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SUSTAINABLE USE AND EFFECT OF SOLVENTS ON PHYTOCHEMICAL EXTRACTION OF FIVE VULNERABLE ECONOMICALLY IMPORTANT PLANTS FROM NARAYANPUR, BASTAR, CHHATTISGARH

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ABSTRACT

Ethno-botany and ethno-medicinal investigations are now recognized as most efficient techniques for keeping informed or refocusing the data on medicinal plants reported in prior research for the possible extraction of useful bio-active compounds. Ethno-botanical research is requisite for exploring the traditional uses of plants for medicinal purposes. Several studies over the past decade have shown promising applications of phytochemicals in drug discovery and treatment. Increasingly we are observing a growing trend of applications of phytochemicals in medical science which is leading to the exponential uncontrol use of medicinal plants with economic importance. The study aims to investigate the presence of phytochemical and bioactive compounds in five medicinal plants by Soxhlet extraction method. Because of the economic and ethnomedicinal importance the selected plants are facing the status of vulnerable in Chhattisgarh state. These studies also emphases on bringing awareness among the folk for their sustainable use. For extraction solvents with different polarities viz., aqueous, acetone, chloroform and petroleum ether are used. Results of qualitative phytochemical screening revealed the presence of alkaloids, phenols, reducing sugar, saponins, tannins, terpenoids, flavonoids, fixed oil and fats, anthraquinones as the major bioactive compounds in all five selected plants. While cardiac glycoside was found to be absent. Maximum number ofbioactive phytochemicals were extracted in the aqueous and acetone leaf extracts of *D. gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn., and *S. urens* Roxb.. While in *D. hispida* Dennst. maximum phytochemicals were observed to be present in the acetone and chloroform tuber extracts. This may be due to different solvents have been reported to have the capacity to extract different phytoconstituents depending on their solubility or polarity in the solvent. As, medicinal plants possess curative properties due to the presence of various bioactive chemical substances of different composition. Results of this study can serve as a preliminary source of knowledge for further isolation, characterization and identification of the bioactive compounds. Selected medicinal plants can also serve as a source of raw material for pharmaceutical industries as a natural source of drug designing. Dose dependent clinical trials are recommended. These plants can serve as a natural source of new drug with cheaper cost and very less side effects. Also, further research on the potential of diversity, ethnobotany, ethnopharmacology and bioactivity of plants used by local tribes is recommended to be documented for restoration of traditional knowledge of Vaid as and to bring awareness among the folk for their sustainable use and protection is being recommended.

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INTRODUCTION

Chhattisgarh renowned as the 'Herbal State', is a premier biodiversity hub with over 44% forest cover, hosting roughly 800 plus reported medicinal plant species. The state exhibits remarkable levels of endemism, particularly among plants with medicinal properties, underscoring its critical role in biodiversity conservation and the preservation of traditional healthcare practices. These plants support the livelihoods of forest dwelling communities and hold immense economic potential for the pharmaceutical and cosmetic industries, with over 75 species highly traded for their therapeutic value. The rich biodiversity, combined with the presence of numerous tribal communities who have long relied on plants for healthcare, makes Chhattisgarh a significant centre for ethno-medicinal knowledge and practices. Tribal communities in Chhattisgarh have a deep-rooted understanding of medicinal plants utilizing them for treating various ailments. This is due to a number of reasons including arability, affordability, accessibility and low cost (Mintah *et al*. 2019). Phytochemicals are primary and secondary compounds. The term 'Phyto' derived from the Greek word which means 'Plant' are

chemical compounds naturally present in the plants attributing to positive or negative health effects. Phytochemicals are naturally occurring medicinally important chemical compounds derived or extracted from various parts of plants such as roots, stem, bark, seeds, leaves, flowers, fruits, tubers, rhizomes and even pulps. The widespread trend to humans to use plant-based medicines due to the high costs of prescription drugs and their increased side effects, there is a growing demand for many medicinal plant species in the pharmaceutical industry and traditional medicine (Chen *et al*. 2015). Medicinal plants represent promising sources for the treatment of various diseases because of their abundance in bioactive compounds with therapeutic properties. Since time immortal, or history, various ailments, and studies have revealed the presence of metabolites with anti-inflammatory, antibacterial, antiviral, antiparasitic, antidiarrheal, antioxidant, and anticancer activities. The secondary metabolites responsible for these properties include alkaloids, phenolic compounds, terpenoids, tannins, anthraquinone, cardiac glycoside, with the latter, particularly flavonoids, being the most associated with their bioactivities (Julian-Flores *et al*. 2025). The plants selected for phytochemicalanalysis possess different activities as mentioned in Table no. 1.

