1. MEDICINAL AND AROMATIC PLANTS

The indispensible role of natural products as a source of medicine in treatment of various
diseases cannot be over-ruled owing to its lesser side effects and natural origin. Sources
of natural product can be both terrestrial and aquatic which include plants and
microorganisms. Therefore, Natural products have been used in modern medicines either
alone or in combination with synthetic drugs [1-5]. The importance of natural products to
be used in medicines is due to their diversity in structures. Many diseases have been
cured or prevented by them and their frequent usage [7]. Likewise, long synthetic routes,
high costs and low yield of synthetic products further enhanced the importance of natural
products. In addition as they have synthesized in living systems, natural products are
more biological friendly than synthetic ones [8]. Biological friendliness makes them ideal
candidates for drug development [9]. Drugs introduced in market from last 25 years
present the great contribution of natural products [10,11] suggesting that natural products
act as a good starting material for new drugs development.

Medicinal and aromatic plants are reservoirs of curative elements used by a large
population in the treatment of various diseases such as malaria, diabetes, mental
disorders, Hypertension, Human immunodeficiency virus/Acquired immunodeficiency
syndrome and cancer. These medicinal and aromatic plants are used on the basis of
ethanobotanical evidences for being safer, acceptable, affordable, culturally compatible
and suitable for chronic treatment. Phytochemical screening of the plants revealed that
they contain bioactive substances such as Alkaloids, Flavonoids, Saponins with
therapeutic potential [12].

The chemical constituents of medicinal and aromatic plants can be found either in the
roots, leaves, stems, flowers or bark which can be separated using an appropriate
extraction technique. Plant selection for new drug discovery can be performed through
phytochemical analysis, conduction of bioassays on experimental model, ethanobotanical
proofs and biological activities reported in the plant. Besides, the benefits obtained from
plants, some of them have few undesirable side effects and complications which may be
due to over dosing and related factors. This may often result in acute toxicities but when these problems are cautiously addressed, it will assist to harness the therapeutic effectiveness of medicinal and aromatic plants for future new drug development [13].

2. CANCER

Cancer is one of the major health hazard in both already developed and developing countries. Because of high death rate associated with cancer and because of serious side effects of chemotherapy along with radiation therapy, many cancer patients turn to alternative methods of treatment. More than 50% of modern drugs in clinical use are of natural products. Cancer is the abnormal growth of cells in our bodies that can lead to death. It is a complex disease that is normally associated with a wide range of escalating effects both at the molecular and cellular levels. It therefore appears unprobable that chemoprevention follows simple rules. The old saying "Prevention is always better than cure" is absolutely true in the case of malignancies where a cure, if ever possible, is associated with high cytotoxic loads followed by invasive procedures [14].

2.1 Research related to cancer

Cancer is a fatal disease characterized by uncontrolled and abnormal growth which involves spread of abnormal cells which can result in death [15, 16]. Cancer is a major public health problem worldwide with millions of new cancer patients diagnosed each year and many deaths resulting from this disease. [17] Cancer is predominantly a disease of regulation of tissue growth. A normal cell requires alteration of genes which regulate cell growth and differentiation [18]. Oncogenes may be normal genes which are expressed at high levels, or altered genes which have altered new characteristics. However, expression of these genes promotes the malignant phenotype of cancer cells. Tumor suppressor genes are genes which cause inhibition of cell division. Typically, changes in many genes are required to transform a normal cell into a cancer cell [19].

2.2 Itiology of cancer

Cancer is a dangerous disease which can be caused by both external exposure like tobacco and other harmful chemicals, radiation and infectious organisms along with
internal changes like mutations. The use of plant extracts in the treatment of cancers is of immense value in the control of malignancies, due to the severe side effects of anticancer drugs which affect the normal cells [20, 21]. Plant secondary metabolites and their semi-synthetic derivatives continue to play an indispensible role in anticancer therapy [22].

These include vinblastine, vincristine, topotecan and irinotecan, etoposide, derived from herbals. Sixty percent anticancer agents in current use are obtained from natural sources [23]. In this view of the continuing need for potential anticancer agents and the association of fruit and vegetable consumption with reduced cancer risk, edible plants are been exploited as sources of anticancer drugs [24, 25]. In this light, in present research work it has been tried to build a correlation between the plant constituents and the anticancer activity.

2.3 Prevention of cancer

The common treatment strategies for cancer involve either cure or increase in quality of life of the patients i.e. palliative treatment. The first FDA approved chemopreventive agent was tamoxifen for breast cancer. But with tamoxifen, there is an increased risk of serious side effects such as uterine cancer. The adverse effect of the FDA approved chemopreventive drugs is an issue of high concern when assessing long-term administration of a drug to healthy people who may or may not develop cancer in future. This clearly points towards the need for agents, efficacious in preventing cancer and reducing the side effects. Diet derived natural products have been proved to be potential candidates. [26].

