

Research Article**Open Access****Physicochemical, Phytochemical and Antioxidant Properties of few South Indian Coastal Sand Dunes (CSD)**

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Abstract: Herbal drugs play an important role in the healthcare program, especially in developing countries. The coastal Visakhapatnam sand dune species are highly significant resources that play a crucial part in neighboring people's financial and social lives. Conservation and judicious use of this coastal riches of plants are essential because they are threatened by over-exploitation, industrialization forest clearing, fast urbanization, fish farming, human settlements, etc. The inventory of ten plant species used in the present study was identified with Gamble, "Flora of the Presidency of Madras" and All the hexane, chloroform and methanol extracts were obtained using Soxhlet extraction and were screened for physicochemical, preliminary phytochemicals and antioxidant studies. The hexane, chloroform and methanol extracts of all the ten sand dune plant species were screened for phytochemical assessment and quantified the alkaloids, total phenolic, total flavonoids, tannins and saponins contents in the parameters the sand dune *Ipomoea pes-caprae* showed better values when compared to other sand dunes of the present study of the ten sand dune plant species hexane, chloroform, and methanol extracts were screened for antioxidant activity with DPPH and FRAP assays, *Ipomoea pes-caprae* gave better antioxidant activities over the rest of the sand dunes.

Key words: *Ipomoea pes-caprae*, physicochemical, phytochemicals, antioxidant studies

Introduction

The coastal sand dunes (CSD) are unique and dynamic ecosystems between marine and terrestrial realms. They are the coastal armoring with bind of biota and sand grains. The coastal sand dune flora has ecological significance and socio-economic values. Visakhapatnam is a maritime district of north coastal Andhra Pradesh situated between 17° 15' to 18° 32' Latitudes and 83° 30' to 83° 54' Longitudes. This coast line has diversified topographical and geomorphology features of 132 km shoreline in length extends along Bay of Bengal from Bheemunipatnam (North) to Pentakota (South) which include mangrove vegetation in Thandava, Sarada, Gosthani river areas.

The CSD legumes have several value-added properties and applications. Usefulness of CSD legumes have been broadly divided into medicinal, pharmacological, industrial, nutritional and ecosystem restoration. Most traditional applications are related to treat skin

diseases and skin injuries (wounds, snake or spider bites). Some specific applications are directed to treat muscle sprain, gynecological problems and to improve the immunological responses. Usually topical applications are common to treat skin diseases or wounds and some involve oral administration.

Many studies have revealed that the medicinal importance of plants is mainly due to the presence of secondary metabolites, especially polyphenolic compounds and antioxidant vitamins, including ascorbic acid, tocopherol, β -carotene, flavonoids, tannins, anthocyanins, and other phenolic constituents (Jang *et al.*, 2007). Phenolics and flavonoids are the most important classes of secondary metabolites, synthesized under stress conditions and capable of scavenging free radicals, reducing cancer and have anti-aging properties (Ghasemzadeh and Ghasemzadeh, 2011).

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Bioactive compounds and phytochemicals of CSD plant species have numerous pharmacological applications (Morris, 1999). Research in the areas of marine natural products has grown geometrically in the recent past (Rawiwon *et al.*, 1990). However, the reports on the bioactive substances possessed by coastal sand dune plant species are very meager. Therefore, the present study is established to Identification and preparation of different phytochemical extracts from the CSDs using different solvents. Qualitative assessment of preliminary phytochemical screening from the CSDs phytochemical extracts. Quantitative assessment of some secondary metabolites from the CSDs phytochemical extracts and assessment of antioxidants in the obtained extracts of the CSDs phytochemical extracts.

Materials and Methods

Sand Dune Plants

All the plant materials selected by using previous work done, folklore reports and all the plant materials were collected from Visakhapatnam coast region and were identified with the help of Gamble, "Flora of the Presidency of Madras" and later verified by comparison with the authenticated specimens available in the herbariums of NBRI, Lucknow and the Department of Botany, Andhra University, Visakhapatnam. Collected ten Sand dune plant species were processed for bioactive chemicals based on the information available from literature (Warrier *et al.*, 1994).

