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Extraction of gum from *Cordia myxa* L. fruit and evaluation of its functional and physicochemical properties

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Abstract

Objective

Gum from the fruit of *Cordia myxa* L. has various applications in various industries, including food and nutrition-related industries, due to its natural origin and functional behavior. Therefore, the aim of this study was to extract the gum from the fruit of the said plant and evaluate its chemical composition, physicochemical properties and functional properties.

Materials and Methods

A water-based extraction method was used to extract gum from the fruit of *Cordia myxa* L.. Its chemical composition was then analyzed. Standard laboratory methods were used to measure physicochemical properties such as pH, bulk density, impact density, and swelling coefficient. In addition, the functional properties of the gum were also considered in the study. These properties include water holding capacity, oil holding capacity, emulsifying ability at different concentrations (0.1, 0.2, and 0.3%), foaming capacity, and stability at room temperature (25 °C).

Results

When the chemical composition of the gum of *Cordia myxa* L. fruit was measured, it was found that it had 4.94% moisture, 1.43% protein, 8.89% fat, 5.33% ash and 79.41% total carbohydrate. The pH value of the gum (6.23) showed that it was almost neutral in nature. The bulk and impact densities were found to be 0.39 and 0.37 g/cm³, respectively, for the studied gum. While, the swelling factor reached 3.9%. Functional tests showed that the gum had good water-holding and

oil-holding capacities of 13.41 and 4.30 g/g of gum powder, respectively. Emulsifying ability increased with concentration. It reached 72.47%, 74.46%, and 76.69% at 0.1%, 0.2%, and 0.3% gum concentrations. Foaming capacity slightly decreased as concentration increased. While, foam stability improved, reaching up to 97% at the highest concentration.

Conclusion

The results indicate that *Cordia myxa* L. fruit gum has desirable physicochemical and functional properties. Due to its good water and oil retention, emulsifying ability, and foam stability, this natural gum could be considered a promising ingredient for use in food and other industrial applications.

Keywords: *Cordia myxa* fruits, *Cordia myxa* gum, functional properties, physicochemical properties

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Introduction

Natural polysaccharides obtain from plants. They have received increasing attention. Because they widely use in food, pharmaceutical, and industrial applications. This growing interest is related to several advantages. Some of them are their natural availability, safety for human use, low cost, and environmentally friendly nature. In addition, many plant polysaccharides show good water absorption or swelling ability. They remain stable under different pH conditions. It increases their usefulness in various formulations (Cui et al., 2007). For these reasons, plant gums and polysaccharides are considered valuable alternatives to synthetic materials. *Cordia myxa* L. is a fruit-bearing plant. It belongs to the Boraginaceae family. In Iraq, this fruit is locally known as “Bumber.” The *Cordia* genus includes nearly 300 species. Their natural habitat is scattered throughout most of the world, including Asia, India, Africa, and

America (Schmelzer & Gurib-Fakim, 2008; Saeed et al., 2022). This wide distribution in the world, as well as its traditional uses in various places, has led researchers to try to study its chemical and functional properties. The fruits of *C. myxa* have been found to be rich in nutrients, especially carbohydrates. The carbohydrate content of the fruits ranges from 57% to 63%. This percentage indicates that its polysaccharide level is high. Its protein content varies from 8.3 to 8.6. While, ash and fat contents were about 6.7% and 9.9%, respectively (Al-Snafi, 2016; Al-Hamdani & Al-Faraji, 2017). This amount of chemical compounds indicates that the fruit must have a good gum balance. Various types of polysaccharides are present in the fruits of *C. myxa* and have been identified so far. Some of these polysaccharides include D-galacturonic acid, xylose, galactan, arabinoglucan, D-glucose and L-arabinose (Thirupathi et al., 2008; Ahuja et al., 2013). One of the most important of them is galacturonic acid, which is of particular importance. Because it provides carboxylic groups. These groups can form hydrogen bonds with mucin glycoproteins. They may improve adhesion to biological surfaces. In addition, polysaccharides extracted from *C. myxa* show suitable rheological properties. They are able to form viscous gels in aqueous systems even at low concentrations. Such behavior makes these polysaccharides suitable for use as mucoadhesive Auxiliary substance and functional hydrocolloids in different formulations (Benhura & Chidewe, 2011; Mohamed et al., 2022). Based on these properties, *C. myxa* fruit gum represents a valuable natural material. Therefore, the present study aimed to extract gum from Iraqi *Cordia myxa* fruits and to evaluate its qualitative, functional, and physicochemical characteristics.

