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The Pharmacological and therapeutic importance of *Cordia myxa*- A review

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Abstract: The preliminary phytochemical screening carried out on *Cordia myxa* fruit extract revealed the presence of oil, glycosides, flavonoids, sterols, saponins, terpenoids, alkaloids, phenolic acids, coumarins, tannins, resins, gums and mucilage**.** Pharmacological studies revealed that *Cordia myxa* possessed analgesic, anti-inflammatory, immunomodulatory, antimicrobial, antiparasitic, insecticidal, cardiovascular, respiratory, gastrointestinal and protective effects. This review was designed to highlight the chemical constituents and pharmacological effects of *Cordia myxa.*

Keywords: *constituents, pharmacology, Cordia myxa.*

I. INTRODUCTION

Medicinal plants are the Nature's gift to human beings to help them pursue a disease-free healthy life. Plants have been used as drugs by humans since thousands of years ago. As a result of accumulated experience from the past generations, today, all the world's cultures have an extensive knowledge of herbal medicine. Two thirds of the new chemicals identified yearly were extracted from higher plants. 75% of the world's population used plants for therapy and prevention. In the US, where chemical synthesis dominates the pharmaceutical industry, 25% of the pharmaceuticals are based on plant-derived chemicals [(1)]. Plants are a valuable source of a wide range of secondary metabolites, which are used as pharmaceuticals, agrochemicals, flavours, fragrances, colours, biopesticides and food additives[(2-40)]. The preliminary phytochemical screening carried out on *Cordia myxa* fruit extract revealed the presence of oil, glycosides, flavonoids, sterols, saponins, terpenoids, alkaloids, phenolic acids, coumarins, tannins, resins, gums and mucilage**.** Pharmacological studies revealed that *Cordia myxa* possessed analgesic, anti-inflammatory, immunomodulatory, antimicrobial, antiparasitic, insecticidal, cardiovascular, respiratory, gastrointestinal and protective effects. This review will highlight the chemical constituents and pharmacological effects of *Cordia myxa.*

II. PLANT PROFILE

Synonyms: *Bourreria glabra* G.Don, *Cordia ixiocarpa* F. Muell., *Cordia latifolia* Wall. ex G. Don, *Cordia myxa* var. *ixiocarpa* (F. Muell.) Domin, *Cordia officinalis* Lam., *Cordia paniculata* Roth, *Cordia paniculata* Roth, *Cordia petta-pelioporet* B. Heyne ex Roth, *Cordia scabrifolia* Benth. ex Griseb., *Cordia sebestena* Forssk., *Ehretia glabra* Roth ex Roem. & Schult., *Ehretia glabra* Roth and *Gerascanthus myxus* (L.) Borhidi[(41)].

Taxonomic classification:

Kingdom: Plantae; **Subkingdom**: Tracheobionta; **Superdivision**: Spermatophyta; **Division**: Magnoliophyta; **Class**: Magnoliopsida; **Subclass**: Asteridae; **Order**: Lamiales, **Family**: Boraginaceae, **Genus**: *Cordia* L., **Species:** *Cordia myxa* L[(42)].

Common names: **Arabic**: bumber**,** makhet, dabag, benber sebstan, megsas; **English**: Assyrian-plum, clammy-cherry, glueberry, Indian-cherry, sapistan, sapistan-tree, sebesten-plum, selu, small cordial, Sudan-teak; **French**: bois savon, sébestier; **Hindi**: Gondi; **Portuguese**: sebesteira, sebesteiro-do-Sudão[43].

DISTRIBUTION:

The plant was native in Asia temperate and Asia tropica. *Cordia myxa* originated from the area stretching from the eastern Mediterranean region to eastern India, and was introduced long ago in tropical Africa, tropical Asia and Australia, and more recently also in the Americas. it was widely naturalized in paleotropics[43-44].