It has been found that most of the antitumor drugs lack tumor specificity and multidrug resistance. Therefore, the search for potent, safe and selective anticancer compounds is crucial for new drug development in cancer research. Natural products provide templates for the discovery of novel compounds. It is well established that plants have been a useful source of clinically relevant antitumor compounds [27, 28]. For example, Hartwell has collected data on a no. of plants which possess anticancer properties [29, 30, 31]. Keeping a view on above facts, in present research work, the extract and its fractions have been investigated by in vitro assay on the cancer causing cell lines along with normal cell lines.
2.4 Plant based anticancer agents in clinical use

The isolation of the Vinblastine and Vincristine from *Catharanthus roseus*, introduced a new beginning of plants as source of anticancer agents. These were the first agents to come into clinical use for the treatment of cancer. The discovery of Paclitaxel (Taxol) from the bark of the Pacific Yew, *Taxus brevifolia* is another evidence of the success in natural product drug discovery.

*Taxus bacatta* was reported to be used in the Indian Ayurvedic medicine for the treatment of malignancy. The structure of Paclitaxel was elucidated in 1971 and was clinically introduced to the U.S market in the early 1990 [32]. Camptothecin, isolated from the Chinese ornamental tree *Camptotheca acuminate*, was advanced to clinical trials by N.C.I in the 1970 [33-34]. Topotecan and irinotecan are semi-synthetic derivatives of camptothecin and are used for the treatment of ovarian and small cell lung cancer, and colorectal cancer, respectively [35]. Epipodophyllotoxin, which was isolated as an anti-tumor agent from the roots of *Podophyllum peltatum* and *Podophyllum emodi* [36].

Etoposide and teniposide are two semi-synthetic derivatives of epipodophyllotoxin and are used in the treatment of lymphomas and bronchial and testicular cancers [37].

Homoharringtonine, isolated from the Chinese tree *Cephalotaxus harringtonia* var. *drupacea*, is another plant-derived agent in clinical use [38]. A racemic mixture of harringtonine and homoharringtonine has been used successfully in China for the treatment of acute myelogenous leukemia and chronic myelogenous leukemia [39].

2.5 Literature review of antioxidant activity on different plants

Oxidative stress results in the damage to membrane lipids, DNA and cellular organelles leading to the development of cancer. The phenolics, mainly the flavonoids, have high antioxidant potential due to its properties of oxidation-reduction which plays an important role in the adsorption or neutralization of free radicals showing raised biological protection [40]. Since free radicals are involved in the establishment of cancer, the methanolic crude extracts of some commonly used medicinal plants were screened for their free radical scavenging properties using ascorbic acid as reference antioxidant. Free radical scavenging activity was evaluated using 1, 1-diphenyl-2-picrylhydrazyl (DPPH)
free radical. The antioxidant activity of green tea (*Camellia sinensis* Linn.) was the strongest, followed by *Camellia sinensis*, *Eugenia caryophyllus*, *Zingiber officinale* and *Piper nigrum*. All the methanolic extracts exhibited antioxidant activity to significant levels. The IC\textsubscript{50} values of the methanolic extracts varied between 6.7 ± 0.1 and 681.5 ± 8.4\mu g/ml and that of ascorbic acid was 8.9±0.1 \mu g/ml. The study reveals that the consumption of these spices would exert several beneficial effects by virtue of their antioxidant activity [41].

Lotus rhizome powder was extracted with different solvents of varying polarities. Antioxidant activities of the extracts were evaluated by a β-carotene bleaching assay which was compared with that of ascorbic acid. Methanol showed the highest extract yield [42].

Sun spurge seedlings (*Euphorbia helioscopia*, L.) were collected from the north of Tunisia. Dried plant parts namely flowers, leaves and stem were extracted with polar solvents. Extracts were screened for their antioxidant activity using the DPPH free radical assay. Total phenolics and total flavonoids were then measured [43].

