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- Jaykumar Chavan
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AAVISHKAR PUBLICATION

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Content

An updates on cytology, phytochemistry, pharmacology and nutraceutical potential of genus *Cissus* L.

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K. D. Asabe, U. S. Pawar, J. J. Chavan, S. V. Thigale, S. M. Deshpande

Abstract

Cissus L. is a diverse genus of flowering plants in the Vitaceae family, with several species occurring in India. *C. quadrangularis* (L.) is a highly medicinal species from this genus. The cytological study of this genus has provided valuable insights into its genetic diversity. This review article presents a comprehensive analysis of the cytological, phytochemical, nutraceutical and pharmacological studies conducted on genus *Cissus* L. highlighting their significance and further research on genus *Cissus* species.

Keywords

Cissus • Cytology • Vitaceae • Phytochemistry • Grape family

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1. Introduction

Among commercially available fruits, the Vitaceae family is significant and is included in the Rhamnaceae order. It is known for its woody plants and frequently unisexual apetalous flowers. Most of the family's members are climbers, have leaves that are opposite tendrils, have stamens that are opposite petals, and have berry-like fruits (Karkamkar et al., 2010). *Cissus woodrowii* (Stapf ex Cooke) Santapau is the only shrub species of the genus *Cissus* (Fig. 1). In general, the genus *Cissus* is distinguished by well-developed thick and undivided floral disks, tetramerous flowers, one-seeded fruits, and seeds with a long and linear chalaza (Lombardi, 2007). It is interesting that the species of the genus *Cissus* are climbing shrubs, tiny trees or herbs with jointed stems or nodes, frequently with watery fluids, and perennial rootstocks (Maurizio et al., 2007).

Understanding cyto-morphological data is crucial before using such a significant genus in breeding programs in order to examine differences and interactions between farmed and wild kinds. Hence the chromosome counts for the members of the Vitaceae family have been recorded, and this work was limited to specific types. According to morphological characteristics, various researchers have proposed categorizing grape types. The chromosome counts and related morphological traits of the various accessions of the members of the family Vitaceae are reported in the current review. The genus *Cissus* is cytologically minutely recognised, till date only 22 species including eight Indian species have been studied cytologically with the basic chromosome numbers in *Cissus* genus (n =10, 11, or 12).

The family Vitaceae includes 350 species of the genus *Cissus*, many of which are used in traditional medicine around the world to cure a variety of illnesses (Fernandes and Banu, 2012). *Cissus quadrangularis*, *C. repens*, *C. rependa*, *C. arnottiana*, *C. discolor*, *C. sicyoides*, *C. populnea*, *C. cornifolia*, *C. verticillata*, *C. vitiginea*, and *C. aralioides* are the species that are most valuable for pharmacological purposes. In order to advance our knowledge of these plants and their prospective applications, the goal of this study is to summarize and assess the results of investigations on the genus *Cissus* in the fields of cytology, phytochemistry, pharmacology, and nutraceuticals.

Figure 1 *Cissus woodrowii* (T. Cooke) Santapau

2. Methods

Information about the genus *Cissus* that was published between 1901 to 2023 is presented in this review. The data was gathered from a variety of sources, including theses, books, and magazines. Information from online electronic journals, Wiley, Springer Link, ScienceDirect, Google Scholar, and other sources was incorporated. The various chromosome databases are also checked for chromosome-related information. The terms *Cissus*, pharmacology, traditional applications, chromosomes, karyotype, phytochemistry, etc. were used in the literature search. The names of specific species were also employed as keywords. The full-text of the publications where the keywords appeared was examined. All the *Cissus*-related publications have undergone a rigorous review. In this review, the findings are critically collated, examined, and presented.

3. Results and Discussion

3.1 Cytological Studies

x = 6 is the basic chromosomal number for the Vitaceae family. By addition of two homologous chromosomes, it can become x = 5; by doubling one or more chromosomes, it can become x = 7, etc. These have been found in stable combinations in nature. Based on fundamental chromosomal counts, the evolution of the Vitaceae family reveals distinct differences between several taxa. The *Cissus* genus has chromosome counts ranging from 2n = 22 to 80. Some of the species in this family are polyploid in nature, such as *Cissus* 2n = 24, 48, and these genera have been reclassified based on chromosomal counts (Karkamkar et al., 2010).

Chromosome number 2n = 24 is the most prevalent in the genus *Cissus*, while other ploidy levels, including (2n =34, 36, 44, 48, and 80), do exist. Only 22 species chromosomal counts were provided by the authors of the previous cytological investigation (Table 1). The given chromosomal indicates that 2n = 24 predominates. Basic *Cissus* chromosomal counts (n = 10, 11, or 12). According to the results of flow cytometry, the *C. quadrangularis* genome is about 2C =1.410 pg in size. The chromosome numbers were determined to be 2n = 48 using fluorescence microscopy and DAPI dye. The basic chromosome numbers in the *Cissus* genus (n = 10, 11, or 12) suggest that *C. quadrangularis* possesses a tetraploid genome.