Description:

Dioecious shrub or small tree up to 12 m tall; bole tortuous or straight; bark grey, cracked; branches spreading, forming a dense crown; branchlets hairy, later glabrous, with very prominent leaf scars. Leaves alternate, simple; stipules absent; petiole 0.5–4.5 cm long; blade broadly ovate to orbicular, sometimes obovate, 3–18 cm × 3–20 cm, base rounded to cordate or cuneate, apex rounded to obtusely acuminate, margins entire to toothed, glabrous above, glabrous to velvety hairy below. Inflorescence a lax terminal or short lateral panicle, 3–8.5 cm long, many-flowered; bracts absent. Flowers unisexual, regular, white to creamy; pedicel 1–2 mm long; male flowers with campanulate calyx 4.5–5.5 mm long, 3-lobed, shortly hairy inside, glabrous outside, corolla tube 3.5–4.5 mm long, lobes 5, elliptical, c. 5 mm × 2 mm, reflexed, stamens inserted at corolla throat, exserted, filaments 1.5–3.5 mm long, ovary rudimentary; female flower with tubular-campanulate calyx 6–8.5 mm long, irregularly 3–4-toothed, densely hairy inside, glabrous outside, corolla tube 4.5–6.5 mm long, lobes 4–6, elliptical to obovate, 5–7 mm long, reflexed and rolled up, staminodes with sterile anthers, ovary superior, ellipsoid to obovoid, 4-celled, style 8–9 mm long, with 4 stigmatic branches 4–5 mm long. Fruit a globular to ovoid drupe 2–3.5 cm long, apiculate, enclosed at base by the accrescent calyx, yellow, apricot or blackish when ripe, pulp almost transparent, mucilaginous, sweet-tasting. Pyrene broadly ellipsoid to globose, c. 12 mm long, deeply wrinkled, 1–2-seeded[44].

Traditional uses:

It was eaten to suppress cough and for the treatment of respiratory infections and a sore throat, as it has demulcent properties. The pulp was also applied as an emollient to mature abscesses, to calm rheumatic pain and as an anthelminthic. In Tanzania the fruit pulp is applied on ringworm. In Mali and Côte d'Ivoire the leaves were applied to wounds and ulcers. A macerate of the leaves was taken to treat trypanosomiasis, and is externally applied as a lotion to tse-tse fly bites. In the Comoros the powdered bark is applied to the skin in cases of broken bones before a plaster was applied, to improve healing. Bark powder was used externally in the treatment of skin diseases. Bark juice together with coconut oil was taken to treat colic[44-47].

Chemical constituents:

The preliminary phytochemical screening carried out on *Cordia myxa* fruit extract revealed the presence of oil, glycosides, flavonoids, sterols, saponins, terpenoids, alkaloids, phenolic acids, coumarins, tannins, resins, gums and mucilage[48-52].

The fatty oil of the seeds of *Cordia myxa* was consisted of palmitic acid, stearic acid, oleic acid and linolenic acid were identified. β-sitosterol was also isolated[53]. The flavonoids and phenolic derivative content of the five species of genus Cordia leaves (*C. francisci*, *C. martinicensis, C. myxa, C. serratifolia and C. ulmifolia*) was investigated. Four flavonoid glycosides, robinin, rutin, datiscoside and hesperidin, one flavonoid aglycone, dihydrorobinetin, two phenolic derivatives, chlorogenic and caffeic acid, were determined[53].

Phenolic content of *Cordia myxa* extracts was measured by Folin-Ciocalteu reagent and was calculated as gallic acid equivalents. The maximum fruit extract rich in phenolic content (11.1±1.47 mg/g gallic acid equivalent) can be obtained by hand-macerating of the peeled fruit[54]. The soluble phenolic acids of *Cordia myxa* were extracted with methanol. Total phenolic compound were 402 mg/100g[55].

The total phenol contents of *Cordia myxa* fruits were 373.91 ± 13.93 mg/100g dry weight, and antioxidant activity (IC_{50}) was 132.53 ± 5.75 µg/ml[56]. A total of eight carotenoids were resolved and identified from the plant. Their relative percent were: 19'-Z-violaxanthin 6.4%, violaxanthin 7.3%, antherxanthin 2.4%, lutein 18.9%, chlorophyll b%, allomer 1.7%, chorophyll-b 22.4%, chlorophyll a allomer 1.9%, chlorophyll-a 29.4%, α β-carotene 1.2% and β-carotene 7.0%[57].

