



Article Review: *Cordia myxa* L.: The Gift of the Nature, A Review

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Abstract: *Cordia myxa* L. is one of the medical plants that plays an important role in the treatment of many diseases. There are many studies explained that *C. myxa* can show anti-inflammatory, anti-diabetic, antiparasitic, antimicrobial and immunomodulatory properties. This review was focused on the active compounds and medical effects of *C. myxa*. The fatty acids contents are particularly high (9.9%). Sodium and potassium constitute the largest mineral proportion (13 ppm and 29 ppm respectively) of the fruit. However, the toxic heavy metals such as lead, cadmium, chromium and copper have not been found in the fruit. This gives an additional significant benefit of the medical uses of the plant. The content of alkaloids, saponin, polyphenols, and comarine were recorded and was relatively high compared to steroids, resins, glycosides, tannins, and gum that found to be in less amounts. When the mucilage was extracted, the alkaloids constitute more than 35%. By using the Folin-Ciocalteu, *C. myxa* extracts have a high Phenolic content. The antibacterial activity against gram-negative bacteria were included in the fruit mucilage extract while the alcoholic extracts have no effect on all bacterial isolates. In addition, the mucilage extract showed anti-parasitic activity when it was tested against *Leishmania infantum* promastigotes. However, the highest concentration of extract significantly reduced the amounts of lymphocytes. Moreover, ethanolic extracts of *C. myxa* fruits give rise to leucocyte and lymphocyte count. Future research needs to be done on this kind of herbs which could show high medicinal activity.

Key words: *Cordia myxa*, nutritional constituents, chemical constituents, antimicrobial activity, antiparasitic, immunomodulatory.

Introduction

The medicinal plants spread in different places around the world which are widely used directly and indirectly in many medical applications. Different kinds of drugs were mainly made from these plants, providing the medications with the properties of anti-inflammatory, anti-bacterial, anti-fungal, anti-diabetic, anti-cancer, anti-oxidant, anti-hypertensive, anti-mitotic actions and the antibiotic properties with promising vision around lacking of the side effects badly shown by chemical drugs (Anand *et al.*, 2019).

The world's cultures keep in their mind special broad knowledge of how, when and where to use herbal drugs. By looking to the cultural habits relate to the world nation, Plants were used by 75% of the world's population for care and prevention. (Orhan, 2012). Nearly 72 000 plant types were projected for having medicinal properties of which, India has more than 3 000 plant types showing medicinal standards (Saranya *et al.*, 2013). *C. myxa* fruit, in Iraq known as "Bumber", is one of the major classes of family Boraginaceae that has 300 species have been recognized worldwide in warmer area such as Central and South America, Asia and Africa (Schmelzer & Gurib-Fakim, 2008). This plant has many medicinal uses as it has very effective ingredients (Aimey *et al.*, 2020). *C. mixa* distribute around many places with public names as Lasura, Assyrian plim, Pidar, Panugeri, Naruvilli, Geduri, Spistan, Burgund duluwanan or Ntege.

Features of *Cordia myxa*

C. myxa is characterized by its broad, alternative, oval shaped. In the flowering season, this kind of herbs carries many white

flowers. The diameter of fruits approximately 15-20 mm and it features a rounded shape set in collections (Fig. 1). Their color yellow is turns blackish after dry. The pulp, has a sweet taste, very hard and mucilaginous (Arbonnier, 2000).

The seeds of *C. myxa* can be considered as an excellent antioxidant agent in our life (Tian *et al.*, 2014). The sweeter contents of *C. myxa* is considerably high a sweeter fruit due to the high proportion of sucrose, glucose, fructose