Antioxidant properties of total methanol extracts from 54 species of 30 families were studied. DPPH (1,1-diphenyl-2-picryl hydrazyl) radical was used for evaluation of free radical scavenging. Among tested species, the extracts of *Rumex crispus* (radix), *Rubus occidentalis* (folia), *Rumex alpines* (radix), *Euphorbia helioscopia* (herba) and *Rubus idaeus* (folia), exhibited the strongest activity. Significant radical scavenging activity was found also in the extracts of *Echium vulgare* (herba), *Plantago arenaria* (herba), *Viola tricolor* (folia), *Pyrus communis* (folia), *Sideritis montana* (folia), *Betula pendula* (folia), *Achillea crimifolia* (herba), *Santolina rosmarinifolia* (herba), *Morus alba* (folia) and *Erigeron canadensis* (herba). Moderate activity was shown by extracts of *Forsythia* (folia), *Bryonia alba* (folia), *Hepatica nobilis* (folia), *Plantago cornuti* (folia), *Maclura cochinchinensis* (folia), *Cichorium inhybus* (herba) and *Caltha palustris* (herba)[44].

The study was designed to examine the *in vitro* antioxidant activities of various extracts of whole plant of *Mucuna pruriens*. The antioxidant activity was investigated by DPPH radical assay and Iron chelating activity with reference standard Rutin, Quercetin and EDTA. The extract of *Mucuna pruriens* was found to more effective in the DPPH
radical scavenging activity. The IC\textsubscript{50} value of the ethyl acetate extract of \textit{Mucuna pruriens} and Rutin were found to be 420\textmu g/ml and 480\textmu g/ml respectively [45].

2.6 Literature review of anticancer activity on different plants

Research is focusing on the search for new types of natural chemotherapeutic agents derived from plants which are proving to be excellent sources of novel compounds. The water extract of Opuntia ficus-indica plant was screened for cytotoxic activities by standard MTT assay against three cancerous viz., A\textsubscript{549}, HeLa and MCF-7 and a normal HEK\textsubscript{293} cell cultures. The successive water extract showed selective toxicity towards cancer cells. The successive aqueous fraction showed potent activity against HeLa cells with IC\textsubscript{50} 39.72\textmu g/ml and 85.63\textmu g/ml by MTT and SRB assay methods respectively and was comparatively nontoxic towards normal HEK\textsubscript{293} cell cultures. The aqueous extract had no activity against A\textsubscript{549} and MCF-7 cell cultures [46].

The present research article was aimed to study the cytotoxic activity of methanolic extracts of \textit{Artocarpus heterophyllus} plant by various \textit{in vitro} cytotoxic assays like MTT and SRB against different cell lines like HEK\textsubscript{293}, A\textsubscript{549}, HeLa and MCF-7. The IC\textsubscript{50} values of methanolic extract of \textit{Artocarpus heterophyllus} were found 35.26 \textmu gm/ml and 35.27 \textmu gm/ml against A\textsubscript{549} cell line by MTT and SRB assay methods respectively whereas this extract was found to be non toxic to normal cells (HEK\textsubscript{293}), proved that the methanolic extract exhibited significant anti cancer potential with no toxicity on normal cell line[47].

\textit{Tabernaemontana divaricata} a native of India and many other tropical regions is a common garden plant that has been used traditionally for treatment of a number of diseases. In the current study the hydroalcoholic extract of the flowers of the plant have been tested for anticancer activity. The extract was prepared by Soxhlet extraction method, petroleum ether and hydroalcohol were the solvents used. The \textit{in-vitro} anticancer studies were performed against human cancer cell line (HeLa) and MTT assay was used to analyze the cell growth inhibition. The results showed that the hydroalcoholic extract of flowers of \textit{T. divaricata} possessed a moderate amount of anticancer activity and the IC\textsubscript{50} value was greater than100 \textmu g/ml [48].
The phenolic-rich fraction of the EtOH extract was subjected to further fractionation, which led to the isolation of a new flavonoid (kampferol-8-C-7-O-β-diglucopyranoside). Whereas, betulin, friedelin, β-amyrin, scopoletin and coumarin were isolated from low polar fraction and identified according to its spectral data and comparison with the literature. Furthermore, the flavonoid compound (kampferol-8-C-7-O-β-diglucopyranoside) has given high cytotoxicity against Hela and MCF-7 cell lines. Also, cytotoxicity of the isolated known compounds was tested [49].

*Mentha spicata* is a herb with several pharmacological uses. Cytotoxicity of essential oils of *M. spicata* on some cancer cells has been known. In this study the cytotoxicity of aqueous extract of *M. spicata* on two tumor cell lines (Wehi-164 fibro sarcoma and U937 leukemic monocyte) has been evaluated *in vitro* [50].

