 studies were removed because they either (1) evaluated insufficient information for Caralluma species, (2) had insufficient data sources, or (3) were convention abstracts lacking full text availability or acceptable analytical information.

104 studies were included in this systematic review after a thorough assessment; and both the scientific and medicinal discriptions, acceptable Online resources such as Flora of Pakistan, The Plant List and Plants of the World Online were used to confirm the accurate species' name and author's name.

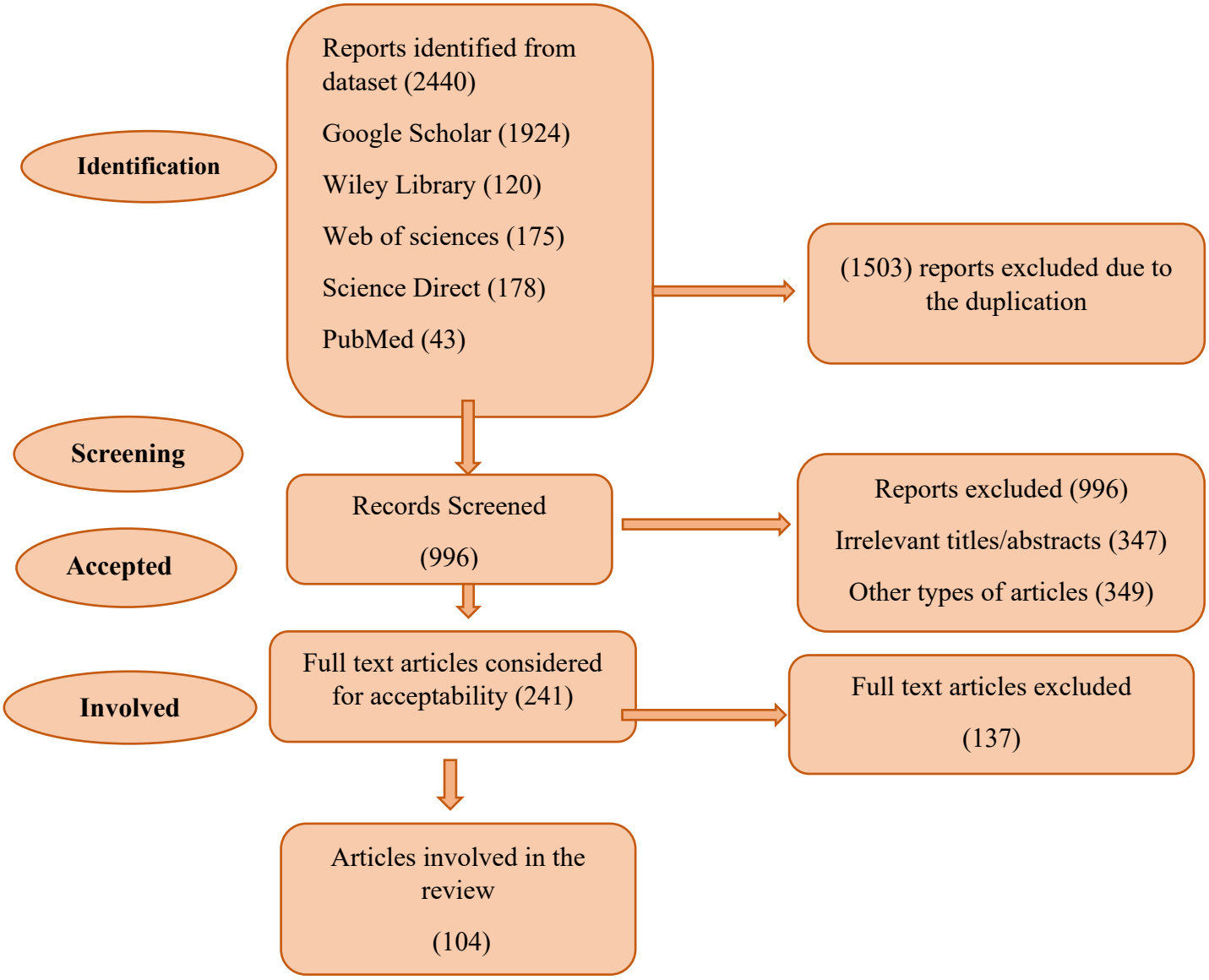


Fig.1 Flow chart exhibited searched datasources for systematic literature review

CHAPTER 4

RESULTS

4.1. Distribution and Conventional Uses of various Caralluma species

The collected data exhibated that Caralluma R. Br species have spread throughout the Asian continent, the Middle East, Africa, and portions of Europe. For instance, certain species, like C. europea (Guss.) N.E.Br., are indigenous to the Mediterranean and South Africa. C. tuberculate N.E.Br. are found in Saudi Arabia, Iran, the Republic of Nigeria, Egypt, Pakistan, India, and the United Arab Emirates. C. retrospiciens and C. quadrangula are primarily found in the East Africa and Arabian Peninsula. C.edulis (Edgew.) Benth. Ex Hook.f. and C. umbelleta Haw. are found in South Asia, Africa, India, and Pakistan. Differences by region demonstrate how well they adapt to semi-arid and drought-prone conditions. These herbs have long been used therapeutically to treat a variety of illnesses. Diabetes, stomach problems, liver problems, skin conditions, and blood purification are all treated with C. tuberculata. Kidney stones, respiratory conditions, obesity and cancer are all treated with C. europea (Guss.) N.E.Br.. A well-known remedy for snake bites, cancer, tuberculosis, and skin conditions is C. quadrangula, whereas C. umbelleta and C. edulis (Edgew.) Benth. Ex Hook.f. have been employed to treat intestinal diseases and stomach, inflammation, ulcers and diabetes. Certain species, such as C. arabic and C. stalagmifera are recommended for rheumatism, leprosy and wound healing, while, C. retrospiciens, C. bhupendiriana and C. indica are especially mentioned due to their wound healing, anti-inflammatory, anti-cancer qualities.

4.2. Preparation and Usage

According to the local traditions and the particular condition being treated, different Caralluma R. Br species are prepared and used in different ways. Most of the time, the plant's apical portions, roots or stems are used both as dried or fresh. C. tuberculata N.E. Br.is frequently taken fresh or in a decoction made from its stems to treat digestive issues, rheumatism and high sugar levels. Likewise, decoctions prepared from dried aerial portions of C. edulis (Edgew.) Benth. Ex Hook.f. are used to treat heart conditions, hyperglycemia and fever. The roots, stem and leaves of C. europaea (Guss.) N.E.Br. are frequently boiled to create a decoction that is used to treat respiratory conditions, digestive disorders and kidney stones.

C. fimbriata is crushed into powder or capsule form and used as an anti-diabetic and appetite suppressant medication in traditional Indian medicine. Usually, C. adscendens is made into decoctions or pests to treat diabetes and inflammation. Additionally, C. umbelleta's stems and roots are brewed to treat metabolic issues. Additionally, C. flava is used in local medicine to treat fever, ulcers and infections using compositions prepared from the plant's sap or extracts. Although C. russeliana is used as aqueous or ethanolic stem extracts, particularly for the management for the enhancement of and kidney and liver functions, C. sinaica is historically prepared as ethanolic or methanolic extracts or decoctions to fight infections and digestive issues.