MATERIALS AND METHODS

Plant collection: Mature green and disease-free leaves of *Desmodium gangeticum* (L.) DC., *Celastrus paniculatus* Willd., *Dillenia indica* Linn., *Sterculia urens* Roxb. and tubers of *Dioscorea hispida* Dennst. were collected from Herbal Garden, Bakhrupara Kasthagar and Raoghat tropical dry deciduous forest area of Narayanpur district during their flowering season. Geographical location of Narayanpur district is 19° 43'39"N Latitude and81° 14'38"E Longitude.

Preparation of extracts: The plant materials were washed thoroughly under running water, air-dried at room temperature, and crushed to fine powder using mixer-grinder. Finally, the powder was stored until it was needed for extraction.

Soxhlet extraction method: Twenty-five grams of powder was uniformly packed into a thimble prepared from Whatman No. 1 filter paper. Extraction was carried out for both aqueous and organic solvent (*viz.,*acetone, chloroform and petroleum ether) of increasing polarity. 250 ml of extracting solvent in flask is heated, and its vapours condense in condenser.

Table 1. Details of the selected five plants

Plant Details		Pharmacological activity
Botanical name	*Desmodium gangeticum* (L.) Dc.	Plant possess various biological activities such as antimicrobial, antioxidant, anti-cancer, anti-ulcer, anti-diabetic, anti-inflammatory, analgesic, anthelmintic, antipyretic, anti-amnestic, anti-secretary, anti-leishmanial,anti-implantation, cardioprotective, hepatoprotective, renal protective, psychopharmacological, immunomodulatory activities, cytoprotective, hypocholesterolemic along with it is effective as anti-writhing and central nervous system (CNS) depressant activity, improving memory and in healing different types of wounds (Mishra et al. 2005; Kawale et al. 2011-12; Rashidi and Deokule 2013; Mahajon et al. 2015; Tailor and Mishra 2023; Jagtap et al. 2025).
Common/local name	Shalparni	
Family	Fabaceae	
Habit	Shrub	
Part used	Whole plant, roots, barks	
Flowering Season	March to December	
Threat Status in India and Chhattisgarh	In India: Vulnerable (http://www.iucn.org.in) In Chhattisgarh: Vulnerable (Chandrakar 2018; http://www.iucnredlist.org; http://www.envis.frlht.org)	
Botanical name	*Celastrus paniculatus* Willd.	Possess biological activities like antifungal, antibacterial, antiviral, antioxidant, anti-inflammatory, antidepressant, anti-arthritic, anti-fertility, analgesic, hypo-lipidemic, anti-malarial, anxiolytic, anti-aging, hypolipidemic, anti-apoptotic, gastroprotective, anti-ulcerative properties, anti-cancerous, cardiovascular, neurological disorders, learning and memory enhancer, anti-depressant, central nervous system, wound healing and immunological activity (Wang et al. 2005; Gnanapragasam et al. 2007; Bhanumathy et al. 2010; Arif et al. 2018; Dwivedi and Maurya 2018; Kumar et al. 2018; Kandikattu et al. 2021;Choudhary and Soni 2021; Baraka et al. 2025; Pandey et al. 2025).
Common/local name	Jyotishmati	
Family	Celastraceae	
Habit	Climbing shrub	
Part used	Seeds, fruits, leaves, stem, roots, barks	
Flowering Season	August to October	
Threat Status in India and Chhattisgarh	In India: Nearly Threatened (http://www.iucn.org.in) In Chhattisgarh: Vulnerable (http://www.iucnredlist.org; http://www.envis.frlht.org; Singh 2013)	
Botanical name	*Dillenia indica* Linn.	Possess activities like antimicrobial, antibacterial, antifungal, antioxidant, anti-inflammatory, anti-cancer, anti-leukemic, anti-proliferative, anti-diabetic, anti-diarrheal, anti-malarial, anti-HIV, analgesic, cytotoxic, hepatoprotective, chemoprevention and many more (Yeshwante et al. 2009; Endringer et al. 2010; Gandhi and Mehta 2013; Islam et al. 2013; Lima et al. 2014; Biswas and Pandita 2015; Kumar et al. 2018; Kumar et al. 2018; Sharma et al. 2022; Sahariah et al. 2025).
Common/local name	Chulta or Elephant apple	
Family	Dilleniaceae	
Habit	Small tree or shrub	
Part used	Fruits, leaves, aerial parts	
Flowering Season	December to April	
Threat Status in India and Chhattisgarh	In India: Narrow distribution and small population (Chaubey et al. 2015) In Chhattisgarh: Least concern (http://www.iucnredlist.org)	
Botanical name	*Sterculia urens* Roxb.	Possess activities like antimicrobial, antibacterial, antioxidant, anti-cancer, anti-inflammatory, anti-diabetic, antispasmodic, analgesic and diuretic properties. Also possess gastrointestinal benefits, wound healing properties, respiratory support (Gritto et al. 2015; Shukla and Modi 2020; Rathore et al. 2022; Patil et al. 2024).
Common/local name	Kullu	
Family	Sterculiaceae	
Habit	Tree	
Part used	Stems, barks, leaves, roots	
Flowering Season	December to January	
Threat Status in India and Chhattisgarh	In India: Critically endangered (Jadhav et al. 2001) In Chhattisgarh:Vulnerable (Chandrakar 2018; http://www.iucnredlist.org; http://www.envis.frlht.org)	
Botanical name	*Dioscorea hispida* Dennst.	Possess various activities such as antimicrobial, antifungal, nematicide, antioxidant, anti-inflammatory, anti-tumor, anti-contusion, anti-phlogistic agent, anti-analgesic, anthelmintic, anti-androgenic, hypocholesterolemic, hemolytic inhibition including potential application of radioprotective phytochemicals effect, hyperglycemic, anti-hyperlipidemic activity and hemostatic properties (Murthy et al. 2011;Punith Kumar et al. 2011; Murthy et al. 2015; Miah et al. 2018; Suryowati et al. 2020).
Common/local name	Baichandi	
Family	Dioscoreaceae	
Habit	Shrub	
Part used	Underground tubers	
Flowering Season	August to November	
Threat Status in India and Chhattisgarh	In India:Rare (http://www.iucn.org.in) In Chhattisgarh:Vulnerable (Chandrakar 2018; http://www.iucnredlist.org; http://www.envis.frlht.org)	