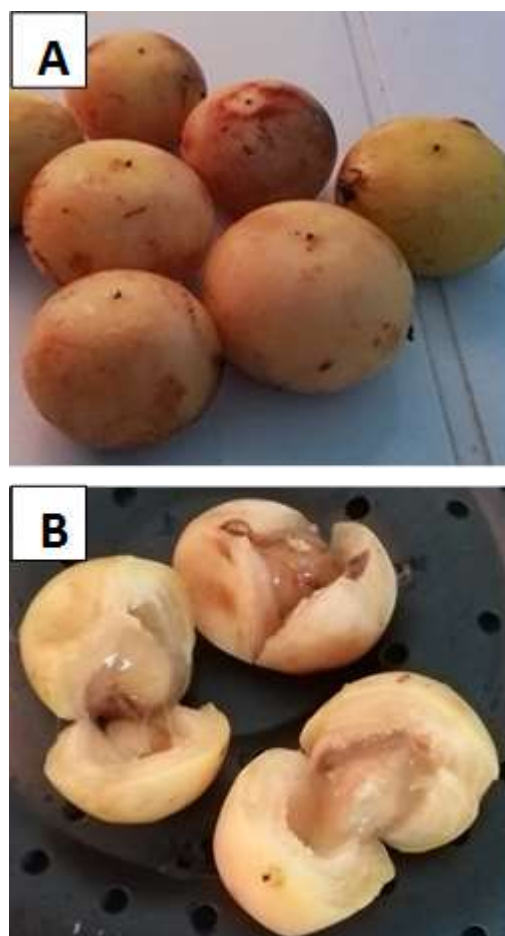


Fig. (1): The fruit of *Cordia myxa*, (A): The fruit after collecting by the authors from a rural place in Al-Rumaitha city, in Al-Samawah city, southern of Iraq. (B): Cutting down the fruit; shows the internal appearance and contents of this plant.

and high total dietary fibers, which in turn can play a major role in limiting the risky effects of several contagious diseases (Aberoumand & Deokule, 2010). Also, *C. myxa* fruit consider as a rich source of proteins, fat, carbohydrates, ash, and essential minerals such as K, Na, Ca, Fe and Zn (Aljeboury, 2021). This plant has high levels of glycosides, flavonoids, sterols, saponins, terpenoids, alkaloids, phenolic acids, gum and mucilage (Jamkhande *et al.*, 2013). Therefore, the fruit is widely and popularly used for treatment of chest and urinary infections, wound healing (Kuppast & Nayak, 2006), an anthelmintic, diuretic, astringent, demulcent, expectorant agent, anti-inflammatory, and antiarthritic (Abdallah *et al.*, 2011; Al-Musayeib *et al.*, 2011). This review aims to comparison between previous studies in determining the chemical components of the *C. myxa* plant. In addition, it will highlight on the pharmacological effects of *C. myxa* and focus on its antimicrobial activity on the known microorganism.

Geographical distribution

C. myxa belongs to Boraginaceae family. It is one of the subtropical plants farmed in central and southern Iraq, especially Basrah (Al-Snafi, 2016). The range of its distribution could include the zone extending from the eastern parts of the Mediterranean to eastern Indian parts and was presented in ancient times in tropical Africa, tropical Asia, and Australia. Recently, it was recorded in the Americas (Plants list for *C. myxa*).

Plant classification (ITIS, 2021)

Kingdom: Plantae

Subkingdom: Tracheobionta

Superdivision: Spermatophyta

Division: Magnoliophyta

Class: Magnoliopsida

Subclass: Asteridae

Order: Lamiales

Family: Boraginaceae

Genus: *Cordia* L.

Species: *Cordia myxa* L.

Morphology of *C. myxa*

C. myxa is dioecious plant or small tree equal to 12 m high; trunk twisting; bark grey, branches distributing, making a thick crown; this plant possesses branchlets hirsute. Its leaves look different, simple; stipules are absent, and the petals length is 0.5-4.5 cm. The edge often ovate, 3-18 cm × 3-20 cm, apex curved to acuminate, borders complete to rough. Inflorescence appear as a slack deadly or little panicle, 3-8.5 cm long, many-flowery; lacking of bracts. Flowers are unisexual, steady, white to creamy; pedicel 1–2 mm long (Jasiem *et al.*, 2016).