4.3. Phytochemical compound classes of Caralluma R. Br species

The existence of a variety of pharmacologically significant chemicals was established by phytochemical screening of the chosen species. Alkaloids, terpenes, sterols, α and β amyrin, lupeol, and pregnane glycosides were identified in C. tuberculata. β-pinene, verbenone, camphene, linalool, and other monoterpenes and sesquiterpenes are abundant in C. europea (Guss.) N.E.Br.. Pregnane glycosides, flavone glycosides, luteolin derivatives, triterpenes, and saponins are all present in C. umbelleta. Alkaloids, tannins, glycosides, carotenoids, and steroids are also characteristics of C. edulis (Edgew.) Benth. Ex Hook.f. Whereas C. stalagmifera is primarily composed of steroidal glycosides like lasianthoside A and B, C. quadrangula is rich in alkaloids, saponins, tannins, flavonoids, phenolics, and quercetin. Alkaloids, flavonoids, glycosides, terpenoids, and phenolphthaleins are found in C. bhupendiriana, while, quinic acid, and hyperoside and apigenin-7-O-glucoside are found in C. arabic. Although C. indica is rich in Polyphenols, steroids, terpenoids, flavonoids, and saponins, C. retrospiciens demonstrated the existence of new pregnane glycosides.

4.4. Phytochemical Analysis Units and Detection Techniques

Using standardized analytical procedures, the phytochemical profiles of C. edulis, C. tuberculata, C. umbelleta and C. indica were carried out to guarantee precise measurement of bioactive chemicals. The aluminum chloride colorimetric method was used to measure the total flavonoid content (TFC), which was then reported as milligrams of quercetin equivalents per gram of dry weight (mg QE/g DW). The total phenolic content (TPC) was measured using the Folin–Ciocalteu method, and the results were presented as micrograms or milligrams of gallic acid equivalents per gram of extract or dry weight (µg GAE/mg or mg GAE/g DW). Alkaloids and tannins were estimated by both colorimetric and gravimetric methods, and their concentrations were expressed as mg/g DW or percentage weight by weight (% w/w). Saponins were analyzed in a similar way and reported either as mg/g or % w/w. To identify specific polyphenols such as rutin, quercetin, and gallic acid, advanced chromatographic techniques including HPLC and UPLC were applied. In addition, GC–MS analysis was carried out to determine the number of

chemical constituents and to identify fatty acids and volatile compounds. Together, these analytical approaches ensured accurate and reliable qualitative and quantitative evaluation of phytoconstituents in Caralluma R. Br species.

4.5. Assessment of Toxicity and Safety

Extracts from C. tuberculata N.E.Br. have been discovered to be non-toxic, with no negative effects on blood parameters, reproductive health and body weight. Because of its great safety margin and little cytotoxic effect, C. europea was likewise regarded as safe. Extracts from C. umbelleta showed non-toxic yet inhibiting properties, particularly when it came to pancreatic lipase. Extracts from C. edulis were also safe towards acute and long-term toxicity and non-antigenic. Extracts from C. stalagmifera proved to be efficient and tolerable against models of arthritis and inflammation, whereas C. quadrangula showed specific cytotoxicity against breast cancer cell lines.
Butanol extracts had a minor impact on C. arabic, whereas methanol extracts demonstrated the strongest cytotoxicity, especially against breast cancer cells. According to reports, C. retrospiciens and C. bhupendiriana are extremely protective and secure, particularly when it comes to medication delivery methods and DNA damage, correspondingly. Lastly, C. indica demonstrated substantial cytotoxic impacts on a cancer cell lines and variety of yeast models.

4.6. Antioxidant activity

Because of their high flavonoid and phenolic content, the majority of the species showed strong antioxidant activity. Extracts of C. tuberculata N.E.Br. made in hexane, methanol and chloroform shown exceptional antioxidant qualities. Flavonoids, phenolic substances and terpenoids in C. europea showed antioxidant activity. Although C. edulis extracts verified antioxidant effects from flavonoids and phenols. C. umbelleta additionally shown antioxidant activity because of triterpenoids and saponins. The primary antioxidant constituent in C. quadrangula was rutin, while glycosides and flavonoids shown action in C. stalagmifera. Polyphenolic acids, ascorbic acid and flavonoids in C. arabic had antioxidant properties. C. bhupendiriana's antioxidant chemicals showed a substantial prevention of UV-induced DNA damage. Flavonoids, tannins and alkaloids were present in C. retrospiciens extracts, which enhanced their antioxidant properties. Likewise, polyphenols and n-hexadecanoic acid in C. indica seeds offered defense against antioxidants.

4.7. Antimicrobial and Cytotoxic Characteristics

It was generally known that Caralluma R. Br species had antibacterial properties. Extracts from C. tuberculata N.E.Br. shown efficacy against Salmonella typhi, E. coli, Shigella sonnei, and Bacillus subtilis. Candida albicans, Bacillus cereus, C. glabrata and Staphylococcus aureus, were all significantly inhibited by C. europea. Extracts from C. umbelleta showed varying results against P. aeruginosa, S. aureus, and E. coli. E. coli, P. vulgaris, P. aeruginosa, and K. pneumonia were all shown to be inhibited by C. edulis. Significant antibacterial activity was demonstrated by C. quadrangula in both aqueous and organic extracts. Likewise, C. stalagmifera shown efficacy against Proteus species, Pseudomonas species, Staphylococcus aureus.
Ethanolic extracts of C. arabica showed more potent antibacterial than antifungal properties. C. retrospiciens had both fungicidal and bacteriostatic properties, C. bhupendiriana nanoparticles shown exceptional antibacterial ability. Lastly, C. indica extracts demonstrated broad-spectrum antibacterial efficacy against Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella typhi, and oral pathogens.