Table 1: Detailed list of Sand Dune plant species used in the present study

Name of the Sand Dune	Family
<i>Ipomoea pes-caprae</i> (L.) R. Br	Convolvulaceae
<i>Spinifex littoreus</i> (Burm. f) Merr.	Poaceae
<i>Launaea sarmentosa</i>	Asteraceae
<i>Oldenlandia umbellata</i> L.	Rubiaceae
<i>Tribulus terrestris</i> L.	Zygophyllaceae
<i>Pedaliium murex</i> L.	Pedaliaceae
<i>Boerhavia diffusa</i> L.	Nyctaginaceae
<i>Tephrosia purpurea</i> (L.) Pers.	Fabaceae
<i>Hydrophylax maritima</i> L. f.	Rubiaceae

All the fresh and healthy sand dune plant species parts were washed with running tap water and double distilled water respectively for several times to remove all the dust and

unwanted visible particles, cut into small pieces and dried at room temperature and then shade dried for 3 to 5 days, and was powdered by using mechanical grinder and then stored for further investigations.

Preparation of Plant extracts

Plants are complex matrices, producing a range of secondary metabolites with different functional groups and polarities. Although water is used as an extractant in many traditional protocols, organic solvents of varying polarities are generally selected in modern methods of extraction to exploit the various solubilities of plant constituents. Soxhlet extraction is widely used for both initial and bulk extraction. Its main advantage is that the material is extracted continuously, i.e., the solvent saturated in solubilized metabolites empties into the flask, fresh re-condensed solvent then re-extracts the material in the thimble. This method is less time and solvent consuming than maceration or percolation.

100 grams of ground weighed material of fine coarse powder was successively extracted by different solvents of hexane, chloroform and methanol, in a specific sequence based on increasing polarity. The soxhlet hot extraction procedure for each of the above solvents was run for about 6 hours, until a colorless solvent was seen in the siphon tube, which indicated complete extraction. The solvents were removed under reduced pressure and controlled temperature by rotary evaporator. The extracts were dried and stored in a clean glass bottle and kept at 2 to 8 degree centigrade for antimicrobial screenings and further investigation.

Physicochemical parameters

The physicochemical parameters were used to analyze the purity and quality of the extract. The extracts were evaluated for parameters like loss on drying, total ash and extractive values according to the methods recommended by the World Health Organization (WHO, 1998). Ash value is useful in determining authenticity and purity of drugs and these values are important for quantitative analysis. Studied plant

materials were evaluated by following physicochemical parameters.

Preliminary phytochemical investigation

The extracts of phytochemical analysis for identification of bioactive chemical constituents were carried out by using standard methods of Sofowora and Kokate (Sofowora, 1993; Kokate *et al.*, 2004).

Antioxidant Studies

Ferric Reducing Antioxidant Power (FRAP) assay

Measurement of ferric reducing antioxidant power of the herbal extract was carried out based on the procedure of Benzie and Strain (1996). Absorbance of the reaction mixture was recorded at 593nm (Wang *et al.*, 2014). The standard curve was constructed using FeSO₄ solution, and the results were expressed as μmol Fe (II)/g dry weight of herbal material.

DPPH radical scavenging assay

Free radical scavenging is one of the mechanisms involved in antioxidant action, a good antioxidant (AH) able to scavenge the DPPH (1,1 Di phenyl 2-picryl hydrazyl) radical and retain its own stability due to its reduction ability as shown in the equation below.



2ml of extract solution of different solvent (Hexane, chloroform and methanol) was taken in different concentration (5, 50, 100 and 400 μg) to which 2ml of 0.4 mM/1 DPPH methanolic solution was added. Solution containing 2ml of methanol and 2ml of the DPPH solution was used as negative control and synthetic antioxidant ascorbic acid was used as positive control. Different concentrations were kept in the dark at room temperature for 30 minutes. The scavenging activity of the DPPH was determined by measuring the absorbance at 517 nm until the reaction reached the steady state, using a spectrophotometer. All the determination was performed five times.

The DPPH radical scavenging activity was calculated using the following equation.

$$\% \text{ inhibition} = (1 - A_1/A_0) \times 100$$

A₁ and A₀ are the absorbance of the tested sample and control respectively.