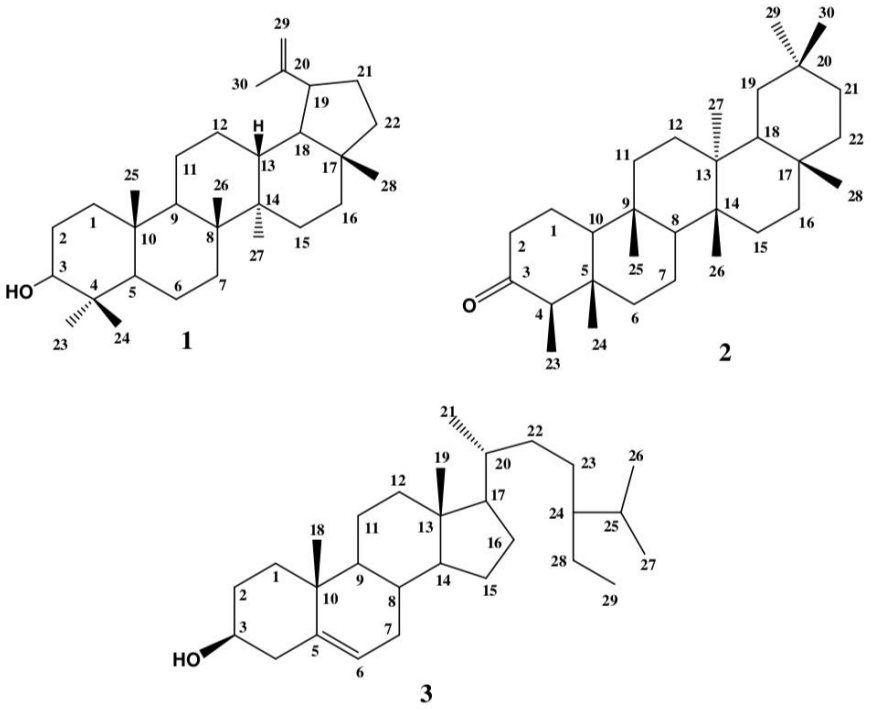
Table 1 *Cissus* species and their chromosome numbers.

Sr. No.	***Cissus* spp**	**Chromosome Number (2*n*)**	**References**
1.	*Cissus vitiginea* L.	26	Cave, 1959
2.	*Cissus pallida* (Wight & Arn.) Steud.	24, 26	Kumar and Subramaniam, 1987
3.	*Cissus repens* Lam.	24	Petria, 1973
4.	*Cissus javana* DC.	48	Agarwal, 1983
5.	*Cissus repanda* (Wight & Arn.) Vahl	24	Kumar and Subramaniam, 1987
6.	*Cissus adnata* Roxb.	22	Sarkar et. al.,1982
7.	*Cissus trifoliata* (L.) L.	80	Khatoon and Ali, 1993
8.	*Cissus aralioides* (Welw.) Planch.	24	Ornduff, 1965
9.	*Cissus arguta* Hook.	20	Goldblatt and Johnson, 1981
10.	*Cissus assamica* (M. A. Lawson) Craib	48	Moore, 1971
11.	*Cissus cactiformis* Gilg	24	Petria, 1973
12.	*Cissus decidua* Lombardi	34	Voelger, 2006
13.	*Cissus elongata* Roxb.	24	Patil, 1980
14.	*Cissus heyneana* Planch	24	Kumar, 1987
15.	*Cissus pulcherrima* Vell.	36	Voelger, 2006
16.	*Cissus quadrangularis* L.	24	Patil, 1980
17.	*Cissus subaphylla* (Balf.) Planch.	24	Lavie, 1979
18.	*Cissus sulcicaulis* (Baker) Planch.	22	Pitrez et al., 2014
19.	*Cissus woodrowii* (Stapf) Santapau	24	Patil, 1980
20.	*Cissus canarensis* (Dalzell) Planch.	44	Patil, 1980
21.	*Cissus gongylodes* (Baker) Burch. ex Baker	36	Darlington and Wylie, 1956
22.	*Cissus verticillata* (L.) Nicolson & C. E. Jarvis	48	Petria, 1973

4. Phytochemical Studies

Numerous biologically active substances have been found in the leaves, stems, roots, flowers, and fruits of *Cissus* species, according to phytochemical research. Different solvents (ethanol, methanol, water, chloroform, ethyl acetate, butanol, acetone, petroleum ether, dichloromethane etc.) were used to record a range of phytoconstituents from diverse plant sections (Salunkhe et al., 2013; Kadam et al., 2014).