S.No	Scientific Name	Distribution	Medicinal uses	Phytochemistry	Antitoxcity	Antioxidant	Antimicrobial	References
01.	C. Tuberculata	Pakistan (Balochistan, Nichara, Herboi ,Gidar) India, United Arab Emerites, Saudi Arabia,Iran ,Nigeria,South east of Egypt	Diebeties, Blood disorders, rheumatism, Hepatitis B and C, Leprosy, Peptic ulcers, Inflamation, Dysentry, digestive issues, Skin issues (pimples, freckles) purifier of the blood, Hypertention, Liver disorders,Gastric issues and Constipation	Terpenes ,Lupeol, α & β Amyrin ,α Amyrincinnamate, Pragnane Caratuberside, Sterols, Glucosides,Flavo noids, Luteolin-4-0-neohesperidosides ,beta-cyaninan and alkaloids	Medicinally considered safe as in a research study ethyle acetate extractions was non toxic and had no negative affects on sperm health,body weight and on blood health	Methanol extracts, Chloroform friction and hexane friction demonstrated amazing anti- oxidant activity .	Bacillus subtilis,Bacillus streptococcus Eschrichiacoli,sal monella typhi and shigell asonnie ,extracts of C.tuberculata were found effective against these microbes	(Duranni et al., 2009; Tareen et al., 2010; shah et al., 2013 Rizwani, 1991; Venkatesh et al., 2003; Ahmed and Shaikh,1989; Bensuzan, 2009; Collennate, 1991; Najam-us-saqib et al., 2013)
02.	C.Europea	Jordan,Morroco,Egypt,Libiya,Tunisia, Spain and Algeria	Coughs, Bronchospasm disorders, sleep disorders, Respirotary diseases, digestive issues, Urinary tract infections, Cancer, anelgasic issues anti-parastic,anti-obesity, anti-atherosclerotic, kidney stones ,cysts	Monoterpene hydrocarbons, sesquiterpenes hydrocarbons γ-Terpinen/Linalool β-Pinene ,camphene, Thujopsene, α-Phellandrene β-Eudesmol , α-Pinene , β-Bisabolene ,Tricyclene, verbonene and Linalool	Had minimum acute and cytotoxic affects and suggested a high safety margin	Terpenoids, flavonoids, and phenolic compounds	Candida albicans, Candida glabrata, Candida krusei, Candida parapsilosis, Micrococcus luteus, Bacillus cereus, Bacillus subtilis, and Staphylococcus aureus exhibited anti-microbial activity against these microbes	(Lahsissene et al., 2009; Dallahi et al., 2016; Mechchate et al., 2020; Meve and Heneidak., 2005; Zito et al., 2013; Ennacerie et al., 2017; Dra et al., 2018; Formisano et al., 2009; Zito et al., 2010; Ouassou et al., 2018; Issiki et al., 2017; Dra et al., 2018; Bourhia et al., 2020).
O3.	C.umbelleta	Pakistan,Africa,Spain,Middle East,Saudi Arabia,India and Middle East	Anti-inflamatory,Stomach disorders,Analgesic, anti-nociceptive, Anti ulcerogenic and intestinal disorders	pregnane glycosides, carumbelloside I to V,flavone glycoside luteolin-4′-O neohesperidoside. megastigvmane glycosides, bitter	Medicinally considered safe and the extract suggested inhabitroy affects against pancreatic lipase.	Sapanions,triterpenoids, falvone glycoside flavnoids,steroidal glycoside	Extracts from the root and stem of C.umbelleta showed both effective and ineffective activity against P.aeruginosa,B.cerus and B.	(Abdel-sattar et al., 2007; Ahmed et al., 1993; Babu et al., 2014; Braca et al., 2002; Bader et al., 2003; Bellamakondi et al., 2014; Jyoti et al., 2015)

				principles saponins and triterpenes			subtillis, S.aureus P.vulgaris and E.Coli	
O4.	C.edulis	South Asia	cancer, tuberculosis, inflammation ,Skin Disorders, Diebeties Mellitus Malaria,Weight Management, obesity and appetite suppressing.	Alkaloids, Tannins, Glycosides, Carotenoids, Flavonoids Sterpenoids, and steroids.	Evaluated as safe and non-antigenic against acute and chornic toxic affects.	Phenols and flavonoids possessed antioxidant activity .	The plant extracts showed inhabitory effects preventing S. aureus, K., P. vulgaris, P. aeruginosa, E. coli and pneumoniaea	(Waheed et al., 2011; Adnan et al., 2014; Dutt et al., 2012; Mradu et al., 2012; Sofi et al., 2016; Elisha et al., 2017 and Ren et al., 2005; Mossa et al., 1995; Bukhari et al., 2007; Bukhari et al., 2016)
05	C.Quadrangula	Arabian Peninnsula,India ,Srilanka,Iran,Africa ,South ,Africa Canary Islands and Europe	High blood sugar, Sting from snakes and scorpions, tuberculosis, fever, skin disorders, cancer and inflammation	phenolics, flavonoids, tannins,quercitin alkaloids, and saponins	C.Quadramgula demonstrated favorable and active cytotoxic effects against MFC7 brest cancer cell lines.	Main antioxidant was Rutin(present in glycosidic form	Aqueous extracts and organic frictions of the C. qaudrangula had been demonstrated as microbial	(Meve and Liede,2004; Leo et al., 2005; Abdallah et al., 2013; wua and Ng, 2007; Miliauskas et al., 2004; Perk et al., 2014; Enogieru et al., 2018; Farouk et al., 2016)
06	C.stalagmifera	Southern India,(Andhara Pardesh,Tamil Nadu and Karnataka	Diabetes, leprosy, and rheumatism	Steroidal glycosides, carumbelloside III, lasianthoside A and B	Medicinallly considered as safe as the Butanol and aqueous extracts showed significant effects as in a experiment upon koalin-associated arthritis within rats and carrageenin-mediated rat paw and also the extracts (in capsulated and and powdered form) showed effective results	glycosides, hydrocarbons, saponins and flavonoid exhibited antioxidant activity	crude extracts from the stem of the plant actively crude extracts from the stem of the plant actively proteus spp,Pseudomonas spp and staphylococcus aureus	(Reddy et al., 1996; (Parihar, 2016; Dutt et al., 2012; Aslam et al., 2019; Chandran et al., 2014; Packialakshmi and Naziya, 2014; Kunert et al., 2006)

					in reducing weight			
07	C.Arabica	Saudi Arabia ,Oman ,Yemen ,United Arab ,Emerites and Africa	Skin diseases and conditions (itchy skin,wounds cuts)	Epigenine-7-0-glucoside,Quinic acid,Naringeinin, Hyperoside (quercitin-3-0-galactoside)	The methanol friction showed strongest cytotoxic effects while Butanol extract showed least friction against MCF-7 brest cancer cell line	polyphenolics compounds like phenolic acids flavonoids and ascorbic acid	Ethanolic extracts of C.Arabica showed stronger antibacterial effects while least antifungal effects evidenced by major inhabitant zones against funga strains compared to bacterial strains	(Abdel-sattar et al., 2022; williams et al., 2004; soobrattee et al., 2005; Khasawneh et al., 2014; Al-Mutaani et al., 2025)
08	C.bhupendiriana Sarkaria	South India	Anti-inflammatory-Anti-cancer ,Anti-tumor,Anti-ulcer,Gastric-mucosa,	phlobatannins, phytosteroids, terpenoids, cardiac glycosides, alkaloids, quinones, phenols, tannins, carbohydrates,saponins flavonoids	Methanol extracts of C.bhupenderiana remarkably inhabited UV-irridiated DNA damage therefore considered safe	The extracts from C.bhupenderiana sarkaria exhibited antioxidant activity and evaluate inhabitory effects against DNA damage .phenols and flavonoids	Nanoparticles prepared from C.sarkaria showed great performance against Anti-microbial activity	(Deepak et al., 1997; Ramesh et al., 1999; Zakaria et al., 2001; Al-Harbi et al., 1994; Zakaria et al., 2002; Umahmaheswari and Chatarjee., 2008; Nunes et al., 2012; Pachipala et al., 2022; Murugapandi et al., 2023)
09.	C.retrospiciens	Eritrea, Ethiopia, Kenya, Saudi Arabia, Uganda and Yemen	Wounds healing	A novel-polyoxy pregnane glycosides (retrospinoids was successfully isolated from the aerial parts of C.retrospiciens	The nanoparticles-based drug delivery mechanisms prepared from the plant reduced all drug toxicity	Alkaloids, flavonoids, tannins, steroids, and saponins	3,4-Altrosan showed fungicidal andbacteriostatic activites and the Benzonic acid identified from C.retrospiciens demonstrated anti-bacterial effects.	Jadhav et al., 2014; Arokiyaraj et al., 2018; Eun-Soo et al., 2001; Bruyns et al., 2010; Patra et al., 2018; Wided et al., 2021; Alqahtani et al., 2022; Elsebai and Mohamed, 2015; Makeen et al., 2020)
10.	C.indica	Andhra pardesh ,karnataka and Tamil nadu	Cancer(oral curvical,brest lungs ,colon and hepatic cancers)	saponins, flavonoids, steroids, terpenoids,	C.indica showed remarkale cytotoxic activity on Oral (OECM-1)	Polyphenols and n-hexadecanoic acid. evaluated from C.indica seeds	Ethanolic extracts of C.indica plant demonstrated significant activities against	(Gnanashree et al.,2018; Sembiring et al., 2018; Periyanayagam et al., 2013; Koch et al., 2005; Chandra et al., 2023; Mostafa et al., 2018;