Results

A total of ten sand dune plant species were subjected to Physicochemical, Phytochemical, antioxidant studies.

Physicochemical properties

Analysis of physicochemical studies of the crude extracts will evaluate the quality and purity of the extracted compounds from plant materials. Various physicochemical parameters like extractive values, ash content and loss on drying were calculated as per WHO guidelines. The information collected from these tests was useful for obtaining the quality standards. The results of the physicochemical constants of ten sand dune plant species lie within the limit which is mentioned in below table signifies that the quality and purity of raw material was good enough.

Extractive Values

As a part of this study, initially plant extractives were analyzed to estimate the percentage yield of individual extracts and found that, the yield was abundant in methanol rather than chloroform, hexane and water. Due to the high polarity of methanol most of the chemical constituents of extracts would be dissolved in it and thus percentage yield was increased tremendously than other solvents. Due to higher yield in methanol, methanol extracts were selected for further studies.

Table 2: Percentage of Extractive Values of ten Sand dune Plant species

Plant Name	% of Extractive Value
<i>Ipomoea pes-caprae</i>	34.60
<i>Spinifex littoreus</i>	24.25
<i>Launaea sarmentosa</i>	29.06
<i>Oldenlandia umbellata</i>	16.42
<i>Tribulus terrestris</i>	30.56
<i>Pedaliium murex</i>	20.78
<i>Boerhavia diffusa</i>	22.60
<i>Tephrosia purpurea</i>	18.34
<i>Hydrophylax maritima</i>	25.10
<i>Lantana camara</i>	17.32

The percent extractive values from the ten sand dune plant species is ranging from 16.42 to 34.60. The maximum percent yield of extractive value was noticed in *Ipomoea pes-caprae* i.e., (34.60) while the minimum was recorded in *Oldenlandia umbellata* (Table 2)

Loss on drying (LOD)

The loss of weight was calculated as the content in mg per gram of air-dried material. The percent loss on drying was then calculated for each plant powder. The results obtained were reported in Table 3. Percent of loss on drying was highest in *Hydrophylax maritima* (9.0) and minimum in *Ipomoea pes-caprae* (4.55).

Table 3: Percentage of Loss on Drying of ten Sand Dune Plant species

Plant Name	% Loss on Drying
<i>Ipomoea pes-caprae</i>	4.55
<i>Spinifex littoreus</i>	8.22
<i>Launaea sarmentosa</i>	5.28
<i>Oldenlandia umbellata</i>	6.40
<i>Tribulus terrestris</i>	3.90
<i>Pedaliium murex</i>	9.11
<i>Boerhavia diffusa</i>	8.80
<i>Tephrosia purpurea</i>	7.90
<i>Hydrophylax maritima</i>	9.00
<i>Lantana camara</i>	6.80

Total Ash content

Ash usually represents the inorganic part of the plant. The total ash method is designed to measure the total amount of material remaining after ignition. In the evaluation of crude extracts, total ash value is particularly important in the evaluation of purity of drugs, i.e. the presence or absence of foreign inorganic matter such as metallic salts or silica. The ash values of ten sand dune plant species were determined and the results were shown in table 4. The amount and composition of ash

remaining after combustion of plant material varies considerably according to the part of the plant, age and treatment etc. The constituents of ash also vary with time and from organ to organ. In the present study we found the percentage of total ash content was highest in *Spinifex littoreus* (18.33) and lowest was recorded in *Ipomoea pes-caprae* (6.0).