The process of extraction was continued until the solvent in thimble tube of an extractor becomes colourless. After that the solvent extracts were filtered with the help of Whatman's No.1 filter paper (Yadav and Agrawala., 2011). After filtration, the solvent was removed by evaporations in a water bath, which gave rise to a solid mass of the extract referred to as the crude extract (Muthukrishnan and Venkatachalan 2012). Further the crude extracts were stored in labelled sterile brown bottle and eppendorf tubes and kept in refrigerator at 4^{o}C for further use. The crude extracts were subjected to phytochemical screening tests.

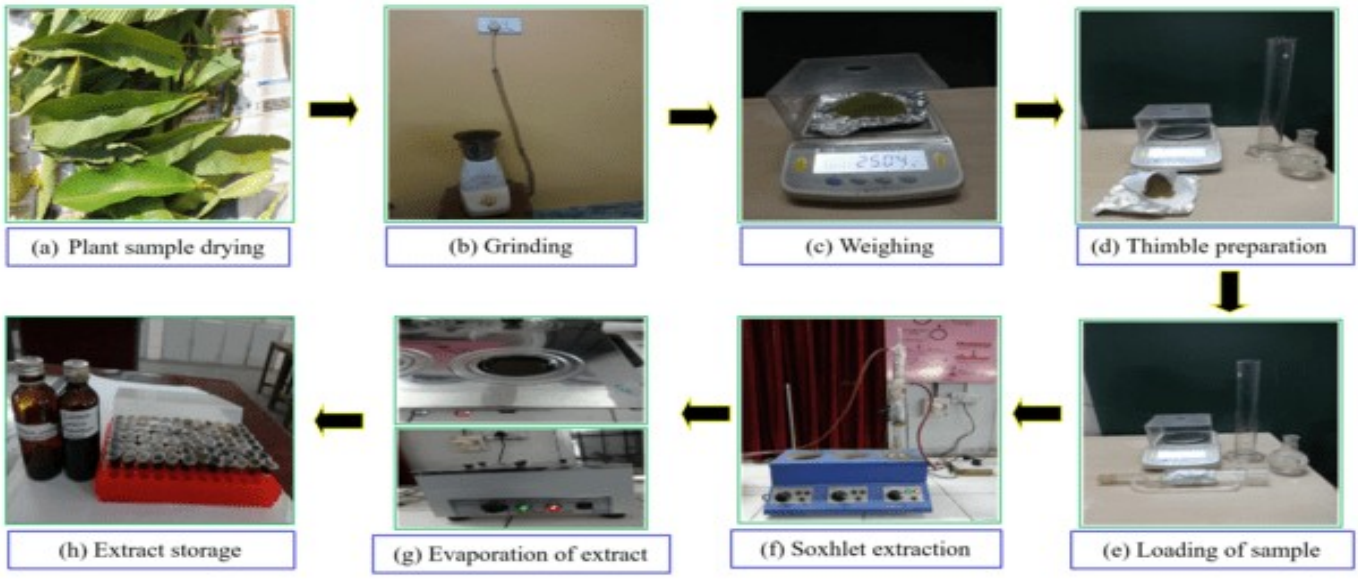

Figure 1. Preparation of plant extracts and method of Soxhlet extraction

Extraction of Secondary metabolites using different solvent extract: Qualitative phytochemical screening was based on the standard procedures described by Harborne (1973), Trease and Evans (1989), Sofowora (1993, 1996); Edeoga *et al*. (2005).

1) ***Test for alkaloids (Mayer's test):*** 6ml of extract was mixed with 6ml 1% HCl in steam both then it was filtered. 1ml of Mayer's reagent was added. Presence of turbidity shows presence of alkaloids. Further addition of a few drops of olive oil to form an emulsion confirmed the presence of alkaloids.
2) ***Test for phenol (Ferric chloride test):*** 2ml of the crude extract was added to 4ml distilled water then few drops of 10% ferric chloride were added. Appearance of blue or green colour indicated the presence of phenol.
3) ***Test for carbohydrate - reducing sugar (Fehling's test):*** 1gm of the extract was dissolved in 10 ml distilled water. This extract was boiled with Fehling solution A and B in test tube colour changes were observed. Presence of brick red colour indicated the presence of reducing sugar.
4) ***Test for saponins (Froth test):*** 0.5gm of the extract was dissolved in 5 ml distilled water. The mixture was shaked vigorously. Formation of stable persistent forth shows the presence of saponins further addition of 6 drops of olive oil while shaking forms an emulsion confirming the presence of saponins.