				polyphenols and tannis	cancerous cells lines and ethanolic seed extracts demonstrated significant cytotoxic action on yeast cells of S. cerevisiae.	exhibited anti-oxidant activity	Pseudomonas aeruginosa was significantly inhibited by ethanolic extracts of the C. indica plant. When it comes to treating oral infectious agents, Staphylococcus aureus, Bacillus cereus, Escherichia coli, Salmonella typhi, and the seeds show organic alternatives to synthetic microbials.	sanchez et al., 2016; Ramalingam et al., 2024; Kunert et al., 2006)

Species	Area/Traditional uses	Preparation and mode of uses	References
C.tuberculata	reported from Pakistan's Khyber Pakhtunkhwa and Balochistan; frequently used to treat rheumatic pain, diabetes, and stomach distress	Fresh stems that are either eaten raw or made into a decoction	Baig et al., (2021);Haider et al., (2022)
c.edulis	used in Pakistan's Cholistan desert to treat heart conditions, high blood sugar and fever	Dry aerial components are used as decoction	Akram et al., (2023);Waris et al.,(2013);Ahmed et al., (2009)
c.europaea	Native to North Africa and some parts of Europe ,used to treat heart ailments ,kidney stones, infection, respiratory and digestive disorders.	Different plant parts (leaves, stems, roots used as decocation	Ouassau et al., (2021);Amrati et al., (2020)
C.fimbriata	used in Indian traditional medicine as an appetite suppressant, to control weight, and to treat diabetes.	Either as extracts in powder form or as capsules	Kuriyan et al., (2007)
C.adscendens	it was discovered in South India and is used to treat inflammatory diseases and diabetes.	Generally made as decoctions or pastes	Bhuvaneswari and Manivannan.(2014)
C.umbelleta	Reportedly from india,used to treat stomach disorders,diabetes .	Root and stem extracts or employed as Decocation	Bellamakondi et al., (2014); Babu et al., (2014)
C.flava NE Br. Int. J.	Detected from Arabian regions; utilized traditionally as anti-pyretic, anti-inflammatory, anti-ulcer, antidiabetic and anti-parasitic properties .	In local medicine ,plant extracts and sap are prepared	Raees .(2018)
C.sinaica	Native to Sinai regions and Egypt; utilized in traditional medicines for the treatment of infections, diabetes and digestive problems.	Traditionally prepared from the ethanolic/methanolic extracts or decocations	Al-Massarani et al., (2012); Habibuddin et al., (2008)
C.russeliana	Derived from the arabian peninsula; stem extract has long been used to treat diabetes and related liver, lipid profile and kidney disorders.	Ethanolic/aqueous stem extracts are either ingested or used in experiments .	Zari and Al-Thebaiti.(2018)

Sr#	Phytochemical compound class	Species	Detection Method	Parts of the plant and Extracting medium	Reported data	References
1	**Alkaloids**	C.edulis	Colorimetric method	Entire plant ,Extracts of methanol	Alkaloids reported	Khan et al., (2022)
		C.indica	Qualitative and MS-GC tests	Stem extract	Alkaloids reported	Vadivu and Velavan.(2020)
		C.umbellata	Phytochemical qualitative method	Entire plant	Alkaloids reported	Bellamakondi et al., (2017)
		C.tuberculata	Colorimetric /Gravimetric method	Entire plant ,Fractions of methanol	Alkaloids reported	Baig et al., (2021)

2	**Tannins**	C.edulis	Colorimetric /Gravimetric assay	Leaves /extracts of methanol	Tannins reported positive	Khan et al., (2022)
		C.indica	Screening qualitative	Extract of stem	Tannins detected	Vadivu and Velavan. (2020)
		C.umbellata	Colorimetric test	Entire plant	Tannins present	Bellamakondi et al., (2017)
		C.tuberculata	Colorimetric /Gravimetric method	Hydroalcoholic extracts of the leaves	Tannins detected	Baig et al., (2021)
3	**Saponins**	C.edulis	Colorimetric technique	Methanolic extracts of the entire plant	Saponins present	Khan et al., (2022)
		C.indica	GC-MS assay	Extracts of the stem	Saponins present	Vadivu and Velavan.(2020
		C.umbellata	Phytochemical techniques	Methanolic extracts of the entire plant	Saponins present	Bellamakondi et al., (2017)
		C.tuberculata	Gravimetric /colorimetric assay	Hydroalcoholic fractions of the entire plant		Baig et al., (2021)
4	**Total phenolic concenteation (TPC)**	C.edulis	Folin-Ciocalteu technique	Apical parts,Acetone,ethanol,methanol.	Highest in methanol fractions	Khan et al., (2022)
		C.indica	Folin-Ciocalteu technique	Extracts of the stem	Phenolic compound present	Vadivu and Velavan.(2020)
		C.umbellata	Folin-Ciocalteu technique	Methanolic extracts of the entire plant	Great phenolic hepatoprotective levels	Bellamakondi et al., (2017)
		C.tuberculata	Folin-Ciocalteu technique	Water-acetone extracts extracts of entire plant	Rich phenolic content	Baig et al., (2021)
5	**Total flavonoids concentration**	C.edulis	Aluminium chloride technique	Methanolic extracts of the apical parts	Richest flavonoids content in methanol	Baig et al., (2021); Khan et al., (2022)
		C.indica	Aluminium chloride technique	Methanolic extract of the stem	Flavonoids detected (MS-GC) verified	Vadivu and Velavan. (2020)
		C.umbellata	Aluminium chloride technique	Methanolic extracts of the entire plant	Actively high flavonoid content detected	Bellamakondi et al., (2017)
		C.tuberculata	Aluminium chloride technique	Acetone/methanol extracts of the entire plant	Good levels of flavonoids detected	Baig et al., (2021); Khan et al., (2022)
6	**Specific polyphenols(Gallic acid, Quercetin, Rutin)**	C.edulis	UPLC/HPLC	Extracts of the methanol	Quercetin,gallic acid	Khan et al., (2022)
		C.indica	HPLC & MS-GC assay	Extracts of the stem	Derivatives of the fatty acid and gallic acid present	Vadivu and Velavan. (2020)
		C.umbellata	HPLC assay	Methanol extract	Gallic acid ,rutin detected	Bellamakondi et al., (2017)
		C.tuberculata	UPLC/HPLC	Extracts of the methanol	Gallic acid and rutin identified	Baig et al., (2021)