Table 4: Percentage of Total Ash of Ten Sand dune plants

Plant Name	% Total Ash
<i>Ipomoea pes-caprae</i>	6.00
<i>Spinifex littoreus</i>	18.33
<i>Launaea sarmentosa</i>	6.43
<i>Oldenlandia umbellata</i>	14.50
<i>Tribulus terrestris</i>	7.42
<i>Pedaliium murex</i>	11.16
<i>Boerhavia diffusa</i>	15.75
<i>Tephrosia purpurea</i>	13.43
<i>Hydrophylax maritima</i>	9.50
<i>Lantana camara</i>	9.37

Phytochemical screening:

Qualitative phytochemical tests for the identification of different phytochemicals present in all the extracts of the ten sand dune plant species. These tests were carried out in triplicate using various concentrations of sample. Solvents of hexane, chloroform and methanol extracts were subjected to phytochemical analysis to ascertain the presence of metabolites such as alkaloids, cardiac glycosides, coumarins, flavonoids, glycosids, phenols, quinones, tannins, terpenoids, saponins and steroids (Table 5). In the present study, the majority of sand dune plant species expressed positive results for all the phytochemicals tested in the present study. This obtained information will be helpful as a primary platform for further phytochemical and microbial studies.

Table 5: Preliminary phytochemical screening of ten Sand Dune Plants hexane, chloroform and methanol extracts

Plant Name	Solvent	Alkaloids	Cardiac Glycosids	Coumaris	Flavonoids	Glycosids	Phenols	Quinones	Tannins	Terpenoids	Saponins	Steroids
<i>Ipomoea pes-caprae</i>	Hexane	+	-	-	+	+	+	-	+	+	+	-
	Chloroform	+	+	-	+	+	+	+	+	-	+	+
	Methanol	+	+	+	+	+	+	+	+	-	+	-
<i>Spinifex littoreus</i>	Hexane	+	-	+	+	+	+	-	+	+	+	-
	Chloroform	+	+	+	+	+	+	-	+	+	+	-
	Methanol	+	+	-	+	-	+	+	+	-	+	+
<i>Launaea sarmentosa</i>	Hexane	+	-	+	+	+	+	-	+	-	+	-
	Chloroform	+	+	-	+	+	+	-	+	+	+	+
	Methanol	+	+	-	+	+	+	-	+	+	+	+
<i>Oldenlandia umbellata</i>	Hexane	+	-	-	+	+	+	+	+	-	+	-
	Chloroform	+	+	-	+	+	+	+	+	-	+	-
	Methanol	+	+	-	+	+	+	-	+	+	+	-
<i>Tribulus terrestris</i>	Hexane	+	-	-	+	-	+	-	+	+	+	-
	Chloroform	+	-	-	+	+	+	-	+	+	+	-
	Methanol	+	-	-	+	-	+	-	+	+	+	-
<i>Pedaliium murex</i>	Hexane	+	-	-	+	-	+	-	+	-	+	-
	Chloroform	+	-	-	+	+	+	-	+	+	+	-
	Methanol	+	+	-	+	+	+	-	+	+	+	+
<i>Boerhavia diffusa</i>	Hexane	+	+	-	+	+	+	-	+	-	+	+
	Chloroform	+	-	-	+	+	+	-	+	+	+	+
	Methanol	+	-	+	+	-	+	+	+	+	+	-
<i>Tephrosia purpurea</i>	Hexane	+	-	-	+	+	+	-	+	+	+	-
	Chloroform	+	-	+	+	-	+	-	+	+	+	-
	Methanol	+	+	+	+	+	+	+	+	+	+	-
<i>Hydrophylax maritima</i>	Hexane	+	+	-	+	+	+	-	+	-	+	+
	Chloroform	+	+	-	+	+	+	+	+	+	+	-
	Methanol	+	+	-	+	+	+	+	+	+	+	-
<i>Lantana camara</i>	Hexane	+	-	+	+	-	+	-	+	+	+	-
	Chloroform	+	-	+	+	-	+	-	+	+	+	-
	Methanol	+	+	+	+	+	+	+	+	+	+	-

Quantitative determination of Phytochemicals

Based on the Preliminary phytochemical analysis for the presence or absence of metabolites such as alkaloids, cardiac glycosides, coumarins, flavonoids, glycosids, phenols, quinones, tannins, terpenoids and saponins were carried out in the ten sand dune plant species. The most biologically active phyto-compounds such as Alkaloids, Phenolics, Flavonoids and Saponins were quantified from all the sand dune plant species hexane, chloroform and methanol extracts.