Male flowers have campanula cups 4.5-5.5 mm long, corolla tube is 3-lobed, hirsute inside, and glabrous outside. 3.5-4.5 mm long, 5 oval lobes, c.5 mm × 2 mm, the stamens introduced at corolla gorge, threads 1.5-3.5 mm in length. While female flowers contain a campanulate calyx like tubular shape which is 6-8.5 mm in length, sporadically 3-4-pointy, densely hairy within, glabrous outside, corolla tube 5-7 mm long, corolla tube 4.5–6.5 mm in length, contain 4-6 lobes, ovoid in shape, 5-7 mm long,

the staminodes rolled up with sterilized anthers. Also, the female's ovary is big in size, ellipsoid to ovoid in shape, style 8–9 mm in length, 4-celled with 4 branches 4-5 mm in length. The fruits of the plant have round to oval drupe 2-3.5 cm long, at the base surrounded by the crescent yellow, apricot or blackish calyx. Pyrene is approximately ellipsoid to globose, 12 mm long, intensely wrinkly (Jasiem *et al.*, 2016).

The chemical constituents

Many previous studies regarding the chemical contents of *C. myxa* fruits showed that fruits are rich in carbohydrate, fat, protein and ash fruit. The highest rate is the carbohydrate and ranging between (57-63%). The rate of protein was 8.3-8.6% while the lowest rate was Ash with proportion of 6.7% (Al-Snafi, 2016; Al-Hamdani & Al-Faraji, 2017). However, the percentage of fat was 9.9% according to (Al-Hamdani & Al-Faraji, 2017) while, (Al-Snafi, 2016) found that 2.2% of the chemical content was fat. The last study was relatively agreed with (Aberoumand, 2011) who mentioned that the concentration of carbohydrates and crude fat were 48.48% and 2.5 % respectively.

Fatty acids

The plant composed of high fatty acids contents and concentrations. Al-Hamdani & Al-Faraji (2017) found that the percentage of fat was 9.9%. Two kinds of saturated fatty acids; C12 and C14, were found at proportion of 48.3% and 15.8% respectively. While, the rate of oleic acid (unsaturated fatty acid) was 12.4% (Al-Hamdani & Al-Faraji, 2017) which plays a very essential role for health and nutrition of human (Sales-Campos *et al.*, 2013).

Mineral analysis

According to some mineral analytic research results, the amounts of potassium (29 ppm), and sodium (13 ppm) represent the greatest proportion of minerals found in the fruits (Aberoumand, 2011; Al-Hamdani & Al-Faraji, 2017). Other minerals distinguished in reasonable quantities were Iron and Magnesium, which were about 0.5 and 0.2 ppm respectively. While, Calcium, Manganese, and copper were 0.07, 0.02 and 0.01 ppm respectively. It is known that minerals can be incorporated in many valuable biological processes. The role of Calcium could be contribution in bone formation and blood coagulation. The main chief of inorganic cation in the extracellular tissue fluids is Sodium (Juel, 1988), while potassium can mainly work as the cation of intracellular cell and also could help in excitability of nerve and muscle (Vaughan, 1991). Iron is vital part of body components as it is a functioning part of haem, an important part of hemoglobin that is essential in respiration (Maughan *et al.*, 2013). The fruits have no lead, cadmium, chromium, and copper thereof, this plant has a very low toxic proportion with heavy metals (Okwu, 2001), While these results did not match the results of the study by Al-Snafi (2016) where the results indicate that sodium (1.62mg. g⁻¹), potassium (7.83 mg. g⁻¹), calcium (0.46mg. g⁻¹), zinc (0.35mg. g⁻¹) and iron (0.51mg. g⁻¹).

Phytochemicals

The Phytochemical screening of *C. myxa* fruits exhibited the presence of alkaloids, saponin, polyphenols, and comarine with relatively high amounts contents. While, steroid, resins, glycosides, tannins, and gum were less

quantities. These phytochemicals have positively contributed according to their medicinal importance and physiological action. For example, the pharmacology of saponins involves expectorant, antiinflammatory, vasoconstrictive, hypocholesterolemic, hypoglycaemic, antiparasitic, hypoglycaemic and several others (Sparg *et al.*, 2004). The effects of glycosides are not common; however, their toxic effects could include some adverse impact such as reduction of heart rate, sympathetic activity, and systematic vascular resistance (Ferguson *et al.*, 1989). While Steroidal compounds are very important in pharmacological medications because of their association with sex hormone (Tanner *et al.*, 1976).