7	**Fatty acids /Volatile**	C.edulis	MS-GC technique	Extracts of the methanol	Fatty acid esters ,hexadecanoic detected	Iftikhar et al., (2022)
		C.indica	MS-GC technique	Extracts of the stem	n-heptadecanoic acid ,hexadecanoic acid detected	Vadivu and Velavan. (2020)
		C.umbellata	MS-GC technique	Methanolic extract	Sterols,phytol,hexadecanoic acid detected	Bellamakondi et al., (2017)
		C.tuberculata	MS-GC technique	Fractions of hexane/ethyl acetate	Hexadecanoic acid ,phytol identified	Khan et al., (2022
8	**MS-GC over all compounds**	C.edulis	MS-GC technique	Extracts of methanol	32 compounds detected	Iftikhar et al., (2022)
		C.indica	MS-GC technique	Extracts of the stem	20 compounds detected	Vadivu and Velavan. (2020)
		C.umbellata	MS-GC technique	Extracts of methanol	30+ compounds identified	Bellamakondi et al., (2017)
		C.tuberculata	MS-GC technique	Extracts of methanol	30+ compounds identified	Khan et al., (2022)
9	**Various secondary metabolites(Terpenoids,phytosterols ,steroids)**	C.edulis	Screening phytochemicals tests	Methanol fractions of the entire plant	Terpenoids ,steroids,phytosterols identified	Khan et al., (2022
		C.indica	Screening phytochemicals tests	Extracts of the stem	Phytosterols,fatty acid esters ,terpenoids identified	Vadivu and Velavan. (2020)
		C.umbellata	Screening phytochemicals tests	Methanol extracts of the entire plant	Glycosides,terpenoids ,steroids identified	Bellamakondi et al., (2017)
		C.tuberculata	Screening phytochemicals tests	Fractional extracts of the whole plant	Glycosides ,steroids ,terpenoids detected	Baig et al., (2021)

CHAPTER 5

DISCUSSION

Caralluma tuberculata N.E.Br. is widely distributaed in Pakistan (Balochistan, Nichara, Herboi, Gidar) India, United Arab Emerites Saudi Arabia, Iran, Nigeria, South east of Egypt (Duranni et al.,2009). The plant is used for several diseases including Diebeties, Blood disorders, rheumatism, Leprosy, (Venkatesh et al., 2003) Peptic ulcers, Inflamation (Ahmed and Shaikh,1989) dysentry, hepatic disorder, skin issue (frackles and pimple), blood purification, gastric issue, hepatitis B and C, hypertention, stomach pain and constipation (Lawrence and Choudhary, 2004; Tareen et al., 2010; Shah et al., 2013). In contrast (Noreen, 2017) reported the use of C. tuberculata N.E.Br. for inflammation diebeties and obesity. The phytochemicals derived from C. tuberculata N.E.Br. including terpenes, Lupeol, α & β Amyrin, α Amyrincinnamate, Pragnane Caratuberside, Sterols, Glucosides, Flavonoids, Luteolin-4-0-neohesperidosides, beta-cyaninan and alkaloids (Bensuzan, 2009). On the other hand, **(**Al-Rubaye et al., 2017) reported the phytochemicals of C. tuberculata such as Flavonoids terpinoids and other metabolites. The extracts of C. tuberculata N.E.Br. possessed anti-oxidant activity (Rauf, 2013). Methanol and choloroform friction of C. tuberculata N.E.Br. showed great antioxidant activites. (Rizwani, 1991) examined that methanol friction had highest antioxidant activity and it also possessed acute and chronic toxic activity. While in contrast to these studies (Ali et al., 2024) reported the phenolic chemicals of the plant that helped in strengthening the bodys defence system against oxidative distructions. (Najam us saqib et al., 2013) reported in their research study that the extraction of ethyle acetate was nontoxic and had no negative effects on blood health, sperm health and body weight. And the extracts were also seemed to be active against all the Gram-postive and Gram-negative bacterial strains including Staphylococcus Bacillus aureus, Bacillus subtilis Streptococcus viridens and The Genera Salmonella typhi, Shigella sonnei, and Eschrichia coli are examples of gram-negative bacteria (Collenette, 1999). Differing from this study (Baig et al., 2021) demonstrated that bioactive chemicals of C. tuberculata N.E.Br. had the capability to destroy the microbial cell wall.

Caralluma europea (Guss.) N.E.Br. is distribution mainly in Jordan, Morroco, Egypt, Libiya, Tunisia, Spain and Algeria (Meve and Heneidak, 2005; Zito et al., 2013). Adnan et al., (2014); Issiki et al., (2017) had similar results. The plant is used for various medicinal purposes coughs, asthma, insomnia, Cancer, Respirotary infections, digestive disorders, cysts, urogenital infections, Kidney stones, anelgasic issue, anti-parastic, anti-obesity, anti-atherosclerotic (Lahsissene et al., 2009; Dallahi et al., 2016; Mechchate et al., 2020). C. europea (Guss.) N.E.Br. contain various phytochemicals such as monoterpene hydrocarbons, sesquiterpenes hydrocarbons β-Eudesmol, α-Pinene, β-Bisabolene, Tricyclene, verbonene, Linalool γ-Terpinen/Linalool β-Pinene, camphene, Thujopsene, and α-Phellandrene (Ennacerie et al., 2017; Dra et al., 2018). While (Douhou et al., 2003) reported phytochemicals for example flavonoid, saponins alkaloids, terpenes, quinones steroids and tannins It Had minimum acute and cytotoxic affects and suggested a high safety margin (Formisano et al., 2009; Zito et al., 2010). Ait Dara. (2019) reported that C. europea was safe in Up to 2000 kg/mg body weight of acute poisoning. Terpenoids, flavonoids, and phenolic compounds possessed antioxidant activity (Ouassou et al., 2018; Issiki et al., 2017). As compare to this study (Burits and Bucar, 2000) described the methanolic extracts of C. europea (Guss.) N.E.Br. evaluated antioxidant activity. Against numerous microbes like Candida albicans, Candida glabrata, Candida krusei, Micrococcus luteus, Bacillus cereus, Bacillus subtilis, and Staphylococcus Aureus C. europea exhibited anti-microbial activity (Dra et al., 2018; Bourhia et al., 2020). In contrast to this study (Amrati et al., 2021) reported that C. europea (Guss.) N.E.Br. frictions were highly active on gram positive bacteria and yeast.

