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CORDIA DICHOTOMA HAS MULTIPLE PHARMACOLOGICAL ACTIVITIES

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ABSTRACT: Natural plants are the most important herbs in the world, and now they have been introduced into one, *i.e.*, *Cordia dichotoma*. Forst is a small to medium-sized deciduous tree or shrub belonging to the family Boraginaceae, commonly known as Bhokar and Bahuvaraka. The rural people of the coastal areas of Orissa eat ripened fruits to enjoy their sweet and astringent taste. The plant is rich in miscellaneous phytoconstituents such as carbohydrates, flavonoids, alkaloids, glycosides, steroids, and proteins. Today, researchers carry out various pharmacological research studies on these plant parts, such as anti-ulcer, anti-inflammatory, anthelmintic, analgesic, anticancer, antioxidant, antimicrobial, antifungal, hepatoprotective, anti-diabetic and antipyretic activity. Thus, the objectives of the present review depict the expansion of the alimentation source, medicinal uses, pharmacobotanical characters, phytochemical screening, and pharmacological activity of *Cordia dichotoma* reported so far.

INTRODUCTION: Ayurveda is the "science of life", The concept of positive health means metabolically well-balanced human beings ^{1, 2}. *Cordia* Linn belongs to the family Boraginaceae. There are around 280 species present in fervent countries. Some species of *Cordia*, like *C. dichotoma*, *C. myxa*, *C. oblique* wild, *C. walchii*, and *C. vestita*, are used medicinally. In Ayurveda, medicinal plants are considered the first line of protection or health maintenance and are used to try to stop illness in fervent countries. Introduced into one, *i.e.*, *Cordia dichotoma* Forst, are well-known traditional medicinal plants commonly

known as "Bhokar or Bahuvaraka, "found throughout India in the tropical and subtropical zones, used in Indian folk medicine ³. Various phytochemical studies are carried out in various parts of the plants, such as flavonoids, tannins, alkaloids, and carbohydrates, which are responsible for pharmacological activity, has to be screened ⁴.

Many researchers reported various pharmacological actions of *C. dichotoma*, such as anti-ulcer, contraceptives, anti-inflammatory anthelmintic, analgesic, anticancer, antioxidant, antimicrobial, antifungal, hepatoprotective, anti-diabetic and diuretic purposes and for treating digestive system, respiratory, urogenital, cardiac, vascular, and blood disorders ⁵⁻⁷. Thus, the objectives of the present review are to provide an overview of the recent research status on morphology, microscopy, phytochemical screening, and pharmacological activity of whole plant parts.

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TABLE 1: TAXONOMICAL CLASSIFICATION, VERNACULAR NAME AND LOCAL NAME ^{2,7,8}

Taxonomical classification	Vernacular name	Local name
Kingdom: Plantae	Sanskrit: Bahuvaraka, Bhukampadaruka, Bhukarbudara,	Assam: Dilk
Division: Magnoliophyta	Bhuselu, Laghupichhila	Bengali: Bohari, buhul
Class: Dicotyledons	Hindi/Indian: Bhokar, Gondi, Lasora;	Gujarati: Vadagunda
Subclass: Astaridae	English: Sebesten Plum, Fragrant manjack, soap berry	Marathi: Bhokar, Bhonkar
Order: Lamiales	Lepcha: Ninut	Kannada: Chikkachalli
Family: Boraginaceae	Sinhalese: Lolu, Lotu	Malayalam: Naruvari
Genus: <i>Cordia</i>	Unani: Sapistan	Punjabi: Lasuda
	Arabic: Dabk	Telugu: Nakkeru
	Myanmar: Thanet	Tamil: Naruvili, Selu, Vid
	Java: Kendal	
	Persian: Sugpistan, Sapistan	
	Tehran: Sepistan; Sino	
	Tibetan: Lao	
	Malay: petekat	
	Nepali: kalobohori, bohori	
	Thai: Mandong, manma	
	Philippines: Anonang	
	Sumatran: Nunang	

Alimentation Source of *Cordia dichotoma*: The whole plant of *C. dichotoma* is esculent and used as food ⁹. The unripe green fruits are usually used for making pickles, preserving in spiced oil, or any cooked vegetables, and the practise is popular in Indian dinner. On most occasions, the rural people of coastal areas of Orissa eat the ripened fruits to enjoy their sweet and astringent taste. The fruits have therapeutic values against diabetes, especially because of their chromium content (0.2 mg per 100 g). A fruit also contains some anti-nutritional factors such as phytic acid (355 mg), phytate

phosphorus (100 mg), and oxalic acid (250 mg) per 100 g. The grinded seed kernels of *Cordia dichotoma*, enriched with fatty oils and proteins, are probable for cattle food. The gum extracted from *C. dichotoma*, containing 97% polysaccharide, is used for pharmaceutical needs. ¹⁰. The plant also produces natural fibre cellulose, first extracted from branches of *Cordia dichotoma*, that can be used in fabric industries. A mixture of flowers and curd is used to protect the body against heavy sun and heat waves ¹¹.