Materials and methods

Sample collection and preparation: Fresh *Cordia myxa* fruits were collected from agricultural lands in Najaf province, Iraq. To remove visible contaminants and foreign matter, the fruits were first cleaned manually. After that, water was used to wash them. At this stage, we separated the seeds from the fruit pulp. In order for the edible part of the fruit to gain a constant weight, they were dried in a laboratory oven at 40°C. An electric grinder was used to powder the dried fruits in a laboratory oven. The resulting powder was placed in packaging containers and stored at -18°C for analysis in the next steps.

Extraction of *Cordia myxa* gum: The methods used by Jasib Habeeb (2022) and Abdul Hadi (2011) were used with some modifications to extract the gum. For this, 300 ml of distilled water was mixed with 30 g of dried fruit powder and the resulting mixture was kept at 37 °C for 6 h. During this step, it was stirred occasionally. To remove the insoluble residues of the extracted mixture, we filtered it through a clean cloth. The filtrate was dried in an oven at 45 °C for 6 h to obtain the gum extract. The dried gum was stored at 4 °C until further use.

Chemical composition analysis: AOAC standard methods (Kavanagh, 1981) were used to determine the chemical composition of the extracted gum. Its chemical composition showed that it contained moisture, protein, fat, ash and total carbohydrates. All our analyses were performed in triplicate and the results were reported as percentages.

Moisture content: Moisture content was determined by drying 2 g of gum sample in a hot air oven at 105 °C until a constant weight was achieved.

Protein content: Nitrogen content was measured using the Micro-Kjeldahl method. The protein content was calculated by multiplying the total nitrogen value by the appropriate conversion factor.

Fat content: Fat content was determined using a Soxhlet extraction system. Five grams of sample were extracted with hexane (boiling range 40-60 °C) for 6 h using a cellulose extraction thimble.

Ash content: Ash content was measured by incinerating 5 g of the gum sample in a muffle furnace at 550 °C until white ash was obtained.

Carbohydrate content: Total carbohydrate percentage was calculated by difference using the following equation:

$$\text{Total carbohydrates (\%)} = 100 - (\text{Moisture} + \text{Protein} + \text{Fat} + \text{Ash})$$

Physicochemical properties-pH measurement: A 1% (w/v) gum solution was prepared in distilled water and stirred for 5 min using a magnetic stirrer. The pH was measured at 25 °C using a calibrated pH meter (Monrroy et al., 2017).

Bulk and tapped density: Bulk density was measured by placing 10 g of gum powder into a 100 mL graduated cylinder and recording the occupied volume. Tapped density was determined by tapping the cylinder 50 times and recording the final volume, according to Huanbutta and Sittikijyothin (2018).

Functional properties-Water holding capacity: To calculate the water holding capacity, 0.2 g of gum powder was mixed with 10 ml of distilled water and stirred for 1 min. Then, a centrifuge was used at 2200 rpm to centrifuge the mixture for 30 min. The supernatant was discarded and the absorbed water was reported as grams of water per gram of sample (Monrroy et al., 2017).

Oil holding capacity: To calculate the oil holding capacity, 0.2 g of gum powder was mixed with 10 ml of sunflower oil and stirred for 1 min. Then, a centrifuge was used at 2200 rpm to centrifuge the mixture for 30 min. The supernatant was discarded and the absorbed oil was reported for each sample (Monrroy et al., 2017).

Emulsifying properties: We used the method of Martinza et al. (2017) to determine and calculate the emulsifying capacity and stability. Gum solutions at concentrations of 0.1, 0.25, and

0.5% (w/v) were prepared in deionized water and adjusted to pH 7. First, we mixed each solution sample with sunflower oil at a ratio of 160:40 (v/v). The resulting mixture was homogenized for 1 minute and then centrifuged for 10 minutes at 8000 rpm. We evaluated the stability of the emulsion after heating at 85°C for 30 minutes.

Foaming properties: The method of Mohammadian and Alavi (2016) was used to evaluate foaming capacity and stability. For this, we mixed gum solutions (0.1, 0.2, and 0.3%) with distilled water and stirred for 3 minutes at 1500 rpm. We recorded the foam volume after 10 seconds and determined the foam stability after 30 minutes.

Results and discussion

Chemical composition of *Cordia myxa* gum: Table 1 shows the chemical composition of the gum extracted from the fruits of *Cordia myxa* in this study. The parameters reported were moisture, protein, fat, ash and total carbohydrate. These indicate that its water content is low and this is desirable for storage stability. The values of these parameters were obtained for protein, fat, ash and carbohydrate content as 1.43%, 8.89%, 5.33% and 79.41% respectively. As it is clear, the carbohydrate content is high. This indicates that the extracted material is mainly composed of polysaccharides. In a study by Haq et al. (2014) reported higher moisture (8.11-8.45%) and protein content (12.1-15.45%) for *Cordia myxa* gum compared to the results of our study. These differences can be attributed to the difference in the extraction method used as well as different drying conditions in the two studies. In their study, the ash content was reported to be between 0.95% and 1.75%. Their reported values were lower than those obtained in our study. The results of other researchers (Fekri et al., 2008) also showed such differences with our results and others. The reason for this can be attributed to environmental growth conditions, soil type, plant genetics and extraction methods.