Alkaloids

The alkaloids are believed to function as defensive elements against predators, especially

mammals because of their general toxicity and deterrence capability as well as analgesic, anti-inflammatory and adaptogenic activities which help to alleviate pains, developed resistance against diseases and endurance against stress. The alkaloid contents was examined in plant extracts and expressed in terms of atropine equivalent as mg of AE/g of extract. The methanol extracts showed superior alkaloid contents over hexane and chloroform extracts of all the sand dune plants. The highest concentration of alkaloid was recorded in methanol extracts of *Ipomoea pes-caprae* i.e. (36.07 mg of AE/g) whereas lowest was observed in the hexane extracts of *Oldenlandia umbellata* 1.18 mg of AE/g.

Total Phenolic Contents

The plant derived polyphenolic compounds are promising nutraceuticals for control of various disorders such as cardiovascular, neurological and neoplastic disease. The total phenolic contents in the examined plant extracts using the Folin-Ciocalteu's reagent is expressed in terms of gallic acid equivalent. The values obtained for the concentration of total phenols are expressed as mg of GA/g of extract. In the present study the ten sand dune plant species hexane, chloroform and methanol extracts results exhibited that methanolic extracts showed significantly higher phenolics content over hexane and chloroform extracts. The total phenolic contents in the examined extracts was ranging from 3.27 to 115.33 mg of GAE/g. the sand dune *Ipomoea pes-caprae* methanol extracts showed maximum total phenolics content i.e. (115.33) over other extracts of the other sand dune plant species of the present study.

Total Flavonoids content

Flavonoids have been referred to as nature's biological response modifiers because of strong experimental evidence of their inherent ability to modify the body's reactions to allergies, virus and carcinogens. Flavonoids are a class of secondary plant metabolites with significant antioxidant and chelating properties. Antioxidant activity of flavonoids depends on the structure and substitution pattern of hydroxyl groups. All the studied plant extracts showed good concentration of flavonoids in particular the methanol extracts expressed higher concentration of flavonoids in all the sand dunes of the present study. Among the ten sand dunes the *Ipomoea pes-caprae* noticed with highest flavonoid contents in the methanol extracts i.e. (198.75) over the remaining sand dunes.

Saponins

The saponins are widely distributed in the botanical kingdom and has many pharmacological and biological activities. Saponins from plants sources are also responsible for some pharmacological effects like anti-inflammatory, molluscicidal, antimicrobial, antispasmodic, anti-diabetic, anti-cancer, hypocholesterolemic, antioxidant,

anticonvulsant, analgesic, antihelmintic, antitussive and cytotoxic activities. In the present study the saponins concentration ranging from 10.64 mg/g to 74.51 mg/g from all the sand dunes all the extracts i.e., hexane, chloroform and methanol. The methanol extracts of *Ipomoea pes-caprae* showed highest saponin content (i.e., 74.51 mg/g) while the minimum saponin contents was noticed in the hexane extracts of *Tribulus terrestris* (i.e., 10.64 mg/g).

Tannins

The tannins contents were examined in plant extracts using the Folin-Ciocalteu's reagent is expressed in terms of gallic acid equivalent. The values obtained for the concentration of tannin contents are expressed as mg of GAE/g of extract. The highest concentration of tannins was measured 48.07 mg of GAE/g of extract *Ipomoea pes-caprae* in methanol extracts and the lowest concentration of tannins was measured 5.29 mg of GAE/g of extract in *Tephrosia purpurea* in hexane extracts.

Antioxidant Studies

The antioxidant capacity of the plant extracts were largely depends on both the composition of the extract and the test system. It can be influenced by many factors and cannot be fully evaluated by one single method. It is necessary to perform more than one type of antioxidant capacity measurements to consider the various mechanisms of antioxidant action.

Ferric Reducing Antioxidant Power (FRAP) assay:

In the present study the Ferric Reducing Antioxidant Power (FRAP) values were higher in methanol extracted samples when compared to hexane and chloroform extracts Table 6. This showed that methanol extraction was more efficient in extracting antioxidants in plant materials compared to hexane, chloroform and water. There was a significant per cent FRAP values was noticed in the sand dune *Ipomoea pes-caprae* over rest of the sand dunes of the present study. The ferric abilities of the studied extracts in all solvent extracts were in the range of 19.5–88.6%, in comparison with ascorbic acid standard (Table 6.)