Caralluma umbelleta Haw. is geographically distributed in Pakistan, Spain, Africa, Middle East, India Saudi Arabia Middle East and India (jyoti et al., 2015). While (Shanmugam et al., 2013) reported the distribution of C. umbelleta Haw. in india. This plant is used for Anti-inflamatory, stomach disorders, analgesic, anti-nociceptive, anti-ulcerogenic and intestinal disorders (Abdel-sattar et al., 2007). Differing from this study (Shanmugam et al., 2013) reported the uses of C. umbelleta Haw. as vegetables. It contain various chemicals including pregnane glycosides, Flavone glycoside, luteolin-4′-O-neohesperidoside, carumbelloside I to V.megastigmane, glycosides, bitter principles, saponins and triterpenes (Ahmed et al., 1993) and (Shanmugam et al., 2013) had closely similar to this findings .Medicinally considered safe and the extract showed inhabitroy affects against pancreatic lipase (Babu et al., 2014) On the other hand (Bellamakondi et al., 2014) revealed that extracts and friction of the cytotoxicity test demonstrated safe concentration even at 500 ug. Sapanions, triterpenoids, falvone glycoside, flavnoids, steroidal glycosides exhibited antioxidant activity (Braca et al., 2002; Bader et al., 2003). Extracts from the root and stem of showed both effective and ineffective activity against P. aeruginosa, B. cerus and B. subtillis, S. aureus, P. vulgaris and E. Coli

(Bellamakondi et al., 2014). Similarly (Bennete, 2003) observed that Chloroform and acetone extracts showed antimicrobial activity against these bacteria, including E. coli, B. subtilis, B. cereus, and S. aureus.

C. edulis (Edgew.) Benth. Ex Hook.f. is distributed in South Asia (Malladi et al., 2018). The medicinal uses of the C. edulis are cancer, tuberculosis, inflammation, skin disorders, diebeties mellitus malaria, weight management, obesity and appetite suppressings (Dutt et al., 2012; Waheed et al., 2011). Adnan et al., (2014) documented the uses of Caralluma edulis for Alzheimers disease, leprosy, hypertention, rehumatsim and obesity. The plant extracts showed inhabitory effects opposing S. aureus, K., P. vulgaris, P. aeruginosa, and E. coli, pneumoniaea (Bukhari et al., 2016). Comparable to this study (Shailemo et al., 2016) demonstrated that various extracts of C. edulis showed best antimicrobial activity Phenols and flavonoids showed antioxidant effects (Mossa et al., 1995; Bukhari et al., 2007). Ansari et al., (2022) highlighted that the extracts of the plant exhibited high antioxidant activity. Evaluated as safe and non-antigenic against acute and chornic toxic effects (Elisha et al., 2017; Ren et al., 2005). Similarly, Sanmugapriya and Venkataraman, (2006) revealed that plant was apparently safe in acute toxicity test. Chemicals present in the plant are alkaloids, tannins, glycosides, carotenoids, flavonoids sterpenoids, and steroids (Sofi et al., 2016; Mradu et al., 2012) whereas Ansari et al., (2022) recorded the phytochemicals in Caralluma edulis such as flavonoids, sterols and pregnane glycosides terpenoids.

C. quadrangula (Forssk.) N.E.Br. is distributed in Arabian Peninnsula (Abdel-Sattar et al., 2017), India, Srilanka, Iran, Africa, South, Africa Canary Islands and Europe (Meve and Liede, 2004). In contrast to this study Guashash. (2006) documented that C. quadrangula (Forssk.) N.E.Br. is found in Saudi arabia. medicinal usage of the plant is diabetes, cancer, snake and scorpion bites, tuberculosis, fever, skin (Leo et al., 2005; Abdallah et al.,2013) while Guashash highlighted the uses of C. edulis (Edgew.) Benth. Ex Hook.f. for vitiligo, melasma. freckles and diebities. C.quadrangula (Forssk.) N.E.Br. showed favorable and active cytotoxic effects against MFC7 brest cancer cell lines (Abdallah et al., 2013) while (Dutt et al., 2013) reported that this plant exhibited nontoxic effects against mammalian cells. Aqueous extracts and organic frictions of the C. qaudrangula (Forssk.) N.E.Br. had been demonstrated as microbial characteristics (Farouk et al., 2016). Although (Al sheikh et al., 2021) revealed that extracts of C. quadrangula like (Cq3, Cq2, Cq1) exhibited antibacterial activity compare to MDRAB AB5057 and MRSA USA300. Main antioxidant was Rutin present in glycosidic form (Perk et al,.2014; Enogieru et al., 2018). Chemicals of the C. quadrangula (Forssk.) N.E.Br. are phenolics, flavonoids, tannins, quercitin alkaloids, and saponins (wua & Ng, 2007; Miliauskas et al., 2004). Compared to this study Abdallah et al., (2013); Al sheikh et al., (2021), Ben said et al., (2023) reported that various pregnane glycosides like favonoid luteolin 4′-O-b-D-neo hesperidoside russeliosides, acylated boucerosides were evaluavted from c. quadrangula.

C.stalagmifera C.E.C.Fisch. Parihar, (2016) documented the distribution of C. stalagmifera C.E.C.Fisch. in Southern India, (Andhara Pardesh, Tamil Nadu and Karnataka. Similarly, (Ramachandra et al., 2014) had similar findings (Kunert et al., 2006) reported the chemicals present in the plant are Carumbelloside III, lasianthosides A and B, and steroidal glycosides While (Kunert et al., 2009) observed that c. stalagmifera is rich in alkaloids, flavonoids and glycosides. This plant is medicinally used for diabetes, leprosy, and rheumatism (Reddy et al., 1996). While Sreenivasacharyulu and Yogaratnakaram, 1939) revealed that mixing C. stalagmifera with black papper is best for the treatment of migraine. Medicinallly considered as safe as the butanol and aqueous extracts showed significant effects as in an experiment on rat paw caused by carrageenan and koalin induced arthiritis in rats and also the extracts (in capsulated and powder form showed effective results in reducing weight (Dutt et al., 2012). In anti-microbial activity crude extracts from the stem of the plant actively inhabited the growth of Escherichia coli, Bacillus sppproteus spp, Pseudomonas spp and staphylococcus aureus (Packialakshmi and Naziya, 2014). Glycosides, hydrocarbons, and flavonoid saponins showed antioxidant activity (Aslam et al., 2019; Chandran et al., 2014). In contrast to these studies (Madhuri et al., 2011) highlighted the prominence antimicrobial, antioxidant activitites of c. stalagmifera C.E.C.Fisch.