Qualitative determination of nutritional composition of the tubers of *Cordia myxa* showed that they contained crude protein (8.32%), carbohydrate (57.08%), Ash (6.7%), fibre (25.7%) and fat (2.2%). Mineral analysis of the tubers revealed that they contained sodium (1.62mg/g), potassium (7.83 mg/g), calcium (0.46mg/g), zinc (0.35mg/g) and iron(0.51mg/g)[52]. Study of some nutritional and anti-nutrient properties of *Cordia myxa* fruits showed that *Cordia myxa* contained (g/100 g of dried product): water 6.21, glucose12.75, fructose 9.38, sucrose 29.09 and starch 29.09. It was also contained phytic acid 248.0mg/100g and trypsin Inhibator 1.39 (TIU/g)[58]. However, Ali and Deokule found that the proximate composition and mineral constituents of *Cordia myxa* fruit were 6.7% ash, 8.32% crude protein, 2.2% crude lipid, 25.7% crude fiber, and 57.08% carbohydrates. The fruit also has high energy value (281.4 kcal/100g dry weight). Mineral ranges (mg/100g dry weight, DW) were: K (7.83), Na (1.62), Ca (0.46), Fe (0.51) and Zn (0.35). Comparing the stem mineral contents with recommended dietary allowances (RDA), the results indicated that *Cordia myxa* fruit could be a good supplement for some nutrients such as fiber, protein and carbohydrates. The wild fruit could be promoted as a carbohydrate and protein supplement for cereal-based diets in poor rural communities[59].

Pharmacological effects:

Analgesic and anti-inflammatory effects:

The analgesic and anti-inflammatory effect of the hydro-alcoholic extract of fruit of *Cordia myxa* was investigated in mice. Formalin test and acetic acid test were used for evaluation. Normal saline, oral indomethacin, intraperitoneal tramadol, 100 mg/ kg, oral hydro-alcoholic extract of fruit of *Cordia myxa*, 200 mg/ kg orally and 100 mg/ kg intraperitoneally were used for comparison. The duration of foot lickings were calculated in formalin- administered within 0 to 5 min (acute phase) and 15 to 25 (chronic phase). Acetic acid-induced writhings were counted within 10 min. The results showed that hydro-alcoholic extract of *Cordia myxa* fruit possessed analgesic and anti-inflammatory properties in both acute and chronic phases[60].

The anti-inflammatory effects of *Cordia myxa* fruit on experimentally induced colitis was investigated in rats. Colitis was induced by intrarectal administration of 4% acetic acid. All the animals were sacrificed 4 days after the fruit treatment. Colitis was monitored histologically and by activity of myeloperoxidase. Glutathione peroxidase, superoxide dismutase, as well as total antioxidant status and concentrations of zinc, copper, manganese, selenium, and iron were assayed in plasma, liver, and colon. Histology of the colon of colitic rats showed acute colitis that was confirmed by a significant increase in the myeloperoxidase activity. Colitis was associated with significant decreases in the tissue activities of glutathione peroxidase and superoxide dismutase and lower concentrations of trace elements. Histologic examination and myeloperoxidase activity showed that the fruit treatment reversed these findings in the inflamed colon, and in liver and plasma of colitic rats. The

authors concluded that the antiinflammatory effect of the *Cordia myxa* may be attributed partly to its antioxidant property and to restoration of the levels of trace elements in the inflamed colon, liver, and plasma[46]. The analgesic, anti-inflammatory and anti-arthritic activities of different extracts of several species of Cordia was evaluated in rat. The results obtained showed that the petroleum ether and alcoholic extracts of *Cordia myxa* leaves exerted a significant analgesic, anti-inflammatory and anti-arthritic activity in rat[61-62].
The analgesic, anti-inflammatory and anti-arthritic activities of different extracts of *Cordia myxa* were studied in rat. The results obtained showed that the petroleum ether and alcoholic extracts of *Cordia myxa* leaves have a significant analgesic, anti-inflammatory and anti-arthritic activity[63].