Table 6: Percent Ferric Reducing Antioxidant Power (FRAP) Assays on ten sand dune plant extracts

S.No.	Medicinal Plant	Hexane	Chloroform	Methanol
01.	<i>Ipomoea pes-caprae</i>	20.7±2.55	38.3±0.61	88.60±2.39
02.	<i>Spinifex littoreus</i>	39.2±0.37	26.16±0.03	64.42±2.55
03.	<i>Launaea sarmentosa</i>	22.2±0.10	42.6±0.02	47.83±2.40
04.	<i>Oldenlandia umbellata</i>	22.6±0.17	22.1±0.26	46.4±0.14
05.	<i>Tribulus terrestris</i>	19.7±2.22	56.6±0.37	70.4±0.18
06.	<i>Pedaliium murex</i>	35.5±1.16	30.6±0.01	78.5±0.89
07.	<i>Boerhavia diffusa</i>	25.2±0.39	47.3±1.41	69.6±0.37
08.	<i>Tephrosia purpurea</i>	28.6±2.39	19.5±1.41	48.6±0.17
09.	<i>Hydrophylax maritima</i>	25.2±1.52	47.3±0.10	69.6±0.09
10.	<i>Lantana camara</i>	28.6±1.67	19.5±2.90	48.6±2.40
11.	Ascorbic acid		96.59 ± 0.07	

Values are Mean ± Standard Error

Free Radical Scavenging activity by DPPH Assay

The antioxidant activity of different plant extracts were screened using a methanol solution of DPPH reagent. The antioxidant activity was expressed in terms of percentage of inhibition (%). The effect of antioxidants on DPPH is thought to be due to their hydrogen donating ability. The observed activities indicate that the plant powder serve as a strong proton donating ability and could serve as free radical scavengers and further acting as primary antioxidants.

DPPH assay is based on the measurement of the scavenging ability of antioxidants towards the

stable radical DPPH. It is considered a valid and easy assay to evaluate the radical-scavenging activity (RSA) of antioxidants. The DPPH scavenging activities of 10 sand dune plant species in various solvent extracts were shown in table 7. The DPPH scavenging activities of the studied plant extracts were increased with the increase of volumes from 5-20µl and hardly changed after 25µl. However, the DPPH scavenging activities of the majority extracts continually increased and are ranging from 17.11% to 91.75% from all the solvent extracts. On the other hand the methanol extracts of the sand dune *Ipomoea pes-caprae* showed highest DPPH radical scavenging activity i.e. (91.75%) than the other sand dunes of the present study.

Table 7: DPPH Radical Scavenging Properties of ten sand dune plant extracts

S.No.	Medicinal Plant	Hexane	Chloroform	Methanol
01.	<i>Ipomoea pes-caprae</i>	71.21±0.25	65.62±0.14	91.75±0.82
02.	<i>Spinifex littoreus</i>	17.11±0.55	23.21±0.21	55.79±1.72
03.	<i>Launaea sarmentosa</i>	47.10±1.21	61.50±0.24	87.73±0.66
04.	<i>Oldenlandia umbellata</i>	41.10±1.06	28.50±0.14	78.75±0.49
05.	<i>Tribulus terrestris</i>	20.11±0.98	31.51±0.14	65.71±1.52
06.	<i>Pedaliium murex</i>	43.64±1.94	57.50±1.21	69.10±0.21
07.	<i>Boerhavia diffusa</i>	23.33±0.56	49.76±0.19	77.25±0.21
08.	<i>Tephrosia purpurea</i>	33.56±1.23	55.62±0.46	37.62±0.21
09.	<i>Hydrophylax maritima</i>	33.56±1.23	55.62±0.46	37.62±0.21
10.	<i>Lantana camara</i>	33.56±1.23	55.62±0.46	45.62±0.21
11.	Ascorbic acid		99.10±1.06	