C.arabica N.E.Br. Abdel-sattar et al., (2022) revealed that C. arabica N.E.Br. is inhabited in Saudi Arabia, Oman, Yemen, United Arab, Emerites and Africa and as compared to this study (Zakaria et al., 2001) reported that C. Arabica N.E.Br. is found in United Arab Emaraties. Abdel-sattar et al., (2022) reported that it is medicinally used for skin diseases and conditions (itchy skin, wounds cut) while (zakaria et al., 2002) reported the use of C. arabica for anti-gastric ulcer. Ethanolic extracts of C. arabica N.E.Br. exhibited stronger antibacterial effects while least antifungal effects and as evidenced by major inhabitant zones against fungal strains compared to bacterial strains and as it was found that the antifungal extract of Caralluma arabica N.E.Br. showed resistant effects against Fusarium oxysporum (Al-Mutaani et al.,2025). Methanolic extracts of C. arabica included finite number of chemicals comprises of six flavonoids and only one phenolic compound. Epigenine-7-0-glucoside, Quinic acid, Naringeinin, Hyperoside

(quercitin-3-0-galactoside) (Al-Mutaani et al., 2025). Opposed to this study (Abdel-Sattar et al., 2022) investigated that arabinoside One of the pregnane glycosides assessed is B. from the aerial parts of C. arabica N.E.Br. Antioxidant activity showed by polyphenolics compounds like phenolic acids, flavonoids and ascorbic acid (Williams et al., 2004; Soobrattee et al.,2005), As compared to this study (Khasawneh et al.,2014) revealed that alcoholic extracts of c. arabica exhibited antioxidant activity. The methanol friction showed strongest cytotoxic effects while butanol extract exhibited least friction against MCF-7 brest cancer cell line (Khasawneh et al., 2014).

C. bhupinderana Sarkaria is found in South India (Lawrence and Choudary, 2004) while (Ugraiah et al., 2011) reported that this plant is depleted by human activites and completely eaten by goates and sheeps in Thirunelveli Tamil Nadu and palayamkotai. It is used for anti-inflammatory, anti-cancer, anti-tumor, anti-ulcer, gastric-mucosa (Deepak et al., 1997; Ramesh et al., 1999; Zakaria et al., 2001). Alkaloids, quinones, phenols, tannins, polysaccharides, saponins, flavonoids, phlobatannins, phytosteroids, terpenoids, and cardiac glycosides (Al-Harbi et al., 1994; Zakaria et al., 2002) while (Pachipala et al.,2022) had similar findings. Methanol C. bhupinderana extracts remarkably inhabited UV-irridiated DNA damage therefore considered safe (Umahmaheswari and Chatarjee, 2008; Pachipala et al., 2022) had closely similar results. The C. bhupinderana Sarkaria extracts demostrated action of antioxidants and assessed protective effects against damage to DNA. (Nunes et al., 2012) similarly examined that extracts of C. sarkaria had the capability of antioxidant for scavenging free radicals. Nanoparticles prepared from C. sarkaria showed great performance against anti-microbial activity (Murugapandi et al.,2023).

C. retrospiciens (Ehrenb.) N.E.Br. is mainly distributed in Kenya, Saudi Arabia, Eritrea, Ethiopia Uganda and Yemen (Bruyns et al., 2010). While (Takholm, 1974) reported that this plant was grown in south east of Egypt specially on the mountainous areas. The indegenious people of Saudi Arabia used this plant for wound healing. Makeen et al., (2020) reported the first authors that investigated the utilization of Caralluma retrospecians (Ehrenb.) N.E.Br. in cancer treatment by the local people of Wadi-E-Damad and Al-Fayfa (Alallah et al., 2018**).** Methyl β-lilacinobioside was first isolated from C. retrospiciens (Ehrenb.) N.E.Br. (Alallah et al., 2018). While (Halaweish et al., 2004) reported the six polyoxypregnane glyocosides evaluavted from C. retrospiciens. Alkaloids, flavonoids, tannins, steroids, and saponins showed antioxidant effects (Alqahtani et al.,2022). Elsebai and Mohamed. (2015) investigated that A novel-polyoxy pregnane glycosides (retrospinoids) was successfully isolated from the aerial parts of C. retrospiciens (Ehrenb.) N.E.Br.. 3,4-Altrosan showed fungicidal andbacteriostatic activites (Jadhav et al., 2014) while the Benzonic acid identified from C. retrospiciens demonstrated anti-bacterial effects (Arokiyaraj et al., 2018; Eun-Soo et al., 2001). Compared to this study (Makeen et al., 2020) investigated that the exudate of Caralluma retrospiciens (Ehrenb.) N.E.Br. exhibited antimicrobial action against both gram-positive and gram-negative bacteria, with the antimicrobial activity against gram-negative bacteria being greater than that against gram-positive bacteria. All medication toxicity was decreased by the plant-based nanoparticle-based drug delivery systems. (patra et al., 2018; Wided et al., 2021). Opposed to this study (Halaweish et al.,2004) reported that the compounds isolated from C. retrospiciens (Ehrenb.) N.E.Br. exhibited cytotoxic effects against brain shrimp

C. indica (Wight and Arn.) N.E.Br. is numerously distributed in Tamil nadu, Karnataka and Andhra Pardesh (Gnanashree et al., 2018). It is used for Cancer (oral curvical, brest lungs, colon and hepatic cancers) (Chandra et al., 2023). The ethanolic extracts of the seeds of C. indica (Wight and Arn.) N.E.Br. contained various categories of chemicals including saponins, flavonoids, steroids, terpenoids, polyphenols and tannis (Sembiring et al., 2018). Whereas (Kunert et al., 2006) investigated three steroidal glycosides and two novel bisdesmosidic glycosides from C. indica. Chemicals present in the extracts of C. indica (Wight and Arn.) N.E.Br. play a vital role in anti-oxidant activites (Shahinuzzaman et al., 2020). Polyphenols and n-hexadecanoic acid evaluated from C. indica (Wight and Arn.) N.E.Br. seeds exhibited anti-oxidant activity (Ramalingam et al., 2024). Ethanolic extracts of C. indica (Wight and Arn.) N.E.Br. plant demonstrated significant activities against. The Pseudomonas bacteria Candida cereus with Staphylococcus aureus Searella typhi with Escherichia coli (Mostafa et al., 2018). And the seeds exhibit natural alternatives to synthetic microbials in the handling of oral pathogens (Ramalingam et al., 2024). C. indica (Wight and Arn.) N.E.Br. exhibited remarkable cytotoxic activity on Oral OECM-1(human oral carcinoma squamous cancerous cells lines (Koch et al., 2005) and ethanolic seed extracts showed strong cytotoxic activity against S. cerevisiae yeast cells (Periyanayagam et al., 2013). Closely similar to these studies (Ramalingam et al., 2024) highlighted that C. indica (Wight and Arn.) N.E.Br. displayed strong antioxidant and antimicrobial activities, effectively targeting oral pathogens. It also showed moderate cytotoxic effects against oral cancer cells and yeast with limited selectivity.