5) ***Test for tannins (Ferric chloride test):*** 0.5gm of the extract was dissolved in 10 ml of distilled water a few drops of 1% ferric chloride solution was added to obtain a brownish green or blue-black precipitate confirms the presence of tannin.
6) ***Test for terpenoids (Salkowski's test):*** 0.5gm extract was dissolved in 2ml of chloroform then 3ml concentrated sulfuric acid was added. A reddish-brown colour in inter phase indicates the presence of terpenoids.
7) ***Test for flavonoids (Ammonia reduction test):*** 5ml dilute ammonia was added to 5ml extract then 5ml concentrated sulfuric acid was added formation of yellow colour shows the presence of flavonoids.
8) **Test for Fixed oil (Filter paper test):** A small quantity of the extracts was pressed between 2 two filter papers. Appearance of oil strain on the paper indicates the presence of fixed oils and fat.
9) **Test for cardiac glycosides (Keller-Killiani test):** 2.5 gm of extract was added to 2.5 ml distilled water 1 ml glacial acetic acid containing a few drops of ferric chloride was added then 0.5 ml of concentrated sulfuric acid was added presence of brown ring at the inter phase indicate the presence of deoxy sugar. A violet ring below the brown ring was observed confirming the presence of cardiac glycosides.
10) **Test for anthraquinone (Borntrager's test):** 2.5 gm extract was dissolved in 5ml of conc. Sulfuric acid and filtered. The filtrate was dissolved in 2.5ml of chloroform. Chloroform layer was pipetted into a tube and 0.5 ml of 10% diluted ammonia was added formation of pink red or violet colour shows the presence of anthraquinone.

RESULTS

According to preliminary phytochemical assays, the plants had different secondary metabolites. The colour change indicates the presence of different phytocompounds. And no. of plus sign indicates the presence of particular phytocompound. Results showed that more phytochemical compounds were extracted in acetone and aqueous plant extract, as compared to chloroform and petroleum ether. Except for Cardiac glycosides was found to be absent in all ive plants (Table 2).