The ability of *Cordia myxa* extract in potentiating the analgesic effect of mefenamic acid (ponstan) was investigated in mice. Two tests were employed, hot plate test and formalin test. Mefenamic acid and *Cordia myxa* extract were given (each one alone) orally as aqueous solutions at a dose of 100mg and 600mg per kg bw. *Cordia myxa* extract alone increased the reactive time to the thermal stimuli. Simultaneous gavages of half of above mentioned doses of *Cordia myxa* extract and mefenamic acid (ponstan) had significantly prolonged the reactive time to the thermal stimulus. This could be due to a synergistic action through a common mechanism of *Cordia myxa* extract and ponstan in producing analgesia and relieving pain by disrupting the chain of synthesis of prostaglandin. In formalin test, a combination of *Cordia myxa* extract at a dose of 300mg per kg bw and mefenamic acid (ponstan) at a dose of 50 mg per kg bw was given before the injection of diluted formalin solution, they were significantly showed antinociceptive effect at the early and late phases, which could be attributed to their inhibitory effect on the nociceptive system and inflammatory mediators[64].

Immunomodulatory activity:
The immune-modulatory activity of aqueous extract of *Cordia myxa* fruit was studied in mice immunized by hydatid cyst fluid antigen HCFAg. Delayed type hypersensitivity (DTH), Mitotic index (MI) and histopathological change in spleen were studied. A higher increase of thickness of the spleen was showed in immunized mice treated with aqueous extract of *Cordia myxa* fruit after 10 days of treatment. The MI of bone marrow and spleen cells was significantly increased as a post immunized and treated mice in comparison with the other groups. Histopathological examination of spleen showed marked hyperplasia of lymphoid corpuscles and some times formed large follicle. Accordingly, aqueous extract was found to stimulate cell mediated and immune responses in mice[65].
The immune-modulating effect of ethanolic extract of *Cordia myxa* fruits was investigated by *in vitro* activated mouse (males type BALB/c) lymphoid & phagocyte, and tested by lympho-proliferation and reduction of NBT stain. The results indicated that concentration of (750, 1000) µg/ml inhibited the proliferation in comparison with negative and positive control. The results of NBT indicated the significant inhibition (without cytotoxicity) in the percentage of PMNLs forming Formazan granules in comparison with control. The percentage of cytotoxicity of the extract on lymphocytes and phagocytes was inhibited significantly ($P<0.05$) with increase the concentration of extract. [66]. The ethyl alcohol (70%) extracts of the fruits of *Cordia myxa* caused elevation in some of blood parameters particularly total count of leucocyte with insignificant elevation of lymphocyte[51].

Antiparasitic and insecticidal effect: The anti-leishmanial activity of the mucilage extract of *Cordia myxa* was examined against promastigotes of *L. infantum* (MCAN/IR/96/LON49)