Medicinal uses of Genus Caralluma R. Br

Caralluma tuberculata N.E.Br. is reported in Pakistan's Balochistan province and Khyber pakhtunkhuwa and it is widely used dor the treatment of diabetes, stomach pain and rhumatisim, its fresh stems are used as decocations (Haider et al., 2022; Baig et al., 2021) While (Akram et al., 2023; Ahmed et al.,2013; Waris et al., 2009) reported that Caralluma edulis (Edgew.) Benth. Ex Hook.f. is present in the cholistan desert of Pakistan and is used for the treatment of diabetes, fever and heart problems, its dried apical parts were used as decocation. Similarly, Caralluma fimbriata is numerously utilized to cure diabetes and control weight in indian local medicine, it is used as poweder or in capsulated form (Kuriyan et al., 2007). Instantly Caralluma europea is present in the regions of Europe and North Africa and it is used to remove kidney stones, heart conditions, digestive and respiratory problem. Its different parts are used as decocations (Amrati et al., 2020; Ouassau et al., 2021). Caralluma adscendens is reported in South India. It is widely used in the treatment of diabetes and inflammation, prepared as pastes or decocation. (Bhuvaneswari and Manivannan, 2014). Comperatevly (Bellamakondi et al., 2014; Babu et al., 2014) reported that Caralluma umbellata is located in india and it is used to treat stomach disease and diabetes. Its stem and root extracts are used as decocations. Caralluma flava NE Br. Int.J. present in Arabian regions applied as anti-inflammatory, anti-ulcer, antidiabetic diaseases and its extracts are prepared as sap (Raees, 2018). Caralluma sinaica is reported in Egypt and in Sinai areas. It is used in the treatment of infections, digestive disorders and diabetes. It is prepared as (Habibuddin et al., 2008; Al Massarani et al., 2012). While Caralluma russeliana is detected from Arabian regions and its is numerously used for the treatment of of lipid profile, liver diseases, diabetes and for removing kidney stones. Stem extracts were ingested (Zari and Al-Thebaiti, 2018).

PHYTOCHEMICAL COMPOUND CLASS OF GENUS CARALLUMA R. BR

Flavonoids content:

The correlative screening of phytochemicals in Caralluma R. Br species exhibited remarkable differences in phenolic, flavonoids and secondary metabolite constituents among various parts of the plant and extracts solvent. Within the studied phytochemicals, total flavonoid compound (TFC) was identified to be distinguished in all four species. Among them, C. umbelleta (Bellamakondi et al., 2017) and C. tuberculata (Baig et al., 2021; khan et al.,2022) exhibited significant flavonoid content, while the extracts of C. indica confirmed the existence of flavonoids by means of MS-GC assay (Vadivu and Velavan, 2020). Likewise, C. edulis (Edgew.) Benth. Ex Hook.f. in methanol extract also demonstrated significant levels of flavonoids. (baig et al., 2021; khan et al., 2022).

Phenolic content

In terms of total phenolic consentration, the Folin–Ciocalteu methods showed that C, tuberculata N.E.Br. and Caralluma eduis (Edgew.) Benth. Ex Hook.f. have prominently higher phenolic content as compare to other species, of which the most efficient solvent is the methanol (Baig et al., 2021; Khan et al., 2022). C.umbellata Haw. also demonstrated prominent levels of phenol which were which were related to hepatoprotective impacts (Bellamakondi et al., 2017). According to Vaidvu and Velavan. (2020) C. indica's secondary metabolites origaneted from phenolic contents of the plant.

Other Phytochemical classes (Saponins, Alkaloids, Tannins, Steroids, Gallic acid, Rutin)

In addition to phenolics and flavonoids, both qualitative and quantitative tests identified that saponins, alkaloids and tannins were found among all the examined species of Caralluma R. Br of these, C. tuberculate N.E.Br. and C. edulis (Edgew.) Benth. Ex Hook.f. especially showed great levels of these metabolites in their methanolic and hydroalcoholic extracts (Baig et al., 2021; Khan et al., 2022). Likewise, GC-MS assays and colorimetric standard tests also identified the presence of these phytochemicals in the C. umbellata and C. indica (Bellamakondi et al., 2017; Vadivu and Velavan, 2020).

According to (Baig et al.,2021; khan et al.,2022; Bellamakondi et al.,2017) the developed techniques of chromatography including (GC-MS and UPLC/HPLC identified the presence of Rutin, quercetin and gallic acid in C. tuberculata, C. edulis (Edgew.) Benth. Ex Hook.f. and Caralluma umbellata, whereas Vadivu and Velavan. (2020) reported phenolic acids and fatty acids derivatives in the C. indica. Chemical diversity is moreover elaborated by GC-MS techniques. Among them 30+ compounds reported in C. umbellata and tuberculata (Khan et al., 2022; Bellamakondi et al.,2017) and approximately 20-32 compounds detected in C. edulis (Edgew.) Benth. Ex Hook.f. and C. indica (Iftikhar et al., 2022; Vadivu and Velavan, 2020).

Across these aromatic compounds, phytol, fatty acid esters, hexadecanoic acid were detected among C. tuberculata, C. edulis (Edgew.) Benth. Ex Hook.f., C. umbellata and C. indica (Khan et al., 2022; Iftikhar et al., 2022; Bellamakondi et al., 2017; Vadivu and Velavan, 2020). Due to phytochemical screening assay all four species significantly showed reliable presence of phytosterols, terpenoids, glycosides and and steroids. Particularly C. edulis

(Edgew.) Benth. Ex Hook.f. and C. tuberculata exhibited rich profiles of these metabolites, while C. indica and C. umbellata dominantly had fatty acid esters, terpenoids and phytosterols and glycosides. (Baig et al., 2021; Khan et al., 2022; Vadivu & Velavan, 2020; Bellamakondi et al., 2017).

CONCLUSION

Caralluma R. Br is a desertic genus that belongs to the family Apocynaceae sub family Asclepiadoideae. it is classified under the order Ceropegieae suborder Stapeliinae. It contains approximetly 120 species. This Genus has various phytochemical compounds that are linked to its medicinal, anti-oxidant, anti-microbial and toxicity properties. The species of the Caralluma R. Br genus are habited in Pakistan, Saudi Arabia, Egypt, Europe, India, Ethiopia, Yamen, Spain, Kenya, Srilanka and canar islands. They are variously used in traditional medicines. Including, cancer, Blood diseases, rhumatisim, inflammations, lipid profile, Dysentry, hepatitis, ulcers, hypertention, gastric, intestinal issues, malaria, TB (tuberculosis), Melliitus, obesity, appetite and weight management, Scorpions and snake bites. Alkaloids, glycosides, teropenoids, flavonoids, tannins, carotenoids, phenolics, quercetin, saponins, rutin, gallic acids, were found in various species of Caralluma R. Br. These chemicals were isolated by using different tecgniques, including GC-MS, colorimetric-gravimetric, Screening and by folin-ciocalteu methods. It showed strong antimicrobial activity against most dangerous bacteria and fungi. The extracts from roots, leaves and stems were reported effectively towards Bacillus species and Eschrichiacoli. At moderate doses the species were generally found safe but at overdoses they may have mild toxicity. Caralluma R. Br is a genus of xerophytic regions and it have various biological activitiiess that are associated with their phytochemical compounds.

RECOMMENDATIONS

- More studies should be focused that how phytochemicals of the genus Caralluma R. Br worked in the body. For instanse the pathogenic bacteria and fungi should be controlled and prevent the body cells from injury.
- Caralluma R. Br species should be tested first in animal models and after then in humans to confirm the safety.
- Endangered species of Genus Caralluma R. Br should be conserved.
- After testing the Caralluma R. Br species in the laboratories herbal capsules should be made for humans.
- The indegenious knowledge from local people about the medicinal uses of genus Caralluma R. Br should be documented.

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