In this study, cytotoxic activity of *Astragalus chrysochlorus* crude extracts was investigated. Hexane, chloroform, ethylacetate, 80% ethanol and water extracts prepared from roots and stems of *Astragalus chrysochlorus* were tested for cytotoxic activity on Vero (V) cells by the MTT reagent. MTT assay was used to investigate the reduction of viability of cell cultures in the presence and absence of the extracts. Cell viability was inhibited to different levels by the extracts. The hexane-root and water-stem extracts of *Astragalus chrysochlorus* were not cytotoxic at 500 μg mL-1. Both the ethanol-stem and water-root extracts exhibited weak cytotoxic activity. The hexane-stem, chloroform-root and stem, ethylacetate root and stem or ethanol-root extracts showed stronger cytotoxic activity than the others. However, the chloroform-root extract exhibited the most effective cytotoxic activity at 500 μg mL-1 (70.3 %) [51].

### 2.7 Literature review on correlation of antioxidant and anticancer activity on different plants

*Lobeliae chinensis*, *Rheum officinale*, *Sanguisorba officinalis*, *Agrimonia pilosa* and *Paris polyphylla* are well-known traditional Chinese medicines. In this study, the antioxidant and anticancer effects of water extracts of these herbs were tested. In the antioxidant and anticancer studies, water extracts of the plants were shown to be the most antioxidative and had the highest growth inhibitory effect on human lung adenocarcinoma A549 cell and human breast cancer MCF-7 cell. A linear relationship
between antioxidant activity and anticancer effect of the five herbal water extracts was found. This suggested that the antioxidants of the herbal water extracts might contribute to their anticancer effects on A549 and MCF-7 cells [52].

Fruit extracts from three strawberries were tested for the ability to inhibit proliferation of A549 human lung epithelial cancer cells. The fruit extracts also were tested for activities against free radicals. Correlations between the proliferation of cancer cells and these antioxidant activities were studied. *F. virginiana* fruit extract inhibited the proliferation of A549 human lung epithelial cancer cells to a significantly greater extent than the extracts from fruit. Extracts from fruit of *F. virginiana* had greater antioxidant activities and higher activities of antioxidant enzymes and nonenzyme components than did extracts from the other two species. There was a high positive correlation between antiproliferation of A549 cancer cells, antioxidant activities against free radicals [53].

The biological activities of garlic may be affected by different techniques of processing. This study, therefore, aimed to evaluate potential anticancer effects of different type of processed garlic extracts on tumor cells in inbred mice and correlate the tumor growth rates with some garlic constituents. Three weeks following tumor inoculation and the mean tumor size in garlic extract groups was reduced with significant reductions observed in the fresh and micro waved extract groups compared with the control group (P<.05). The antioxidant capacity and the amounts of allicin, flavonoids, and phenolics in differentially processed garlic were evaluated and correlated with their anticancer activities.

3. RESEARCH ENVISAGED

Interest in traditional medicines is not new but has been spurred in recent years by methodological advances in ethnobotanical and pharmacological studies. On practical ground herbal medicines beset with problems like misleading botanical identification, adulteration, variability in application of common standardization procedures and above all limited studies towards ascertaining the correct origin of the drug. Hence, scientific evaluation of herbal drugs with promising therapeutic use is very much essential.

The observation, identification and experimental investigation of the ingredients and the therapeutic effects of indigenous drugs are all interdisciplinary field of research.
Hence, it was aimed at an interdisciplinary study starting with Pharmacognosy, and Pharmacological studies. Based on the extensive medicinal claims of the plants the current research work was carried out in order to scientifically evaluate the folklore claims and to explore the unexplored phytochemical constituents since no scientific claim has been made on anticancer activity in these two plants.

The objectives of the present study were:

- To collect, identify and confirm the authenticity of the plant species (attach authentication)
- To obtain and develop pharmacognostical standards
- To perform chemical tests for various phytochemical constituents present in the plant extracts.
- To select therapeutically active extract by in-vitro pharmacological studies
- To isolate and identify the structure of the phytoconstituents from the methanolic extract.

On the basis of exhaustive literature survey, two plant drugs have been selected for the study:

(A) Aerial parts of *Digera muricata*, Amaranthaceae
(B) Dried seeds of *Cordia dichotoma*, Boraginaceae
3.1 Aerial parts of *Digera muricata*

- **Plant Profile**

3.1.1 Introduction

*Fig.1.1 Digera muricata*

*Digera muricata* (L.) of family *Amaranthaceae* is a wild edible plant commonly known as ‘latmahuria’. It is commonly distributed throughout the India. In Ayurveda, this herb is considered as a cooling, astringent to the bowels and also used as laxative.