DISCUSSION

On the basis of the above findings, phytochemical screening is essential for revealing the chemical constituents that may have potential health benefits. Extraction of a phytochemical from the plant material is mainly dependent on the type of solvent used. Qualitative phytochemical screening of all five plants in the present study showed the presence of alkaloids, phenols, reducing sugar, saponins, tannins, terpenoids, flavonoids, fixed oil and fats, anthraquinones as the major bioactive compounds.These findings were similar to those of a previously carried out studies by Hill 1952; Ghosal and Bhattacharya 1972; Leete and Pinder 1972; Haq and Gomes 1974; Rahman *et al*. 1981 d; Leete and Michelson 1988; Avasthi and Tewari 1995; Mishra *et al*. 2005; Ning *et al*. 2009; Shah *et al*. 2009; Bose *et al*. 2010; Vijayalaksmi *et al*. 2011; Kawale *et al*. 2012; Vaghela *et al*. 2012; Debnath *et al*. 2012; Arora and Pandey-Rai 2012; Kalaskar *et al*. 2012; Suttee *et al*. 2012-13; Bhattacharjee 2013; Gandhi and Mehta

2013; Lima *et al*. 2014; Deodhar and Shinde 2014-15; Cui *et al*. 2014; Dat *et al*. 2015; Deodhar and Shinde 2015; Biswas and Pandita 2015; Haridas *et al*. 2016; Vepal *et al*. 2016; Lagadu and Owk 2016;Boparai *et al*.2016; Al- Rahman 2017;El-Sherei *et al*. 2016;Dwivedi and Maurya 2018; Srivastava & Srivastava 2018; Kanoje *et al*. 2019; Sushma *et al*. 2020; Bains *et al*. 2020; Mohan *et al*. 2020; Ly *et al*. 2021; Mane *et al*. 2021; Mohan *et al*. 2021; Kanoje *et al*. 2021; Shinde *et al*. 2022; Jayasuriya *et al*. 2025; Nahar *et al*. 2025; Kabir and Lawan 2026).

Phenols present in all the extracts studied for *D. gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn., *S. urens* Roxb., *D. hispida* Dennst. Phenolic compounds are polyphenols that can be divided into flavonoids, phenolic acid, tannins, propanoid, tocopherols and phenolic diterpenes (Ali *et al*. 2008; Thagriki *et al*. 2015). Phenols are found to possess antioxidant, anti-hypertensive, blood viscosity reducer, diuretic and choleretic functions. It also possesses anti-apoptosis, anti-aging, anti-carcinogenic, anti-inflammatory, anti-atherosclerosis, anti-diabetic, anti-microbial, anti-bacterial, anti-mutagenic, anti-proliferative, angiogenesis inhibitor, immune system, cardiovascular protective and also found to assist the endothelial function. Earlier researchers have also reported the use of these bioactive compounds in dye, cosmetic, food and pharmaceutical industries due to their wide therapeutic and pharmacological properties (Shui and Leong 2002; Han *et al*. 2007; Tungmunnithum *et al*. 2018; Airaodion *et al*. 2019; Al-Snafi 2020; Albuquerque *et al*. 2021; Madhu *et al*. 2025).

Flavonoids present in all the extracts studied for D. *gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn., *S. urens* Roxb. whereas in *D. hispida* Dennst. present only in acetone extract. Flavonoids are hydroxylated phenolic substances synthesized by plants in response to microbial infection and possess antimicrobial substances against a wide array of microorganisms *in vitro*. Activity is most likely due to their ability to form complex with extracellular and soluble proteins and to complex with bacterial cell wall (Marjorie 1996). They also are effective antioxidants and show strong activities. It also functions as free radicals, platelet aggregation, ulcers, hepatotoxins, viruses and tumours, and protection against cytostatic (Salah *et al*. 1995; Del-Rio *et al*. 1997; Okwu 2004; Compean and Ynalvez 2014). Biological functions of flavonoids apart from its anti-oxidant and free radical scavenging capacity includes coronary heart disease prevention, hepatoprotective, osteoporosis, anti-carcinogenic properties coupled with their capacity to modulate key cellular enzyme function and neurodegenerative diseases. It also possess anti-diabetic, anti-allergic, anti-ulcer, anti-parkinson, anti-depressant, anti-hypertensive, spasmolytic, anti-inflammatory, anti-mutagenic, anti-diarrheal, anti-microbial, anti-viral properties (Barakat *et al*. 1993; Rauha *et al*. 2000; Cushnie and Lamb 2005; Ververidis *et al*. 2007; Spencer 2008; Mamadalieva *et al*. 2011; Kumar and Pandey 2013; Chen *et al*. 2015; Panche *et al*. 2016; Dzialo *et al*. 2016; Sulsen *et al*. 2017; Andreu *et al*. 2018;Wang and Bi 2018; Rana and Gulliya 2019; Karak 2020; Rupasinghe 2020; Wen *et al*. 2020; Mutha *et al*. 2021; Agidew 2022; Sharma *et al*. 2025).