The fruits have no lead, cadmium, chromium, and copper thereof, this plant has a very low toxic proportion with heavy metals. The fruit extract has a high concentration of phenolic compounds about 11.1 ± 1.47 mg.g⁻¹ gallic acid equivalent, which can be obtained by hand macerating the fruit shed. Methanol can be used to extract the solvent phenolic acids of *C. myxa* fruits. The whole phenolic compound was 402 mg.100g⁻¹ (Aberoumand & Deokule, 2008). *C. myxa* fruits have phenol contents of approximately 373.91 ± 13.93 mg.100g⁻¹ dry weight, IC50 for antioxidant activity was 132.53 ± 5.75 mg.ml⁻¹. (Souri *et al.*, 2008). The plant contains eight carotenoids, were determined and recognized. Their percentages were as follows: canthaxanthin 2.4%, 19'-Z-violaxanthin 6.4%, lutein 18.9%, chlorophyll b%, violaxanthin 7.3%, allomer 1.7%, chlorophyll-b 22.4%, chlorophyll-a 29.4%, chlorophyll allomer 1.9%, β -carotene 7.0% and α β -carotene 1.2% (Al-Snafi, 2016).

Polyphenols extracted constituent showed anti-inflammatory, antibacterial, antiviral, anti-allergic, and antineoplastic activity (Al-Hamdani & Al-Faraji, 2017).

Nutritional and anti-nutrient properties

According to several studies *C. myxa* fruits' nutritious and anti-nutrient properties, reported that the fruit of *C. myxa* has 100g of the dried crop: glucose 12.75, fructose 9.38, sucrose 29.09, water 6.21, and starch 29.09. It also had 248.0 mg.100g⁻¹ of phytic acid and 1.39 TIU.g⁻¹ of trypsin inhibitor (Al-Snafi, 2016).

The antimicrobial activity

Extracts of fruits (Mucilage)

The mucilage extract of *C. myxa* fruit showed antibacterial activity against gram-negative bacteria isolated from urine samples. Different mucilage extract concentrations (1000, 500, 250, 125 and 63.5 mg. ml⁻¹) exhibit variable inhibition zones (15, 13, 13, 12 and 12 mm) respectively in against *E. coli* isolates while at concentration 500, 250 and 125 (mg.ml⁻¹), the inhibition zones were 10, 10 and 8 mm respectively against *Klebsiella pneumonia* bacteria. As well as the mucilage extract of *C. myxa* fruit has no effective against either *Streptococcus pyogenic* or *Haemophilus influenza* isolates from sputum samples (Jasiem *et al.*, 2016). The inhibition of bacteria increased considerably with increased concentration of fruit extract related to antibiotic inhibition (Al-Hamdani & Al-Faraji, 2017).

Extracts of leaves (Alkaloids)

Jassem *et al.* (2016) explained that the alcoholic extracts of *C. myxa* leaves can be inactivate against all bacterial isolates. However, (Pandey *et al.*, 2014) found that *C. myxa* give a good inhibition zone against gram-positive bacteria (*S. aureus*) and gram-negative bacteria (*E. coli*) in the high concentration extracts of *C. myxa* leaves that could start with 4.5%. Moreover, they mentioned that the leaf extract of *C. myxa* cannot be effective on fungi (Pandey *et al.*, 2014). While Ali (2008) did not agree with Jassem *et al.* (2016) as he explained that the extracts of *C. myxa* leaf can show antimicrobial activity against three kinds of bacterial isolates (*Escherichia coli*, *P. aeruginosa* and *S. aureus*), and three mycological isolates (*Penicillium* spp., *Aspergillus niger* and *Scytalidium* spp.). While Pandey *et al.* (2014) found that the alkaloid extract has not antifungal activity.