TABLE 2: *C. DICHOTOMA* PLANT PART AND THEIR NUTRITIONAL COMPONENTS

Plant part	Nutritional component (/ 100 g)
Leaves	15 % protein, 27 % crude fibres, 52 % Nitrogen free extract ~17 % Ash, 4 % Calcium, 0.3 % Phosphorus.
Seeds	32 g water, 46 % oil, 31 % protein.
Fruits	6 g Water, 35 g Protein, 37 g Fat, 18 g Carbohydrate, 55mg Calcium, 275 mg Phosphate, 2mg Zinc, 6mg Ferrous, 2mg Magnesium, 0.2 mg Cr, 1.6 mg Cu

Botanical Description of *Cordia dichotoma* Forst: *C. dichotoma* family Boraginaceae is a small to average-sized autumn tree with a short, flexuous trunk. Leaves are simple, entire, and slightly dentate, elliptical-lanceolate to broad ovate, with a round and sagittate base. The stem bark is longitudinally creased and greyish-brown in colour.

These flowers are 25 mm long, dull pinkish or white, small in axillary cymes, and polygamous. Fruits have edible sticky yellow or greenish-yellow shining glabrous or minutely pubescent calyxes. It turns black on ripening, and the pulp gets viscid, sweetish, transparent, surrounding a central stony part. It is used in food and pickles ^{7,9}.



LEAVES



ROOT



FLOWER



RIPE FRUIT UNRIPE FRUIT BARK STEM
FIG. 1: PLANT PARTS OF *C. DICHOTOMA*

Microscopy of *Cordia dichotoma*: The qualitative and quantitative microscopical assessments of *Cordia dichotoma* leaf exhibit superfine characters such as vascular bundles with patches of perimedullary phloem and unicellular and multicellular covering trichomes. The prime

characteristics of powder include xylem vessels with reticulate thickening and calcium oxalate prisms and congregation. Powder microscopy of seeds shows bunches of scleroid cells and single-cell scleroids¹².



FIG. 2: T. S. OF *C. DICHOTOMA* LEAF



FIG. 3: POWDER MICROSCOPY OF *C. DICHOTOMA*

Phytoconstituents^{5, 6, 13, 14, 28}: Various analyzers were used to identify various phytoconstituents and various classes of secondary metabolites from various parts of *C. dichotoma* with the help of the recognition and isolation methods. Which have been manifested in the different plant parts are as follows:

Seed: Carbohydrates (D-arabinose, L-fructose, D-glucose, D-xylose, galacturonic and glucuronic acids, lactose, D-ribose, and L-rhamnose) alanine, aspartic acid, cysteine, glutamic acids, glycine, leucine, proline, threonine, -amyrins, betulin, octacosanol, lupeol-3-rhamnoside, -sitosterol, -sitosterol, glucoside, hentricontanol, hentricontane, taxifolin - 3 - 5 - dirhamnoside, hesperitin - 7-rhamnoside, and fatty acids such as palmitic acid, stearic acid, arachidic acid, behenic acid, oleic acid, and linoleic acid. Four flavonoid glycosides (robinin, rutin, rutoside, datiscoside, and hesperidin), a flavonoid aglycone (dihydro-robinetin) and two phenolic derivatives (chlorogenic acid and caffeic acid) were isolated from seeds.

The significant anti-inflammatory activity of seeds is because of -amyrins and taxifolin-3- 5-dirhamnoside (71.4% and 67.8%, respectively).

Bark: Allantoin, β -sitosterol and 3', 5-dihydroxy-4'- methoxy flavanone - 7 - O - α - L - rhamnopyranoside, Holocellulose, lignin, tannin.

Leaves: Pyrrolizidine alkaloids, coumarin, flavonoids, saponins, terpenes, sterols 4 (e.g. 4-hydroxy-transcinnamate ester 8, 13, β -sitostero 14, 14, quarcetin and quercitrin, protein, tannins.

Fruits: Arabinoglucan and polysaccharide compound of (1-6) linked D- glucopyranosyl and (1-2) L-arabinofuranosyl residues. Pyrrolizidine alkaloids, coumarins, flavonoids, saponins, terpenes and sterols 4, D-glucose (67.6%) and L-arabinose (13.2%).