Tannins present in *D. gangeticum* (L.) DC. (aqueous and acetone extract), *C. paniculatus* Willd. (aqueous, acetone and petroleum ether extract), *S. urens* Roxb. (acetone extract). Tannin's antioxidant property is responsible for its anti-carcinogenic and anti-mutagenic potentials by protecting cellular oxidative damage, including lipid peroxidation. The generation of superoxide radicals was reported to be inhibited by tannins and related compounds. Tannins also have the anti-inflammatory and antiulcer potency on rodents showing a strong antioxidant property for possible therapeutic applications. Tannins are effective in protecting the kidneys and also showed antimicrobial, antiviral, antibacterial, antiparasitic, antioxidant, anti-inflammatory, anti-nutritional, anti-asthmatic, anti-carcinogenic, anti-allergy, anti-hypertension and cardiovascular system-protective effects. It also possesses a wide range of pharmacological and biological activities, which include anticancer, as astringent medicine for the treatment of intestinal disorders, such as dysentery and diarrhoea, hasten the healing of wounds, antitumor and inflamed mucous membrane. Tannins have also been reported to exert other physiological effects, such as to accelerate blood clotting, reduce blood pressure, decrease the serum lipid level, and modulate immune-responses. Analgesic and anti-inflammatory properties can be attributed to terpenoids and tannins. Apart from these tannins contribute properties of astringency i.e., faster healing of wounds and inflamed mucous membrane. Tannin has been widely used topically to sprains, bruises and superficial wounds (Chung *et al*. 1998; Okwu and Josiah 2006; Usman and Osuji 2007; Serrano *et al*. 2009; Ashok and Upadhyaya 2012; Avinish and Waman 2014; Zarin *et al*. 2016; Smeriglio *et al*. 2017; Suvanto *et al*. 2017; Britto *et al*. 2017; Ejiofor *et al*. 2018).

Terpenoids present in D. *gangeticum* (L.) DC. (aqueous extract), *C. paniculatus* Willd. (aqueous and petroleum ether extract), *D. indica* Linn. (aqueous extract), *S. urens* Roxb. (aqueous and acetone extract), *D. hispida* Dennst. (acetone extract). The presence of terpenoids in various plants was reported by various researchers (Scortichini and Rossi 1991; Tsuchiya *et al*. 1996) and that plants were widely used in herbal medicines due to the presence of terpenoids (Hayashi *et al*. 1993; Edeoga *et al*. 2005). Terpenoids have been found to be useful in the prevention and therapy of several diseases due to its anti-malarial, promote transdermal absorption, prevent and treat cardiovascular diseases and have hypoglycemic activities. Terpenoids have many potential applications, such as insect resistance, immunoregulation, antioxidant, anti-aging, neuroprotection, anti-allergenic, antispasmodic, anti-hyperglycaemic, anti-microbial, anti-bacterial, anti-viral, anti-parasitic, anti-inflammatory, anti-diabetic, anti-tumour, anti-HIV, cardio hepatoprotective effects including cancer and immune-modulatory properties. It is also found to be associated with inhibition of cholesterol synthesis and insecticidal activities and for the treatment of metabolic diseases (Mahato and Sen 1997; Fernandez *et al*. 2001; Wagner and Elmadfa 2003; Rabi and Bishayee 2009; Saleem 2009; Hill and Connolly 2012; Sulsen *et al*. 2017; Yang *et al*. 2020).

Alkaloids present in all the extracts studied for *D.gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn. (except chloroform extract), *S. urens* Roxb., *D. hispida* Dennst. In almost all plants alkaloids are one of the most abundant and diverse groups of secondary metabolites found at 10-15% concentration. Many alkaloids are toxic and often have a pharmacological effect, which renders them as medications and recreational drugs (Manske 1965). The high abundance of alkaloids in most of the extracts confirmed the therapeutic use of the plants have been associated with medicinal uses for centuries (Nobori *et al*. 1994). Available literature tells us about the broad range of pharmacological potentials as an anti-malarial, anti-diarrheal, anti-asthmatic, anti-carcinogenic, anti-bacterial, anti-analgesic, anti-inflammatory and antispasmodic. They are found to reduce stress and depression-like symptoms (Antherden 1969; Harborne 1973; Odebiyi and Sofowora 1978; Stray 1998; Okwu and Okwu 2004).