The flowers and seeds are used to treat urinary discharges. Boiled root infusion given to mother after child birth for lactation purpose. *Digera muricata* is used in renal disorders in folk medicaments. Generation of free reactive radicals has been found in carbon tetrachloride-induced nephrotoxicity, which are found in lipid peroxidation along with accumulation of dysfunctional proteins, leading to injuries in kidneys. *Digera muricata* treatment augments the antioxidants defense mechanism against carbon tetrachloride induced toxicity and provides evidence that it may have a therapeutic role in free radical mediated diseases [54].
3.1.2 Taxonomic classification

<table>
<thead>
<tr>
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<tbody>
<tr>
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<td>Digera muricata</td>
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</table>

3.1.3 Vernacular names

**Common name:** False Amaranth

**Hindi:** Latmahuria, Lesua.

**Marathi:** Gitana, Getna.

**Tamil:** Toya keerai, Kaatu keerai.

**Telugu:** Chenchali koora.

**Kannada:** Chenchali soppu, Goraji palya, Kankali soppu.

**Sanskrit:** Aranya, Aranyavastuka, Kunanjara.

3.1.4 Geographical distribution

This weed flower is known as false amaranth. It is widespread in eastern tropical Africa, Madagascar and tropical and subtropical Asia. In India it is widely distributed in Andhra Pradesh and Maharashtra.

3.1.5 Botanical description

False Amaranth is an annual herb, growing to 20-70 cm tall. It is seen growing wildly in wasteland. Stems are simple or branched from the base, almost hairless. Alternately
arranged leaves which are linear to broadly ovate. Leaf stalks are long, base is narrowed and the tip is pointed. Flowers are present on slender spike-like racemes. The racemes are on a stalk that can be up to 14 cm long. Flowers are almost hairless, white mixed with pink colour, usually becoming greenish-white in fruit. Fruit are slightly compressed, 2-2.5mm, bluntly ribbed along each side and surmounted by a thick rim. Flowering occurs in between the month of August and September annually.

3.1.6 Phytoconstituents reported in *Digera muricata*

The primary metabolites like proteins, lipids, phenols, amino acids etc. of this plant in different solvent extracts have been investigated. The plant contains α- and β- spinasterol. Analysis of various fractions of the *Digera muricata* indicated the presence of flavonoids, saponins, coumarins, tannins, cardiac glycosides, alkaloids, anthraquinones and terpenoids. Rutin and Hyperoside flavonoids have been isolated from hexane extract of this plant [55].

3.1.7 Ethnobotanical Uses

The *Digera muricata* (L.) is a wild edible herb used by village people. It is popularly known for herbal remedy for various ailments. In Ayurveda, this herb is considered as cooling, astringent of bowels and also used as a laxative. The leaves are used for treatment of diabetic. But the scientific basis for its medicinal use especially for boiled root infusion given to mother after child birth to increase lactation purpose is to be investigated. The flower and seeds are used to treat urinary discharges. Ethyl alcohol extract of plant is diuretic. The whole plant is used in digestive system disorders. The leaves and young shoots of this plant are locally used as a vegetable and given to relieve constipation. The whole plant is used in urinary disorders. The extract of this plant used in biliousness and in urinary discharges [56, 57].

3.1.8 Phytochemical literature review

- **Khan M.R et al., 2011,** performed preliminary phytochemical investigation which revealed the presence of tannins, flavonoids, alkaloids, glycosides as the major constituents in the methanol extract [56].
Khan M.R et al., 2011, *Digera muricata* is considered as an edible green leafy vegetable. Fifty six percent edible portions are present in this weed. This plant is a rich source of magnesium, calcium, phosphorus, iron, potassium [56].

Mathad P. et al., 2010, performed the successive soxhlet extraction of *Digera muricata* (L.) Mart. (Amaranthaceae) using petroleum ether, chloroform, ethanol and distilled water in ascending order of the polarity. These extracts were screened by phytochemicals tests. The results indicate the presence of flavonoids, phenols, alkaloids, tannins and saponins [58].

### 3.1.8 Pharmacological literature review

Khan M.R. et al., 2011, evaluated Protective potential of methanol extract of *Digera muricata* on Acrylamide induced hepatotoxicity in rats. This study was aimed to evaluate the probable protective effects of *Digera muricata* methanol extract against acrylamide induced hepatocellular injuries in female Sprague-Dawley rat. In conclusion, the results suggest that the hepatoprotective effects of methanolic extract against acrylamide induced oxidative injuries could be attributed to the phenolics and flavonoids. Phytochemical screening for the presence of different bioactive chemical groups was also carried out [56].