and *L. major* (MRHO/IR/75/ER) (1×10^6 cells/ ml). They were seeded in a 96-well microtiter plate, in the presence of the serial concentrations (0, 0.61, 1.22, 2.44, 4.88, 9.75, 19.5, 39, 78, and 156 mg/ ml w/v) of the extract and then incubated at 24°C, for 72 hours. Antileishmanial activity was assayed by light microscopy and (3-(4,5-dimethylthiazol-2-yl)-2,5 diphenyl tetrazolium bromide) MTT method. The concentration inhibiting parasite growth by 50% (IC_{50} value) was calculated with a sigmoid dose-response curve. Mucilage extract of *Cordia myxa* was active against promastigotes form of *L. major* and *L. infantum*, with an IC_{50} of 26 ± 2.2 mg/ml and an IC_{50} of 35 ± 2.2 mg/ml, respectively. The survival percentage of *L. major* and *L. infantum* promastigotes after 72 hours treatment appeared concentration dependent. Percentage of survival *Leishmania major* after 72 hours reached 17.68% in a concentration of 156 mg/ml, while the percentage of survival of *L. infantum* promastigotes after 72 hours reached 16.68% in a concentration of 156 mg/ml[67]. *Cordia myxa were tested for* antiplasmodial activity. *Antimalarial effects were quantified with respect to inhibition of parasite growth, as measured by the production of Plasmodium lactate dehydrogenase*. Alkaloids extract of *Cordia myxa* showed good antiplasmodial activity, IC_{50} was 6.2 µg/ml, while dichloromethane extract of *Cordia myxa* showed moderate antiplasmodial activity IC_{50} was 4.2 µg/ml, followed by aqueous and methanol extracts[68]. The crude alkaloid compounds for *Cordia myxa* leaves was tested against *Culex pipines* at (10, 7.5, 5, 2.5, 0) mg /ml. It possessed significant effect on some biological aspects of *Culex pipines*. The results showed that of eggs and larval stages (1^{st}, 2^{nd}, 3^{th}, 4^{th}) was (13.38 , 0, 0, 0, 0) respectively in 10 mg/ml. At the same concentration, it also reduced productivity from 320 egg/ female to 0 egg/ female[69].

Effect on blood pressure and respiratory functions:

The comparative pharmacological activity of *Cordia* fruit mucilage at different stages of maturity was investigated to determine the stage at which active substances were present in high proportions. The fruit mucilage of ripe and unripe *Cordia myxa* (RCm and URCm) decreased rabbit arterial blood pressure in a dose dependent manner without affecting the respiratory rate. Mucilage from both ripe and unripe *Cordia obliqua* (RCo and URCo) decreased rabbit blood pressure and stimulated the respiratory rate. URCo was 12.37-fold more potent as a hypotensive agent than RCo. However the respiratory stimulant effect of RCo is 7-fold more than its own hypotensive effect. Investigation of the mode of action revealed that the hypotensive effect was more likely due to activation of parasympathetic ganglia and dilatation of peripheral blood vessels, whereas the respiratory stimulant effect may partly be due to activation of chemoreceptors in the aortic arch and carotid body. In addition, a sub-effective dose of the ripe fruit mucilage specifically antagonized nicotine-induced hypotensive effect on rabbit and nicotine ganglionic stimulant effect on the isolated guinea pig ileum[70].

The mechanism of broncho-relaxant effect of *Cordia myxa* was studied in sheep trachea. *Cordia myxa* extract inhibited contraction in both epithelium-intact and denuded sheep trachea rings induced by acetylcholine. The scale of relaxation with *Cordia myxa* extract was dose dependent and slightly more potent in epithelium denuded rings than epithelium-intact preparations. L-NAME (10 nM-100 uM) but not DNAME completely inhibited the relaxant effect in a concentration dependent manner. *Cordia myxa* extract -induced relaxation was inhibited by methylene blue (1 -100 uM), and verapamil (100 nM), and removal of extracellular Ca^{2+}. In contrast, *Cordia myxa* extract - induced relaxation was potentiated by Nw-nitro-Larginine (L-NOARG) treatment. Accordingly, the *Cordia myxa* extract -induced relaxation may be due to nitric oxide from aupplied exogenously administered L-arginine as well as endogenous nitric oxide donors such as amino acid and arginine derivatives[71].

Protective effects: The potential protective effects of methanolic extracts of *Cordia myxa* against doxorubicin (DOX)-induced cardiotoxicity was studied in rats. It showed promising cardioprotective potential. Its extracts showed potent *in vitro* radical scavenging and antioxidant properties. It significantly protected against DOX-induced alterations in cardiac oxidative stress markers (GSH and MDA) and cardiac serum markers (CK-MB and LDH activities). Additionally, histopathological examination confirmed the protective effect against DOX-induced cardiotoxicity[(72)].