Antiparasitic and insecticidal effects

The mucilage extract of *C. myxa* has an anti-leishmanial activity. The extract was studied against promastigotes of *L. infantum* (MCAN/IR/96/LON49) and *L. major* (MRHO/IR/75/ER) (1×10^6 cells.ml⁻¹) (Saki *et al.*, 2015). In this study, several concentrations were prepared of the mucilage extract (0, 0.61, 1.22, 2.44, 4.88, 9.75, 19.5, 39, 78, and 156 mg mg. ml⁻¹ w/v) and added to the promastigotes. After that, they were plated in a 96-well microtiter plate, followed by a 72-hour incubation period at 24°C. The action of antileishmanial was evaluated under the light microscope using a 3-[4,5-dimethylthiazol-2-yl]-2,5 diphenyl tetrazolium bromide (MTT) stain. The growth of parasite was checked via using 50% IC50 value. IC50 of 35 ± 2.2 mg.

ml⁻¹ and an IC50 of 26 ± 2.2 mg. ml⁻¹ of *C. myxa* mucilage extract showed effective lethal dose against promastigotes of *L. major* and *L. infantum*. After 72 hours, the percentage of existence *L. major* and *L. infantum* reached around 16-17% when 156 mg mg. ml⁻¹ mucilage extract of *C. myxa* was used (Saki *et al.*, 2015). Also, *C. myxa* has antiplasmodial activity as the plant can inhibit parasitic growth and determined through the Plasmodium lactate dehydrogenase production. The antiplasmodial activity of alkaloids extract of *C. myxa* could be high (the IC50 was 6.2µg.ml⁻¹), while the antiplasmodial activity of dichloromethane extract which is moderate and the IC50 was 4.2µg.ml⁻¹. However, methanol and aqueous extracts did not have any activity against Plasmodium (Sanon *et al.*, 2013).

Immunomodulatory activity

The *C. myxa* fruit's aqueous extract was tested on the immune-modulatory activity in mice injected with hydatid cyst fluid antigen HCFAg. Different parameters were studied such as Mitotic index (MI), Delayed type hypersensitivity (DTH), and spleen histopathological changes (Ali, 2008). After 10 days of treatment, the treated mice with aqueous extract of *C. myxa* fruit have increase in the size of the spleen. According to histopathological analysis, the spleen had marked hyperplasia and sometimes developed large follicles. Aqueous extract of *C. myxa* fruits stimulates cell-mediated immune responses in mice. The ethanolic extract effect of *C. myxa* on immune-modulation of mice was examined *in vitro* using the lymphoid and phagocytes of the mouse (males' type BALB/c) and tested by NBT stain. The results showed

that the concentration of lymphocytes was significantly declined compared with negative and positive control. The use of the NBT stain revealed that there is a significant inhibition in the ratio of formazan granules (without cytotoxicity). The ratio of cytotoxicity was increased at higher concentrations of extract, and the number of lymphocytes and phagocytes was significantly reduced ($P < 0.05$). Moreover, the ethanolic extracts of *C. myxa* fruits rise leucocyte and lymphocyte counts (Ali, 2008).

Antioxidant effect

Several molecules (enzymes, vitamins, lipids, etc.) can be classified as antioxidants that help suppress free radicals that form in the cells in order to help the organism to produce energy. However, an excessive number of free radicals, such as superoxide, hydroxyl, peroxy, and peroxy radicals are also produced (Valko *et al.*, 2007). A large number of widely accepted and widely acknowledged and well-recognized medical conditions, including cardiovascular disease, obesity, insulinoma, and dementia, have been shown to arise from the production of radicals and their harmful effects on fats and proteins in cells (Maddu, 2019). This innate organism-protecting strategy to protect the cells from the damaging effects of free radicals can only be partly achieved through superoxide dismutase (SOD), glutathione reductase (GR), and the reductase (GSH-RADC) (He *et al.*, 2017). Nowadays, the use of herbal medicines has become increasingly widespread as a treatment for therapeutic issues (Yang *et al.*, 2017). Medicinal plants are of interest because of their pharmacological activities, their economic feasibility, and low toxicity, all of which has resulted in them being the subject of

extensive research (Ayoub & Mehta, 2018). A vast majority of these plants are used for treatment of wounds, cancer, and other inflammatory conditions (Abdel-Aleem *et al.*, 2019). In multicellular organisms, programmed cell death or apoptosis refers to the killing of a cell with a protein released by another cell or organism.