Wood: α -, β -, and γ -eudesmol, guaiol.

Roots: lupa - 20 (29) - ene - 3 - O - α - L - rhamnopyranoside.

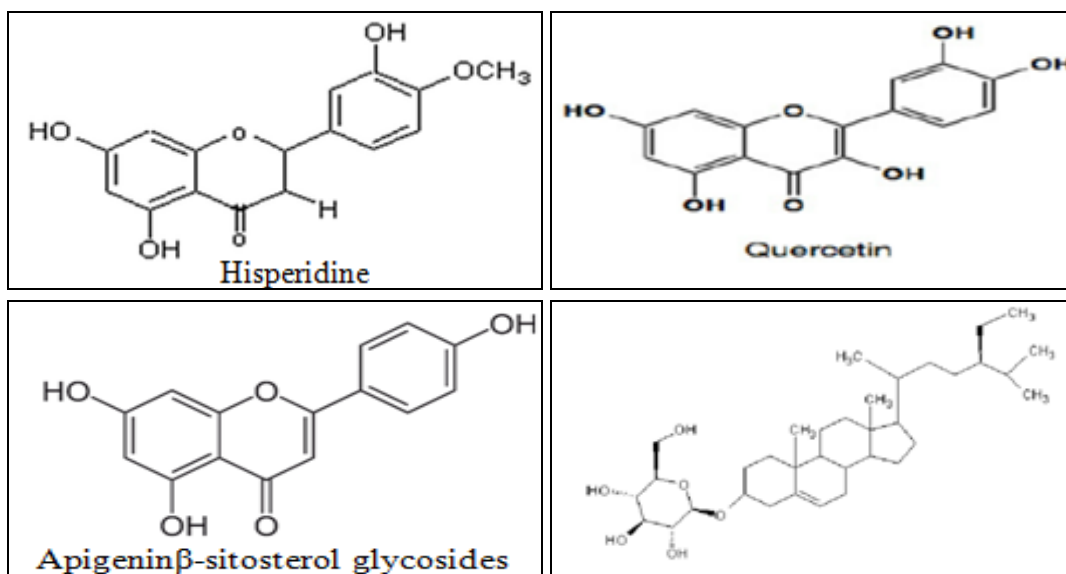


FIG. 4: CHEMICAL STRUCTURE OF IDENTIFIED PHYTOCONSTITUENTS

Medicinal uses: The various plant parts of *Cordia dichotoma* were used in the Ayurvedic and Unani systems of medicine for the treatment of various

illnesses and conjugation conditions. However, different plant parts have been reported for various pharmacological activities.

TABLE 3: MEDICINAL USES OF DIFFERENT PLANT PARTS OF *C. DICHOTOMA* ⁷

Sr. no.	Plant part of <i>C. dichotoma</i>	medicinal uses
1.	Leaves	Aphrodisiac, gonorrhoea and Ophthalmodynia
2.	Bark	Astringent, acid after digestion, constipation, anthelmintic, dyspepsia, fever, diarrhoea, burning sensation, leprosy
3.	Fruit	Anthelmintic, purgative, diuretic, expectorant, febrifuge, and are useful in vitiated condition of vatta and pitta, ulcer, spleen, leprosy skin disease hyperdipsia, pharyngopathy, urethralgia urethritis, ringworm.
4.	Root	Ringworm

Ethnopharmacological Activity:

Anti-inflammatory Activity:

TABLE 4: ANTI-INFLAMMATORY ACTIVITY OF VARIOUS PART OF *CORDIA DICHOTOMA*

Sr. no.	Plant part	Activity performed	Method	Response	References
1.	Leaves	Anti-inflammatory	Carrageenan-induced rat paw edema method	Methanolic extract of <i>C. dichotoma</i> leaves high dose 400mg/kg and standard (Indomethacin) was correlate and outcomes was found to be highly significant as compared to standard drug.	15
2.	Bark	Anti-inflammatory	Carrageenan-induced rat paw edema method	Methanolic extract of <i>C. dichotoma</i> shows 29.7 % maximum inhibition of edema at low dose (250 mg/kg) group. While 48.6 % inhibition of edema was observed at higher dose (500 mg/kg). The percentage inhibition of paw edema was significant relative to the control group	31
3.	Seed		Carrageenan -induced paw oedema and Dextran -induced paw oedema in Wister rats	Ethanollic and aqueous extracts doses 250mg/kg and 500mg/kg shows significant effect at (p<0.05 and p<0.01) compared with control group in both of this model	16

Analgesic and Antipyretic Activity: Methanolic extracts of *Cordiadicotoma* leaves were estimated

for analgesic activity by Eddy's hot plate model on SD female rats. Indomethacin is used as a standard.