Khan M.R et al., 2011, evaluated antioxidant and fertility effects of *Digera muricata* in male rats. The methanolic extract suggested to have therapeutic effects against carbon tetrachloride induced oxidative stress and hypogonadism. Treatment of carbon tetrachloride, 1 ml/kg b.w. (10% in olive oil) to Sprague-Dawley male rats once a week for 16 weeks caused a significant increase in serum level of Alanine transaminase, lactate dehydrogenase, Alkaline phosphatase, cholesterol, low density lipoprotein direct bilirubin and prolactin whereas suppressed level of testosterone were restored with the administration of n-hexane extract of *Digera muricata* [57].
Khan M.R. et al., 2011, performed prevention of carbon tetrachloride -induced oxidative damage in adrenal gland by *Digera muricata* extract in rat against carbon tetrachloride -induced oxidative stress in adrenal gland of Sprague-Dawley male rats [59]. These results indicate that *Digera muricata* extract is able to ameliorate oxidative stress in adrenal gland induced by carbon tetrachloride in rat.

Jagatha G. et al., 2011, evaluated anti-diabetic activity of methanol extract of *Digera muricata* (l) mart in Alloxan induced diabetic rats [60]. These results suggest that (200mg/kg) methanol extract of *Digera muricata* showed antihyperglycemic activity in Alloxan induced diabetic rats. *Digera muricata* (L.) Mart, Amaranthaceae.

Pratima M. et al., 2011, analyzed the free radical scavenging and antioxidant activity of different solvent extract like hexane, petroleum ether, chloroform, methanol, ethanol and aqueous. The maximum activity recorded in methanol and least activity was recorded in hexane. The methanolic crude extracts of *Digera muricata* was screened for their free radical scavenging properties by DPPH (1, 1-diphenyl-2-picryl hydrazyl) radical scavenging assay [61].

Pratima M. et al., 2010, performed soxhlet extraction and these extracts were further subjected to the antimicrobial activity. Among the bacteria used, the petroleum ether extract gave highest zone of inhibition at 400 μg/well against *V. cholerae*. Similarly, in fungi the ethanol extract exhibited highest zone of inhibition at 400 μg/well against *Candida albicans* [58].

Khan M.A. et al., 2009, performed antiurolithic activity of *Digera muricata* extract in rats. Present study was designed to investigate antiurolithic activity of hydroalcoholic extract of whole herb of *Digera muricata* on experimental model of urolithiasis. It was observed that in selected animal model urolithiasis developed significantly [62].
➢ Khan M.R. et al., 2009, demonstrated the enhancement of GSH content in the testicular tissue of rats by *Digera muricata*, a plant rich in flavonoids and proved the protective effects of *Digera muricata* (L.) Mart. on testis against oxidative stress of carbon tetrachloride in rat [64].

3.1 Dried seeds of *Cordia dichotoma*

➢ Plant Profile

3.2.1 Introduction

![Cordia dichotoma](image)

**Fig.1.2 Cordia dichotoma**

*Cordia dichotoma* L., Family-Boraginaceae is a medium sized tree with short crooked trunk; leaves are simple, entire and dentate, elliptical-lanceolate to broad ovate with a round base; flower are white in colour and small in lax terminal or axillary cyme; fruits drupe, yellowish brown, pink or nearly black when ripe with viscid sweetish transparent pulp surrounding a central stony part. This handsome greenish tree from tropical Asia and Australia grows to 30 ft (9m) high with a broadly spreading habit and broad, shiny leaves to 8 inch (20cm) long. It produces both male and hermaphrodite orange flowers. These
flowers are followed by 1 inch (25mm) long dull pinkish edible fruits with sticky flesh. The plant part used is bark, leaves and fruits. It is also known by various other names; for example Bird Lime Tree (common name), Sebastian Plum, Indian cherry (English), Lasora, Lasura (Hindi) and Slesmatakah (Sanskrit) [65].

3.2.2 Taxonomic classification

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3.2.3 Vernacular names

**English**- Sebestan plum, Soap berry, fragrant manjack

**India** - Gonda, lasora, leshora

**Malaysia**- Sekendal, sekendai, petekat

**Javanese**- Kendal

**Sumatran**- Nunang

**Thailand**- Paw man

3.2.4 Geographical distribution

It is a tree of tropical and subtropical regions. It grows in the sub-Himalayan tract. It is found in forests ranging from dry deciduous forest of Rajasthan to the moist deciduous forest of Western Ghat and tidal forest of Myanmar. In Maharashtra, it grows in moist monsoon forest. It does not grow gregariously, but is found growing singly in moist
shady ravines and valley. In areas with rainfall less than 500 mm, it thrives along streams in presence of moisture.