Saponins present in all the extracts studied for *D. gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn., *S. urens* Roxb., *D. hispida* Dennst. (except petroleum ether extract). In general, saponins have been related to immunostimulatory, hypocholesterolemic, hepatoprotective, anti-tumour, anti-ulcer, antimicrobial, antibacterial, antiviral, antifungal, antiparasitic, adjuvant and cholesterol reducing activity is most pronounced. Saponins act as an expectorant and are used in the management of upper respiratory tract inflammations, atherosclerosis, diabetes, acute lung injury, cancer, and cardiovascular diseases. Medically they are used as expectorant, emetic and for the treatment of excessive salivation, epilepsy, chlorosis and migraines. Saponins are used in ayurvedic medicine as a treatment for eczema, psoriasis and for removing freckles and are also believed to be useful in the human diet for controlling cholesterol. The heart muscle causing the heart to pump more efficiently can be strengthened by treating with digitalis-type saponins. Saponins also inhibit cancer tumour growth in animals, particularly lung and blood cancers without killing normal cells. Saponins are characterized by their bitter taste and their ability to haemolyze red blood cells other characteristics including haemolytic activity, cholesterol binding and

Table 2. Results of Qualitative Analysis of Phytocompounds from Five Vulnerable Medicinal Plants

Plant species	Solvent	Phytochemical Bioactive Compounds									
		Alkaloids	Phenols	Reducing sugar	Saponins	Tannins	Terpenoids	Flavonoids	Fixed oils and fats	Cardiac glycoside	Anthaquinones
Desmodium gangeticum L. (DC.) (Leaves)	AQ	++	+	++	+	+	+++	+	+++	-	++
	AC	++	++	++	+	++	-	+	+++	-	-
	CF	+	+	++	+	-	-	+	+++	-	-
	PE	+	+	++	+	-	-	+	+++	-	-
Celastrus paniculatus Willd. (Leaves)	AQ	++	+	+	+	+	+++	+	++	-	++
	AC	+++	+	+	+	++	-	+	+++	-	-
	CF	+	+	++	+	-	-	+	++	-	-
	PE	+++	+++	+	+	+	+	+	+++	-	-
Dillenia indica Linn. (Leaves)	AQ	++	+	++	++	-	+++	+	++	-	++
	AC	++	+	++	+	-	-	+	++	-	-
	CF	-	+	+++	++	-	-	+	++	-	-
	PE	+	++	-	+	-	+	++	++	-	-
Sterculia urens Roxb. (Leaves)	AQ	+	+	++	+	-	+	+	+	-	++
	AC	+	+	++	+	++	++	+	++	-	-
	CF	+	+	++	+	-	-	+	++	-	-
	PE	+	+	-	+	-	-	++	+	-	-
Dioscorae hispida Dennst. (Tubers)	AQ	++	+	-	++	-	-	-	-	-	-
	AC	+	++	-	+++	-	+	++	-	-	++
	CF	+	+	+	+	-	-	-	-	-	-
	PE	+	+	-	-	-	-	-	-	-	-
Phytochemical Tests		Mayer's Test	Ferric Chloride Test	Fehling's Test	Froth Test	Ferric Chloride Test	Salkowski's Test	Ammonia Reduction Test	Filter Paper Test	Keller- Killani Test	Borntrager's Test
Inference		Presence of turbidity	Bluish green color	Brick red color	Frothing persist 15 mins	Dark blue or greenish grey Cream ppt	Bluish-green color at interphase reddish colour	Yellow color	Oil stain develops	Violet ring below brown ring interphase	Deep red or pink color of aqueous layer
Solvents: Aqueous (AQ); Acetone (AC); Chloroform (CF); Petroleum ether (PE)											
Indication:'+++' relatively a strong presence; '++' relatively moderate presence; '+' relatively low presence, '-' indicates absence.											

formation of foams in aqueous solutions (Oakenfull and Sidhu 1990; Kamel *et al*. 1991; Just *et al*.1998; Sodipo *et al*.2000; Okwu 2004; Moghimipour and Handali 2014; Xu *et al*. 2019). Saponins act as an immune system in plants, acting as an antibiotic to protect them against microbes and fungus. The formulation of studied plants may be helpful in the development of drugs against diseases caused by microorganisms. Saponins serve as natural antibiotics against fungal and yeast infections and help the body to fight infections and microbial invasion. Saponins have been extensively used as detergents, as pesticides and molluscicides, in addition to their industrial applications as foaming and surface-active agents and also have beneficial health effect (Shideler 1980; Chatterjee and Chakravorty 1993; Shi *et al*. 2004; Santhi *et al*. 2011; Venkataramaiah and Wudayagiri 2013; Saxena *et al*. 2013).