The antipyretic activity was screened by using the yeast-induced pyrexia method. Paracetamol (100 mg/kg) is used as a standard drug. *C. dichotoma* leaves extract at a high dose of 400 mg/kg and standard were correlated, and outcomes were found to be highly significant as compared to standard drug^{15, 18}.

The effects of ethanolic and aqueous extracts of *Dichotoma* seeds (dose 500 mg/kg) on various acute inflammations by using carrageenan-induced paw oedema and Dextran-induced paw oedema in Wister rats were evaluated, and both plant extracts showed significant effects compared to the standard (Diclofenac sodium 10 mg/kg)¹⁶.

Transcutaneous films are made using natural polymers (fruit gum) of *dichotoma* with different percentages of plasticizer, deterrent, and standard drug. The films were estimated for anti-inflammatory activity by using the carrageenan-induced raw paw odema model, and the outcomes correlated with the standard drug, diclofenac sodium. The proportion of restraint odema was detected to be preeminent in seeds extract (0.20 ferent percentages of plasticizer, deterrent, and standard drug. The films were estimated for anti-inflammatory activity by using the carrageenan-induced raw paw odema model, and the outcomes correlated with the standard drug, diclofenac sodium. The proportion of restraint odema was detected to be preeminent in seeds extract (0.20%) (w/v) glycerine-treated animals, which intimates the eloquent anti-inflammatory activity¹⁷.

Antidiabetic Activity: The intense toxicity was determined by an appropriate fixed dose method to monitor and oversee experiments on animals. The methanolic extract of *Dichotoma* was governed by augmenting doses of mg/kg body weight to lay down the variations in parameters for assessing toxicity in animals. The effect of a methanolic extract of *C. dichotoma* fruit pulp on antidiabetic activity was estimated in a healthy male Wistar albino rat (160–200 g). Immortality was examined at doses as high as 1 g/kg body weight. So, a 400 mg/kg body weight dose was pondered for the experiment ahead. Alloxan-induced diabetic rats were randomly assigned into four groups, each with six rats. Prominent deficiency in blood glucose level and the rate of body weight loss were

observed in glucose-loaded rats and alloxan-induced diabetic rats when treated with methanol extract from fruit pulp, which discloses the antidiabetic potential of the fruit pulp of *C. dichotoma* and can be useful for the supervision of diabetes mellitus¹⁹.

The methanolic bark extract of *Dichotoma* was estimated for antidiabetic activity on unisex Wister albino rats (170-200 g) treated with glibenclamide as the standard drug. *C. dichotoma* bark extract doses of 250–500 mg/kg and standard were correlated, and outcomes were found to be highly significant compared to standard drugs. [20]5.3. Antimicrobial and Antifungal activity of *C. dichotoma*

The ethanolic and butanolic bark extracts of *C. dichotoma* contained contradictory two gram-negative and two gram-positive bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Streptococcus pyogenes*, and *Staphylococcus aureus*). The antifungal activity of bark extract was contradictory to that of *Aspergillus niger*, *Aspergillus clavatus*, and *Candida albicans*, the declinable fungi. Dissuasion of region extracts was analogical with different criteria, such as Ampicillin, Ciprofloxacin, Norfloxacin, and chloramphenicol for antibacterial activity and Nystatin and Griseofulvin for antifungal activity. The extract showed exceptional dissuasion of the region for bacterial and fungal growth, and the results were analogical with those of criterion drugs that contradicted the organisms^{7, 14, 21}.

Anthelmintic Activity: The aqueous and ethanolic extract concentrations (10–100 mg/ml) of the fruit of *C. dichotoma* demonstrated prominent anthelmintic activity in the paralysis and death of worms compared with standard drugs such as piperazine citrate (10 mg/mL) and distilled water. The study was terminated using *Eudriluseuginiae* earthworms. Aqueous extracts of the *C. dichotoma* fruit showed dominant anthelmintic activity compared to ethanolic extracts. Thus, the result exhibits the fruits of *C. dichotoma's* subservient eventual anthelmintic activity²².

Antiulcer and G.I.T. Protective Activity: The expulsion of *dichotoma* fruits was performed using ethanol, and the extract was fractionated using

petroleum ether, solvent ether, ethyl acetate, butanol, and butanone in combination. The extract was studied in albino Wistar rats using multiple models like pyloric ligation, aspirin, and indomethacin-induced ulcers, and rats were injured in the gastric mucosa relevant to the above models. Fruit extracts of various solvents (petroleum ether, solvent ether, ethyl acetate, butanol and butanone) were administered at 300 mg/kg body weight. The results reveal that the expulsion of ethyl acetate, butane, and butanone prominently inhibits ulcer activity.