3.2.5 Botanical description

A polygamo-dioecious tree which is up to 15 m tall with branchlets pubescent. Leaves obovate, pubescent, the base is cuneate to oblique or rounded. Petioles are up to 3.0 cm long. Flowers are in dichotomous cymes, ebracteate. Male flowers: Calyx is 2.5 mm long, shallow 5-lobed, hairy to the inside. Corolla is campanulate, 6 mm long tube, dense hairy within. Lobes oblanceolate or broadly so recurved. Filaments 4.5 mm, lower half hairy and adnate to tube; anthers about 3 mm long; bisexual flowers. Calyx is 5-6 mm long, campanulate and up to 10 mm in fruit. Filaments are long. Style is branched and yellowish-red in color.

3.2.6 Phytoconstituents reported in *Cordia dichotoma*

It is taken as food. The immature fruits are pickled and are also used as vegetable. The rural people of coastal areas of Orissa eat the ripe fruits raw. The leaves contain 12-15% crude protein, 16-27% crude fibres, 42-53% nitrogen free extract, 2-3% ether extract. The seed kernels of *Cordia dichotoma* contain high proportion of fatty oils and proteins which has potential as cattle feed. The fruits also contain moisture 74, proteins 2, fats 2, crude fibres 2, carbohydrate 92 and ash 2 gm /100gm, Ca 55, P 275, Zn 2, Fe 6, Mn 2, Cr 0.2, Cu 1.6 mg/100 gm. *Cordia dichotoma* seeds has disclosed the presence of α-amyrins, betulin, octacosanol, lupeol, β-sitosterol, taxifolin-3’, 5-dirhamnoside and hesperitin-7-rhamnoside. The mucilage could sustain release of drug through tablet up to 11-12 h. The seeds contain alpha amyrrins and taxifolin 3’5, dirhamnoside which show significant anti-inflammatory activity by an oral dose of 1 gm/kg in albino rats.

Seeds of the species are anti-inflammatory compounds alpha amyrrins and 5-dirhamnoside has been isolated. The bark is medicinal and chemicals have been identified including Allantoin, beta-sitosterol and 3’,5-dihydroxy-4’-methoxy flavanone-7-O-alpha-rhamnopyranoside.
3.2.7 Ethnobotanical Uses

In India (Western Rajasthan) ripe fruits are eaten. Leaves are used as vegetable. A method treating a human body for delaying effects of aging on skin thereof, by applying to a part of skin in need thereof of a cosmetic or pharmaceutical composition containing an amount of an extract of *Cordia dichotoma* effective to inhibit effect of elastase in the skin, delaying of the effects of ageing on the skin, is mentioned. The bark is bitter astringent, acrid after digestion, constipating, antihelmenthic, cooling and is useful in dyspepsia, fever and diarrhoea. The leaves are aphrodisiac and are useful in gonorrhoea and ophthalmodynia. The fruits are emollient, anti-helminthic, diuretic, expectorant, vulnerary, depurative and febrifuge and are useful in vitiated conditions of vata and pitta, ulcers, leprosy, skin diseases, urethritis, chronic fever, arthralgia and ring worm infestations [66, 67].

The bark decoction is used in treatment of dyspepsia. The powdered bark is applied to mouth ulcers. The bark is used to treat fever, abscesses and tumours. The extract of the bark mixed with coconut water relieves colic. The mucilage of the fruit treats coughs and chest related problems. The plant is also a diuretic and a laxative [68].

3.2.8 Phytochemical review

- **Yang et al., 2002**, isolated four flavonoid glycosides (robinin, rutin, hesperidin and datiscoside), a flavonoid aglycone (dihydrorobinetin), and phenolic derivatives (chlorogenic acid, caffeic acid) were isolated [69].
- **Aguilar et al., 2001**, found that *Cordia dichotoma* seeds have disclosed the presence of \(\alpha\)-amyrins, betulin, octacosanol, lupeol-3-rhamnoside, taxifolin-3, 5- dirhmnoside and hesperitin-7-rhamnoside. The seed contain \(\alpha\)-amyrin and toxifolin showing significant anti-inflammatory activity by an oral dose of 1gm/kg in albino rats. The seeds of the plant was reported to contain flavonoids [70].
- **Larson et al., 1998**, ethanol extract of the leaves reduced acetylcholine-induced contractions of ileum of guinea-pig. The Ethanol extracts from leaves showed
significant antioxidant activities due to the carotenoids but no antimicrobial activity against gram-positive or gram-negative bacteria. Seeds of the plant are anti-inflammatory, two compounds alpha-amyrin and 5-dirhamnoside have been isolated [71].

- **Alarcon et al., 1994**, chemical screening of both the leaves and the fruits showed the presence of alkaloids, coumarins, flavonoids, saponins and sterols [72].