Values are Mean ± Standard Error

Discussion

Infectious diseases and Cancer are major cause of health-related issues and deaths in India. The number of non responsive anti cancer therapeutics and multi drug resistant microflora

and the appearance of the strains with reduced susceptibility to antibiotics are continuously increasing. This situation provided the impetus to the search for new anti cancer and antimicrobial substances from various sources like plants. It is important to investigate

scientifically these plants which have been used in traditional medicines as a potential source of novel anti cancer and antimicrobial compounds. The potential for developing novel therapeutics from higher plants appears rewarding as it will lead to the development of phytomedicines to act against various cancer and multidrug resistant diseases. Plant based drugs have enormous therapeutic potential as they can serve the purpose with lesser side effects that are often associated with synthetic antimicrobials (Iwu *et al.*, 1999).

In order to assess the quality and purity of any drug innovation, standardization process is essential. Standardization process includes phyto, physicochemical analysis is necessary for identification, authentication and detection of adulteration and compilation of quality control of crude extracts. Extractive values are primarily useful for the determination of exhausted and adulterated drugs. It is also useful to evaluate the chemical constituents present in crude drug and helps in determination of specific constituents soluble in particular solvents.

Total ash value is important in the evaluation of quality and purity of drugs, i.e. the presence or absence of foreign inorganic matter such as metallic salts and/silica (Musa *et al.*, 2006). The amount and composition of ash remaining after combustion of plant material varies considerably according to the part of the plant, age and treatment etc. The constituents of ash also vary with time and from organ to organ. It contains inorganic material of the plant because ashing destroys all the organic material present in the sample. Ash values mainly reflect the presence of high inorganic content. However, the ash content is possibly due to the Na⁺ and Ca²⁺ salts which are not harmful. Heavy metals are being spoken out vary widely in the global scenario, due to the recent episodes of a few Indian Ayurvedic formulations which have been found to have heavy metals more than that of the permissible level as advised by WHO and FAO. But in our study the percentage of macronutrients like sodium, potassium and magnesium were within the stipulated limits. Toxic heavy metals like arsenic, lead, palladium

and mercury were within the limit and ensure the safety of the study.

Many researchers have studied and analyzed the influence of various types of solvents, such as hexane, chloroform, methanol and ethyl alcohol, for the purpose of bioactive compounds from various plants parts. Solvents used for the extraction of biomolecules from plants are chosen based on the polarity of the solute of interest. The polarity from least polar to most polar, of a few common solvents is from low polar to high polar such as follows: Hexane < Chloroform < Ethylacetate < Acetone < Methanol < Water. Researchers have discovered that highly polar solvents such as methanol have a high effectiveness

Most of the plant secondary metabolites are bioactive chemicals and are synthesized from all components of the plant's body: bark, leaves, stems, roots, flowers, fruits, seeds, etc. (Lalitha and Jayanthi, 2012). They have been recognized as the basis for traditional herbal medicine practiced in the past and now (Govindarajan *et al.*, 2005). All plant parts are usually screened for phytochemicals, the presence of a phytochemical of interest may lead to its further isolation, purification, and characterization. Then it can be used as the basis for a new pharmaceutical product.

Several earlier reports correlated the plant phytochemicals with their bioactive attributes and reported the antibacterial and free radical scavenging activities of the phytochemical constituents (Medini *et al.*, 2014). The quantity of phytochemical components may vary with the plant part, leaf and stem (Patra *et al.*, 2011). Saponins are liable for precipitation and coagulation of red blood cells, cholesterol binding, haemolytic activity, froth formation in aqueous solutions and bitterness. On the other hand, flavonoids are cogent water-soluble antioxidants and free radical scavengers which can avert oxidative cell damage. Besides, they are also known to have strong anticancer activity. Steroidal components are of great prominence in pharmacological aspect because of their

association with sex hormones (Okwu, 2004). Alkaloids are in use as primary medication agents for antispasmodic, analgesic and antibacterial effect. Phenolic constituents generally observed in plants are stated to have potential antioxidant and antimicrobial activities. Different phenolic compounds such as tannins existing in plant cells are effective inhibitors of hydrolytic enzymes used by plant pathogens. Several studies have been concentrated on the biological activities of phenolic compounds, which are acting as powerful antioxidants and free-radical scavengers (Devi *et al.*, 2011). The healing properties of medicinal plants are well recognized at worldwide level, particularly for antibiotic development.