Reducing sugar present in all the extracts studied for *D. gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn. (except chloroform extract), *S. urens* Roxb. (except petroleum ether extract) whereas in *D. hispida* Dennst. chloroform extract. *D. hispida* Dennst. Reducing sugar possesses pharmacological applications such as antioxidants, anti-tumor, anti-virus, immunoregulatory, hypoglycaemic activity and plant immunity (Khatri and Baruwal Chhetri 2020).

Fixed oils and fats present in *D. gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn., *S. urens* Roxb., while absent in *D. hispida* Dennst.. It possesses biological properties for preparation of ointment. Fixed oils possess activity like anti-inflammatory, antioxidant, antihistaminic, immune-modulator, antimicrobial, analgesic effects and plant immunity. Studied plants can be used for the preparation of joint pain reliving and ointment and helps in growth and development, provides essential fatty acids and fat-soluble vitamins for the system, boost the immune system and improves food palatability (Falodun *et al*. 2008; Islam 2016; Mahboubi 2018).

Anthraquinones present in only *D. gangeticum* (L.) DC. (aqueous extract),*C. paniculatus* Willd. (aqueous extract), *D. indica* Linn. (aqueous extract), *S. urens* Roxb. (aqueous extract), *D. hispida* Dennst. (acetone extract).

Anthraquinones possess pharmaceutical properties like antimicrobial, antibacterial, antiviral, antioxidant, anti-inflammatory, anti-tumor, anti-arthritic, anti-angiogenic, anti-diabetic stilbene, cytotoxic and anti-nociceptive (Jasril 2003; Choi *et al*. 2005; Tarasiuk *et al*. 2009; Mohammed *et al*. 2013; Kosalec *et al*. 2013; Kshirsagar 2014; Park *et al*. 2016; Pang *et al*. 2020; Shami *et al*. 2020; Nam *et al*. 2021). Anthraquinones naturally occur in some plants, fungi, lichen and insects, wherein they serve as a basic skeleton for their pigments. Anthraquinones are used in the production of dyes and are also used as a laxative (Chatterrjee and Chakravorty 1993; Samp 2008).

Cardiac glycosides gave negative tests for *D. gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn., *S. urens* Roxb., and *D. hispida* Dennst.. Cardiac glycosides are plant secondary metabolites that act on the contractile action of the cardiac muscle, treatment of congestive heart failure, cardiac arrhythmia and anti-cancer so these plants may become the cheapest source to develop cardio protective medicine by further pharmacological studies in future (Iyer *et al*. 2010). Glycosides are known to lower the blood pressure and also as an arrow head poisons in hunting (Nyarka and Addy 1990; Ververidis*et al*. 2007).

CONCLUSION

On the basis of the above findings, all five selected plants viz., *D. gangeticum* (L.) DC., *C. paniculatus* Willd., *D. indica* Linn., *S. urens* Roxb., (leaves) and *D. hispida* Dennst. (tubers) are the source of secondary metabolites i.e., alkaloids, phenols, reducing sugar, saponins, tannins, terpenoids, flavonoids, fixed oil and fats, and anthraquinones.Since, bioactive compounds occurring in plant material consist of multi-components mixtures, their separation and determination still create problems. Further, to perform more precise investigations by isolation, purification and characterization of particular active compound is being suggested. The phytochemical analysis of medicinal plants is also important and have commercial interest in both research institutes and pharmaceutical companies for the manufacturing of new drugs and biofertilizers for the treatment of various plant diseases. Also, it is being suggested to take an urgent action to protect these vulnerable medicinal plants species in Chhattisgarh state and to protect and conserve the loss of natural biodiversity. Government and local tribes should take proper action to maintain its number by limiting the uncontrol use of medicinal plants. Suggestion is to follow proper agricultural practices like propagation, seed conservation and less exploitation of plants to prevent the loss and promote sustainable use of the natural resources. As herbal medicines are becoming popular and this has enhanced the ethnomedicinal investigation on herbal products. Consequently, medicinal plants are now under great pressure due to its increase demand.

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