The hepatoprotective effect of *Cordia myxa.* (CM) extracts was studied in rats. Oxydative liver damage in rats was induced by two agents, carbon tetrachloride (CCl_4) and thioacetamide (TA). Oxydative damage was evaluated by a measurement of aspartate transaminase (AST), glutamate transaminase (ALT) and alkaline phosphatase (ALP) in sera of the rats. Several extracts of *Cordia myxa* were prepared and were fed to experimental animals over a period of two weeks. Liver recovery was assessed by re-measuring the hepatic enzymes and their comparison with the control group. CCl_4 and TA induced comparable oxidative liver damage as measured through hepatic enzymes. A significant (P=0.05) liver recovery was noticed when animals treated with CCl_4/TA were fed with CM extracts[(54)].

The protective role of *Cordia myxa* (CM) extracts (50-500mg/kg) against liver fibrosis induced by carbon tetrachloride or thioacetamide (TA) was investigated in rats. The serum aspartate transaminase (AST), glutamate transaminase (ALT) and alkaline phosphatase (ALP) were significantly improved in rats after administration of (CCl_4) + CM, or (TA) + CM as compared to rats treated alone with CCl_4 or TA[(73)].

The influence of *Cordia myxa* extract on blood picture after administration of a high dose of mefenamic acid (ponstan) was studied in mice. Four groups of mice were used in this experiment, and designated as A, B, C and D. Group A received distilled water and served as control. Group B received plant extract at a dose of 600mg per kg bw. Group C received ponstan at a dose of 100mg per kg bw and group D received the half dose of both treatments simultaneously. After 21 days, all mice were euthanized and blood sample from each animal was taken for examination. The right femur bone of each animal was taken to perform histological sections. The extract showed an enhancing effect on some blood parameters both when the plant extract was given alone or simultaneously with ponstan. The plant extract caused disappearance of mild degenerative and other adverse changes resulted from ponstan on bone marrow[(74)].

Anti- stomach ulcer effect:

The protective effects of *Cordia myxa* fruit extract (CME) was investigated against indomethacin-induced gastric ulcer in rats. Gastric ulceration was induced by a single intraperitoneal injection of indomethacin (30 mg/kg bw). CME was administered orally at a dose of 125 mg/kg bw, while ranitidine (RAN), which used as a reference drug, was given at a dose of 50 mg/kg bw, two weeks prior to indomethacin injection. Pretreatment with CME produced significant reduction in gastric mucosal lesions, malondialdehyde (MDA), and serum tumor necrosis factor (TNFα) associated with significant increase in gastric juice mucin content and gastric mucosal catalase (CAT), nitric oxide (NO), and prostaglandin E2 (PGE2) levels. A similar increase in mucin content, NO and PGE2 was not observed with RAN although it generated a preventive index of 75.9%. RAN significantly increased pH value and decreased pepcin activity, and gastric juice free and total acidity. Histological studies of stomach mucosa confirmed these results. Stomach of rats administrated with RAN

showed leukocytic infiltration in submucosal layer. Meanwhile, stomach of rats administrated CME either alone or with RAN showed no histopathological changes. CME can protect indometacin-induced gastric ulceration due to its antioxidative and mucin enhancing properties. The protection afforded by co-administration of CME and RAN was found to be better than that of RAN alone[50].

Antimicrobial effect: The antimicrobial activity of *Cordia myxa* leaf extracts was studied against three bacterial strains (*E. coli, Staphylococcus aureus* and *Pseudomonas aeruginosa*), and three fungal strains (*Aspergillus niger, Penicillium spp* and *Scytalidium spp*). *Cordia myxa* showed highest inhibition in case of *Staphylococcus aureus* and then *E. coli*. However, it showed no antifungal activity[49].
Extracts of *Cordia myxa* were tested for their anti–HIV–1 activity using the syncytia formation assay. All the extracts showed a weak anti–HIV–1 activity[48].

Antioxidant activity:

The total phenol contents of *Cordia myxa* fruits were 373.91 ± 13.93 mg/100g dry weight, and antioxidant activity (IC_{50}) was 132.53 ± 5.75 µg/ml[56].
Plant extracts were evaluated for their phenolic content and antioxidant activity. Phenolic content was measured using Folin-Ciocalteu reagent and was calculated as gallic acid equivalents. Antiradical activity of *Cordia myxa* extracts was measured by DPPH assay and was compared to ascorbic acid. One milligram of the crude extract was found to be equivalent to 15µg of ascorbic acid[73].