Conclusion

C. myxa fruits known as "Bumber" is one of the major classes of family Boraginaceae that have been recognized worldwide in warmer area such as Central and South America, Asia and Africa. A large number of earlier studies have shown that the chemical content of *C. myxa* fruit to be rich in carbohydrate, fat, protein, and ash. The plant contains high amounts of fatty acids 9.9%. The amounts of potassium (29 ppm) and sodium (13 ppm) which represent the largest proportion of minerals found in the fruit, according to some mineral analytical results. Lead, cadmium, chromium and copper have not been found in the fruit, and this is of significant benefit to vital organs because such heavy metals have been identified as toxic. The phytochemical screening of *C. myxa* fruits showed that the presence of relatively high content of alkaloids, saponin, polyphenols, and coumarin. While, there were less quantities of steroids, resins, glycosides, tannins, and gum. Mucilage extraction shows that the alkaloid constitutes more than 35 per cent. The FolinCiocalteu reagent was used to determine the Phenolic content of *C. myxa* extracts, which was measured as gallic acid equivalent. *C. myxa* fruit mucilage extract showed antibacterial activity against gram-negative bacteria isolated from urine samples. The

alcoholic extracts of *C. myxa* leave have no effect on all bacterial isolates. The mucilage extract has anti-leishmanial activity. The extract was tested against *L. infantum promastigotes*. However, the highest concentration of extract significantly reduced the amounts of lymphocytes. Moreover, ethanolic extracts of *C. myxa* fruits give rise to leucocyte and lymphocyte count.

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البمبر *Cordia myxa*، هبة الطبيعة: مراجعة بحثية

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المستخلص : البمبر *Cordia myxa* يعتبر من النباتات الطبية التي تلعب دورًا مهمًا في علاج العديد من الأمراض. هناك العديد من الدراسات التي أوضحت أن *C. myxa* يمكن أن تظهر تأثيرات مضادة للالتهابات، ومضادة للسكري، ومضادة للطفيليات، ومحفزة للمناعة ومضادة للميكروبات. تم تحضير هذه المراجعة للتركيز على المركبات النشطة والتأثيرات الدوائية لثمار *C. myxa*. حيث ان محتويات الاحماض الدهنية عالية بشكل خاص بنسبة 9.9%. يشكل الصوديوم والبوتاسيوم أكبر نسبة معدنية (13 جزء في المليون و 29 جزء في المليون على التوالي) من الفاكهة. ومع ذلك، لم يتم العثور على المعادن الثقيلة السامة مثل الرصاص والكاديوم والكروم والنحاس في الفاكهة. هذا يعطي فائدة إضافية كبيرة من الاستخدامات الطبية للنبات. تم تسجيل محتوى القلويات والسابونين والبوليفينول والكومارين وكان مرتفعًا نسبيًا مقارنة بالستيرويدات والراتنجات والجليكوزيدات والتانينات والصبغ التي وجدت بكميات أقل. عندما تم استخلاص الصمغ النباتي، فان القلويدات الموجودة تشكل أكثر من 35%. وباستخدام كاشف Folin - Ciocalteu، فان مستخلصات *Cordia myxa* تحتوي على نسبة عالية من الفينول. مستخلص الصمغ النباتي للفاكهة تضمن فعالية مضادة للبكتريا خصوصا ضد البكتريا السالبة لصبغة كرام بينما المستخلصات الكحولية لا تمتلك تأثير على العزلات البكتيرية. بالإضافة إلى ذلك، أظهر مستخلص الصمغ نشاطًا مضادًا للطفيليات عندما تم اختباره ضد *L. promastigotes* و *Leishmania infantum*. ومع ذلك، فإن أعلى تركيز للمستخلص يقل بشكل كبير من كميات الخلايا الليمفاوية. علاوة على ذلك، فإن المستخلصات الإيثانولية لثمار *C. myxa* تؤدي إلى زيادة عدد الكريات البيض والخلايا الليمفاوية. يجب إجراء أبحاث مستقبلية على هذا النوع من النباتات الطبية التي يمكن أن تظهر نشاطًا طبيًا عاليًا.

الكلمات المفتاحية: فاكهة البمبر، المكونات غذائية، المكونات الكيميائية، الفعالية المضادة للميكروبات، الفعالية المضادة للطفيليات، المحفزات المناعية.