- **Tiwari et al., 1979**, bark is medicinal values and several chemicals have been identified; Allantoin, beta-sitosterol and 3',5-dihydroxy-4'-methoxy-flavanone-7- O- alphrhamnopyranoside [73].

- **Srivastava et al., 1979**, studied that the fruit contains about 70% pulp; the pulp contains water 6 g, protein 35 g and carbohydrate 18 g. The seed contains per 100 g: water 32 g, fat 46 g; the main fatty acids are: stearic acid, arachidic acid, and linoleic acid [74].

### 3.2.8 Pharmacological review

- **Mishra et al., 2011**, performed antidiabetic activity of fruit pulp of *Cordia dichotoma* in alloxan induced diabetic rats. This study was designed to investigate *in vivo* hypoglycemic and antidiabetic potential of methanol extract of fruits of *Cordia dichotoma* in Glucose loaded animals and Alloxan induced diabetic animals [75]. The results of this study revealed the presence of a significant antidiabetic potential of methanol extract of *Cordia dichotoma* in alloxan induced diabetic rats.

- **Sharma et al., 2010**, performed anti-inflammatory activity of *Cordia dichotoma* seeds extracts. The effects of *Cordia dichotoma* seeds extract on different phases of acute inflammation were examined. Both the extracts showed significant activity (*p<0.05 & **p<0.01) compared with the control in both of the models.
The dried seeds were found to contain alkaloids, glycosides, saponins, tannins and carbohydrates [76].

- **Thirupath et al., 2007**, studied hepatoprotective activity of the methanolic extract of *Cordia dichotoma* in male Wistar rats with Carbon tetrachloride induced heart damage [77]. Protective role of *Cordia myxa* L. (CM) against liver fibrosis induced by carbon tetrachloride or Thioacetamide was investigated. Antiradical activity of the *Cordia myxa* extracts was measured by α, α-diphenyl-β picrylhydrazyl (DPPH) assay and was compared to ascorbic acid.

- **Sharma et al., 2007**, studied the role of *Cordia dichotoma* seeds and leaves extract in degenerative disorders. The current study is therefore carried out to investigate the free radical scavenging potential of methanolic extract of seeds and leaves of *Cordia dichotoma* using in-vitro models. This activity was more pronounced in leaves as compared to seeds studied the role of *Cordia dichotoma* on behavioral changes by using long–term hypoperfusion in rats [78].

- **Kuppasta et al., 2006**, studied the fruit extracts of *Cordia dichotoma* showed significant wound healing activity on three different models, viz. excision, incision and dead space wound models on albino rats. These fractions were screened for wound healing activity using three different models on either sex of albino rats of Wistar strain. All the fractions showed significant (P<0.001) activity on the fruits contain large quantities of flavonoids are used as wound healing agent in households [79].

- **Kuppasta et al., 2003**, performed the antimicrobial activity. The data showed inhibitory activities against all the tested bacterial, fungal and yeast species. Water extracts of the *Cordia dichotoma* plants did not show any antimicrobial activity against all the tested microorganisms [80].
Wassel et al., 1987, performed the antiulcer activity and the study yielded flavonoids in all three extracts of *Cordia dichotoma* tested and showed significant anti-ulcer and cytoprotective effects against gastric ulcer in rats. The anti-ulcer effect of extracts of *Cordia dichotoma* fruits (300mg/kg body weight) was studied in albino rats of Wistar strain using three different models. The results suggest that the extracts of *Cordia dichotoma Forst.* fruits possess significant antiulcer activity [81].

Lorke et al., 1983, performed the acute toxicity study which was designed to elucidate the toxicity of the widely used plant *Cordia dichotoma* in rats. methanolic, chloroform, aqueous extracts were isolated from the leaves of *Cordia dichotoma* and studied their toxic effects. Acute toxicity values were determined in experimental rats [82].

Day et al., 1983, reported the antihyperglycemic effects of *Cordia dichotoma* in the glucose induced hyperglycemia. The effect of the aqueous extract of alloxan induced and normoglycemic Wister rats has been investigated. The 500 mg/kg extract of *Cordia dichotoma* did not show any significant change in the blood glucose levels in normoglycemic and 250 mg/kg did not show any significant change in the blood glucose levels in alloxan Induced Diabetic Wister rats, when compared to untreated control [83].
REFERENCES


77 Thirupathi, K. and Kumar, S. (2007). **Hepatoprotective action of Cordia dichotoma against Carbon tetrachloride induced heart injury in Rats.** Journal of Natural Products and Medicine, 2:11.