Figure 2 Structures of three compounds isolated from *Cissus quadrangularis*. 1) lupeol[20] 2) Friedalin, and 3) β-sitosterol[19]



Sterols, quinones, and phenolic chemicals are present in *cissus* leaves. In addition, plants' leaves and fruits include anthocyanins, saponins, and flavonoids (Toledo et al., 1983). Due to their abundance in polyphenols, proteins, carbs, and vitamins, the species of the genus *Cissus* are frequently employed as therapeutic plants (Singh et al., 1984). A new coumarin glycoside, 5, 6, 7, and 8-tetrahydroxycoumarin-5-xylopyranoside, was discovered and isolated from the aerial parts of *C. sicyoides* through phytochemistry studies, along with two flavonoids, kaempferol 3-rhamnoside and quercetin 3-rhamnoside, and two steroids, itosterol and 3-O-dglucopyranosylsitosterol (Beltrame et al., 2002). Vitamins, terpenoids, phenolic acids, lignins, stilbenes, tannins, flavonoids, quinones, coumarins, alkaloids, amines, betalinins, and other phytochemical molecules are found in *C. aralioides* Planch.

(Lakshmanan et al., 2020). Friedalin, β−sitosterol[19] and lupeol[20] are also isolated from *C. quadrangularis* (L.) (Fig. 2) (Rao et al., 2011).

5. Pharmacological Effects

Around 350 varieties of plants in the genus *Cissus* are found around the world and at least 12 of these are used as traditional medicines for a variety of illnesses. According to Udupa and Prasad, (1962), *Cissus quadrangularis* is mostly used to treat fracture in the Indian subcontinent and Sri Lanka. The *Cissus* species were utilized to cure a wide range of medical conditions by ancient Asian cultures. In China and other countries in the Far East, sarafotoxin 6b is utilized locally as anti-snake venom to reduce endothelin-1 produced by *C. assamica* (Yang et al., 1998). In addition to being applied to itching sores, *C. discolor* is used to alleviate digestive issues (Sawmliana, 2003). According to Oleski et al., (2006), *C. hamaderohensis* is employed in West Asian nations due to its ability to suppress the enzymes angiotensin-converting enzyme (ACE), neutral endopeptidase (NGP), and aminopeptidase N (APN), as well as its antiviral properties (Mothana et al., 2006). *C. verticilata* is mostly used as an anti-diabetic and to treat urinary issues by the people of the Caribbean islands of Trinidad and Tobago (Lans, 2006). In in-vitro tests, the methanol extracts of *C. populnea* stimulated the proliferation of sertoli cells TM4 (Osibote et al., 2011).

5.1 Antimicrobial activity

C. rubiginosa is frequently utilized as an anti-dysentery and anti-diarrhea agent, primarily in Congo (Otshudi et al., 2000). According to Alzoreky and Nakahara, (2003), *C. rotundifolia*, which is frequently found in Africa and Asia, exhibits both antidiabetic and anti-parasitic characteristics. As one tribe in Cameroon employs *C. aralioides* as an antibacterial agent against microbes in the gastro-intestinal and urogenital tracts, several African nations have used various *Cissus* species as part of their traditional medical practices (Assob et al., 2011). Some local Nigerians employ *C. populnea*, *C. ibuensis*, and *C. quadrangularis* as traditional medicines. According to Suhasini and Chandra, (2015), the petroleum ether extracts of *C. quadrangularis* have antibacterial action against Gram-negative *Salmonella typhi* and *Escherichia coli* pathogens as well as Gram-positive *Staphylococcus aureus* and *Bacillus cereus*. The most effective treatment for peptic ulcers is *C. setosa* (Venkatachalapathi et al., 2015). According to Rashid et

al., (2016), *C. adnata* is effective in treating dysentery, epilepsy, fever, scurvy, cancer, hemorrhoids, asthma, malaria, and food poisoning.

5.2 Antifungal activity

The methanolic extract of *Cissus ibuensis* showed a broad-spectrum of activity against the fungi which are known to be associated with different types of infections. Bioactive substances from this plant can therefore be employed in the formulation of antifungal agents for the treatment of various fungal infections (Okeh et al., 2017). Ethanol extract of *C. elongata* showed good antifungal activity (Kunder and Vidya, 2016).