However on another study, DPPH assay was used to measure antiradical activity of the extracts and it was compared with ascorbic acid. Its antiradical activity was measured as 16.34±0.81 that was calculated as 10.0±1.24 ascorbic acid equivalent[74].
Performance of antioxidants is improved by incorporating them into polymer matrix such as polysaccharides based edible coatings. Gum cordia, an anionic polysaccharide extracted from the fruits of *Cordia myxa* could be used as carrier of antioxidants by virtue of its strong adhering and emulsifying properties. The potential of gumcordia as carrier of antioxidants when applied as edible coating on peanuts was investigated. Gum Cordia was compared with carboxymethyl cellulose (CMC) in delivering of antioxidants: butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and ascorbic acid (AA). Coated and uncoated peanuts were stored at 35 °C for 126 days and coating carrier effectiveness was measured by following lipid oxidation using chemical parameters (peroxide value and thiobarbituric acid reactive species) and sensory evaluation (oxidized flavor). Significant differences ($p < 0.05$) between coated and uncoated samples were observed. Gum cordia was found better than CMC to deliver the antioxidants. Gum cordia based coating in combination with BHA/BHT exhibited highest protection (290 % higher shelf life than control) based on peroxide value (40 meq.O_2/kg) followed by gum codia plus BHT (244 %), gum cordia plus BHA (232 %), CMC plus BHA/BHT (184 %), CMC plus BHA (139 %), CMC plus BHT (119 %), gum cordia plus AA (96 %) and CMC plus AA (46 %)[75].

Using of *Cordia myxa* as pharmaceutical preparations:

The dilution and rapid elimination of topically applied drugs due to the flushing action of saliva was a major difficulty in the effort to eradicate infections of oral cavity. Utilization a proper delivery system for incorporation of drugs has a major impact on drug delivery and such a system should be formulated for prolonged drug retention in oral cavity. The use of mucilage of *Cordia myxa* as a mucoadhesive material in production of

chlorhexidine buccal tablets and its substitution for synthetic polymers such as HPMC was carried out. The influence of mucilage concentration on the physicochemical responses (hardness, friability, disintegration time, dissolution, swelling, and muco-adhesiveness strength) were studied and swelling of mucilage and HPMC was compared. The evaluated responses included pharmacopoeial characteristics of tablets, the force needed to separate tablets from mucosa, and the amount of water absorbed by tablets. In comparison to HPMC, the rise of mucilage concentration in the formulations increased disintegration time, drug dissolution rate, and reduced MDT. Also, compared to 30% HPMC, muco-adhesiveness strength of buccal tablets containing 20% mucilage was significantly higher. Therefore, the presence of *Cordia myxa* powdered mucilage significantly affect the tablet characteristics, and increasing in muco-adhesiveness[(76)].

On the other hand, cream containing *Cordia myxa* fruits was prepared using different bases and emulsifiers and evaluate them at *in vitro* condition to achieve the best formulation. Cream formulations contained 5% of aqueous extract of *Cordia myxa* fruits and different amounts of lipids and surfactants were prepared by fusion method. Some hysicochemical properties of formulations such as pH, consistency, viscosity, and physical stability, were evaluated. Antimicrobial challenge test against *Pseudomonas aeruginosa* was also carried out. All of the formulations were homogeneous with an odor and color related to *Cordia* extract, a proper consistency, a pH average of 7.175 and average of 9010 cps for viscosity. They were physically stable and there was no coalescence or creaming after 1, 3, and 6 months of storage. No sedimentation and phase separation were observed after centrifugation at 2000 rpm and no microbial growth was seen after the period of storage. As a conclusion *Cordia myxa* can be formulated as a topical cream[(77)].

III. CONCLUSION

This review discuss the chemical constituent, pharmacological and therapeutic effects of *Cordia myxa* as promising herbal drug because of its safety and effectiveness.

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