Other than apigenin (5 mg/kg, p.o.) from *C. dichotoma*, prominent ulcer medication and scarcity in inflammatory enzymes were estimated for ulcerative colitis. The methanolic and water extracts of *Dichotoma* fruit were screened for gastroprotective effects using an aspirin-induced gastric ulcer and pylorus ligation model in rats, and OECD 423 guidelines calculated the oral dose, and it falls in the GSH 5 category. Effective deficiency in ulcer index is observed in water extract-treated Wistar rats as equivalence to methanolic extract, and results were equivalence to standard ranitidine (50 mg/kg). The water extract showed a prominent antiulcer effect in the aspirin-induced gastric ulcer model (P 0.001) as well as in the pylorus ligation model²³.

Wound Healing Activity: Ethanolic extract of *C. dichotoma* Fruits contain a high amount of flavonoids, which 0.001s are responsible for wound activity. They activity showed significant wound healing activity in various models, like excision, incision and dead space wound models in Afters that, tfruitat Fruit extract was ahead using petroleum 40–60r (40-60%), solvent ether, ethyl abutanol, butanol and butanone in series. These fractions were tested for wound healing ausingthey using above models.

The various d fractions were reactions byanuated by acutet study, tandthetudy and the result was 300 mg/kg. The results were analyzed by student t-test at a prominent level of P<0.001 The earlier epithelization of wounds and the highly prominent increase in tensile strength as equivalent to control were found in rats treated with fractions of ethanolic extract. Results show that fruit extracts of *C. dichotoma* have dominant wound healing properties^{24, 25}.

Anticancer Activity: Methanolic extracts of *C. dichotoma* leaves have been evaluated for anticancer activity by using apoptosis-inducing effects on human cervical cancer cell lines and allocating the total phenolic content. MTT assay and DAPI staining tests were carried out to estimate anticancer potential and assess apoptosis-induced effects in the human cervical cancer cell line (HeLa). Results reveal that MECD with an IC₅₀ of 204 g/mL intercepted the in vitro prevalence of human cervical cancer cells and its apoptosis-inducing action discloses its obligatory anticancer activity as equivalent to the standard tamoxifen with an IC₅₀ of 48 g/mL. The dried extract shows 176.5 mg GAE/g total phenols. Thus, methanolic extract was a novel dominant chemotherapeutic agent for treating human cancer^{26, 27, 32}.

Antiimplantation Activity: The petroleum ether and methanolic extracts of *C. dichotoma* bark were screened by observing the implantation site at various doses. The Wister male rats were microscopically examined for the estrus cycle, and female rats with normal oestrus cycles (200–250 g) were selected for the study. According to OECD guidelines, the acute study was estimated using 50–100 mg/kg body weight doses. There was no change in ovulation because the rats in proestrous and estrous stages were caged with fertile males in the ratio 2:1, the vaginal smears were criticised, and the plausibility of the sperm clusters in the smears was inscribed as Day 1 of pregnancy. The implant number and size were corrected on Days 10 and 21 by laparotomy. After analysis, the antiimplantation activity showed no augmentation in body weight or uterine content of blood glucose, cholesterol, or triglyceride levels when compared with the control group²⁹.

Hepatoprotective Activity: The methanolic extract of *C. dichotoma* leaves was screened for hepatoprotective activity in male Wister rats at 300–500 mg/kg doses. Carbon tetrachloride (CCl₄) induced liver damage and Silymarin was used as a standard. The extract (300-500 mg/kg) predominately reduced the AST level (P<0.001), ALT level (P P<0.001), TBR levels (P<0.001) and lipid peroxide levels (P<0.05). The results reveal that the hepatoprotective activity of *C. dichotoma*

leaf extract was found to be comparable with the standard (100mg/kg)³⁰.

CONCLUSION: *Cordia dichotoma* is considered one of the foremost important and has a diversification of therapeutic competency reported in pristine Ayurveda. The leaves and seeds of *C. dichotoma* show microscopy and various parts of the plant contain different phytoconstituents that show contradictory and multifarious illnesses. This review article concludes with the ethanol-pharmacological activities of *C. dichotoma* with its taxonomical description and plant parts used in various activities, which have already been proven experimentally by various researchers. *C. dichotoma* is an alternative role in treating various diseases because of various useful phytoconstituents in this plant.

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