5.3 Anticancer activities

According to Line-Edwige et al., (2009), the various alcoholic extracts of the Gabonese medicinal plant *C. debilis* have excellent antiproliferative activity on human CaCo-2 cells. The plant oil appears to lower the incidence of Alzheimer's disease, stroke, inflammation, and several types of cancer, according to epidemiological and clinical investigations on *Cissus aralioides* (Thiyam-Hollander et al., 2012). With an IC50 value of 40 g/ml, the flavonoid fraction has strong anticancer properties against breast cancer cells (MCF7). According to Vijayalakshmi et al., (2013), *Cissus quadranqularis* methanol extracts demonstrated antitumor action in the aerial region. For the HeLa and Vero cell lines, the IC50 value was discovered to be at concentrations of 62.5 g/ml and 125 g/ml, respectively (Dwivedi et al., 2013). By boosting the antioxidant activity, quercetin and other phytochemical components in the *C. quadrangularis* extract may contribute to the anticancer treatment effectiveness. Additionally, the flavonoid components in *Cissus quadrangularis* (L.) extracts may have anti-cancer properties (Dhanasekaran, 2020).

5.4 Antioxidant activity

The stem of *C. quadrangularis* (L.) is useful for antioxidant activity (Nawghare et al., 2017). The methanol extract of the *C. quadrangularis* (L.) shows a remarkable scavenging effect on DPPH free radical, hydroxyl radical production, superoxide radical, and controlling lipid peroxide production in rat models (Jainu and Devi, 2005). On $FeSO_4$ and sodium nitroprusside (SNP)-induced lipid peroxidation in rat testes, water-extractible phytochemicals from the stem bark of *C. populnea* were examined in vitro for their antioxidant capabilities and potential inhibitory effects. The extract

demonstrated a strong reducing power in addition to being able to chelate Fe2+ and scavenge DPPH radicals (Akomolafe et al., 2013). With an inhibitory concentration 50 (IC50) of 16 g/mL, the crude methanol extract of *C. populnea* rhizomes demonstrated strong DPPH anti-radical action (Nyemb, 2018).

5.5 Anti-inflammatory activity

In rat models, paw edema caused by arachidonic acid and carrageenin as well as edema in the ears caused by ethyl phenylpropiolate has both been controlled by the methanolic extract of the *Cissus quadrangularis* (Panthong et al., 2007). Conjunctivitis has been treated in Liberia using sap from macerated *C. polyantha* leaves, while discomfort and inflammation are treated with a decoction made from the subterranean root and leaves (Burkill, 1995). *C. routndifolia*, a spice with anti-inflammatory properties, has been the subject of biological studies (Raslan, 2015).

5.6 Wound healing activity

Blume's *Cissus discolor*, the whole plant is crushed and made into a paste; this paste is blended with egg white and applied to the cattle wound. The well-known herb *Cissus latifolia* Lam. is used to cure bone fractures, osteoporosis, and scurvy. The folk remedy *C. Repanda* Vahl, also called "Panivel" in Hindi, is renowned for possessing therapeutic properties in both the roots and stem. On boils, small abscesses, sloughing and fetid ulcerations, plant paste made from the *C. repens* is applied as a maturant. Root juice and paste are used to treat dog bites (Kunder and Vidya, 2016). "Hadjod" is one of the common names for *C. quadrangularis*. For the treatment of piles, chronic ulcers, wounds, and to hasten the healing of fractures, it is one of the most often used Ayurvedic ingredients (Patwardhan et al., 2004).

6. Nutritional properties

Chutney made from *Cissus quadrangularis* and coconut is made in Tamil Nadu and offered as a side dish to boost immunity. The stems of *C. quadrangulris* are consumed as a pickle in Southern India to strengthen the bones and repair epithelial cell damage in the event of an accident (Grinnell et al., 1981). It is an excellent source of beta-carotene and vitamin C (Kaur and Malik, 2010). In Ayurveda, *C. vitiginea* was employed as an alternate, dyspeptic, digestive, tonic analgesic in the treatment of asthma, eye and ear problems, and irregular menstruation (Niki, 2010).

The southern region of Saudi Arabia is home to a large population of *C. rotundifolia* plants, and locals frequently boil and eat the plant's leaves as leafy vegetables (Korish, 2016). The *C. quadrangularis* plant is a highly rich source of nutrients and chemical components needed for the body to function properly. It is a highly rich source of nutrients and chemicals needed for the body to function properly (Lakshmanan et al., 2020).

7. Conclusion

In conclusion, the plants of genus *Cissus* are good source of nutrients and phytochemicals. Due to occurrence of numerous bioactive drugs, many species will contribute for treating human diseases and disorders. Many species have pharmacological importance as these species possesses antifungal, antioxidant, antibacterial, wound-healing properties and several other properties. The comprehensive data compiled on chromosomes as well as taxonomic information on the genus *Cissus* will help in breeding programmes.

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Conflict of Interests

The authors declare no conflicts of interest related to this article.

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