Coastal sand dunes are found in various parts of the world. They are natural structures that safeguard the coastal environment by absorbing wind, tide and wave power (Corre Jean Jacques, 1991). The coastal biota is wealthy in plant resources, with many species of economical medicinal plants and local community relies on the Coastal Sand Dunes for most of their needs. (Subudhi *et al.*, 1992) Several direct and indirect uses of CSD plant species are unnoticed as they are used in traditional medicinal practices. Many legumes of CSDs of west coast of India are useful as green manure, mulch, cover crops, fodder, pasture legumes, oil yield and medicinal value (Arun *et al.*, 1999). The extractives were analyzed to estimate the percentage yield of individual extracts and found that, the yield was abundant in methanol rather than chloroform and hexane. Due to the high polarity of methanol most of the chemical constituents of extracts would be dissolved in it and thus percentage yield was increased tremendously than other solvents.

The ten sand dune plant species showed the maximum extractive in methanol extracts of all the ten sand dunes in the order of *Oldenlandia umbellata* < *Lantana camara* < *Tephrosia purpurea* < *Pedalium murex* < *Boerhavia diffusa* < *Spinifex littoreus* < *Justicia procumbens* < *Launaea sarmentosa* < *Tribulus terrestris* < *Ipomoea pes-caprae* on the other hand the loss on drying was

observed is less than 10% in all the sand dune plant species. Further the total ash content in the studied sand dunes is ranging from 6.00 to 18.33% and in the preliminary phytochemical screening all the sand dune plant species showed positive indications for all the studied phytochemicals i.e., alkaloids, cardiac glycosides, coumarins, flavonoids, glycosids, phenols, quinones, tannins, terpenoids, saponins and steroids. These results were agreed with the previous reports on the studied sand dunes reported by several workers (Raja and Venkataraman, 2011; Amritha *et al.*, 2019).

The present study the ten sand dune plant species showed moderate to good antioxidant activity which is fairly correlated with the previous reports on different sand dune plant species (Hatipoglu *et al.*, 2013). Among the ten sand dunes the *Ipomoea pes-caprae* expressed higher antioxidant values than the other sand dune plants of the present study and also earlier reports on this sand dune (Umamaheshwari *et al.*, 2012)

Conclusion

Herbal drugs play an important role in healthcare programme especially in developing countries. There is a need for documentation of research work carried out on traditional medicine and also it becomes extremely important to make an effort towards standardization of plant materials to be used as medicine. Secondary metabolites are the molecules that are not necessary for the growth and development of plants, but may serve some role in the plant defense mechanism. They act as phytoalexins, killing microorganisms which are recognized on a threat.

The costal Visakhapatnam sand dune species are highly significant resources that play a crucial part in neighboring people's financial and social lives. Conservation and judicious use of these coastal riches of plants is essential because they are threatened by over-exploitation, industrialization forest clearing, fast urbanization, fish farming, human settlements, etc. As their foundation sand surfaces are always washed away by river or sea water, the vegetation cover of ancient dunes


should be shielded. The inventory of 10 plant species used in the present study sheds some light on these species medicinal significance.

The obtained all extracts of all the ten sand dune plant species extracts were assessed with physicochemical parameters, i.e., Extractive values, Total ash content and Loss on drying where the sand dune *Ipomoea pes-caprae* showed good values over the remaining sand dunes. All the hexane, chloroform and methanol extracts of all the ten sand dune plant species were screened for preliminary phytochemicals were found various phytochemicals available in sand dunes viz., alkaloids, cardiac glycosides, coumarins, flavonoids, glycosids, phenols, quinones, tannins, terpenoids, saponins and steroids

The hexane, chloroform and methanol extracts of all the ten sand dune plant species were quantified for alkaloids, total phenolic, total flavonoids, tannins and saponins contents, antioxidant activity with DPPH and FRAP assays where the sand dune *Ipomoea pes-caprae* gave better antioxidant activities over the rest of the sand dunes.

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