Table 1. Chemical composition reported *Cordia myxa* gum (% , dry basis) in this study

Component	Percentage (%)
Moisture	4.94
Protein	1.43
Fat	8.89
Ash	5.33
Carbohydrates	79.41

Values show the mean of three replicates.

Physicochemical properties of *Cordia myxa* gum: Table 2 shows the physicochemical properties of the extracted gum. The pH of the 1% gum solution was neutral (6.23). Sodam et al.

(2012) also reported a neutral pH (6.32) for basil seed gum. In aqueous systems, this pH value performs a similar behavior. In our study, the bulk density of *Cordia myxa* gum was 0.39 g/cm³ and the impact density was slightly lower, equal to 0.37 g/cm³. One of the important factors affecting the determination of packaging, transportation cost and handling properties of the powder is the bulk density (Hebert & Sales, 2011). The lower the bulk density, the higher the porosity and the larger the interparticle spaces, which can improve the flow and mixing behavior (Tosif et al., 2021). On the other hand, the lower the density, the weaker the adhesion between particles, which affects the compressibility (Shende et al., 2015). Two widely used indicators of powder quality and packing efficiency are bulk and impact densities (Singh et al., 2010). The swelling coefficient of the gum in distilled water was found to be 3.9, which indicates the ability of the gum to absorb water and expand. Research results have shown that the difference in swelling behavior is often related to the extraction conditions and molecular structure of the polysaccharides. The higher the swelling capacity, the greater the water absorption. This is because the presence of hydrophilic groups traps water in the polymer network and leads to gel formation (Panda et al., 2014).

Table 2. Calculated physicochemical properties for *Cordia myxa* fruit gum in the current study

Parameter	Value
pH	6.23
Bulk density (g/cm ³)	0.39
Tapped density (g/cm ³)	0.37
Swelling coefficient	3.9

Functional properties of *Cordia myxa* gum: Table 3 and Figures 1-3 show the results of the functional properties of the extracted gum in the present study. These properties include water-holding capacity, oil-binding capacity, emulsifying ability, and foaming behavior.

Water holding capacity (WHC): The water-holding capacity of *Cordia myxa* gum was 13.41 g water/g gum powder. This value is comparable to that reported for lemon basil seed gum (12.31 g/g) by Guan et al. (2023). Lorenc et al. (2022) reported a wide range of water-binding values (7.03-15.94 g/g) for flaxseed gel. High WHC is mainly related to the presence of hydroxyl (OH) groups in polysaccharides, which enhance water absorption and retention (Dantas et al., 2021; Malviya et al., 2011). High water-holding capacity is beneficial in food products. Because it improves texture and reduces moisture loss, especially in frozen foods (Nilofar et al., 2024). The water absorption capacity of *Cordia myxa* gum reached 16.67 mL water/g gum powder.

Table 3. Functional properties of *Cordia myxa* gum

Property	Value
Water-holding capacity	13.41 g water/g gum powder
Oil-binding capacity	4.30 g oil/g gum powder

Oil binding capacity (OBC): The oil-binding capacity of the gum was 4.30 g oil/g gum powder when sunflower oil was used. Variations in oil-binding ability are related to the chemical structure and polarity of the gum. Gums with higher galactose content tend to show lower affinity for lipids due to increased polarity (Segura-Campos et al., 2014).

Emulsifying and foaming properties: Figure 1 shows the emulsifying ability of *Cordia myxa* gum at different concentrations. Emulsification values increased from 72.47% to 76.69%. Gum concentration increased from 0.1% to 0.3%. The improved emulsion stability may be attributed to the presence of protein fractions in the gum. They enhance surface activity and stabilize oil-water interfaces (Dickinson, 2003; Ali et al., 2022). Foaming capacity decreased slightly with increasing gum concentration. It was shown in Figure 2. It reaches 87%, 84%, and 82% at 0.1%, 0.2%, and 0.3%, respectively. On the other hand, as the gum concentration increases, the foam stability also increases. In this study, the foam stability reached a maximum of 97% at 0.3% concentration (Figure 3). As the concentration increases, the viscosity also increases, which helps to maintain the foam structure and prevent bubble collapse.

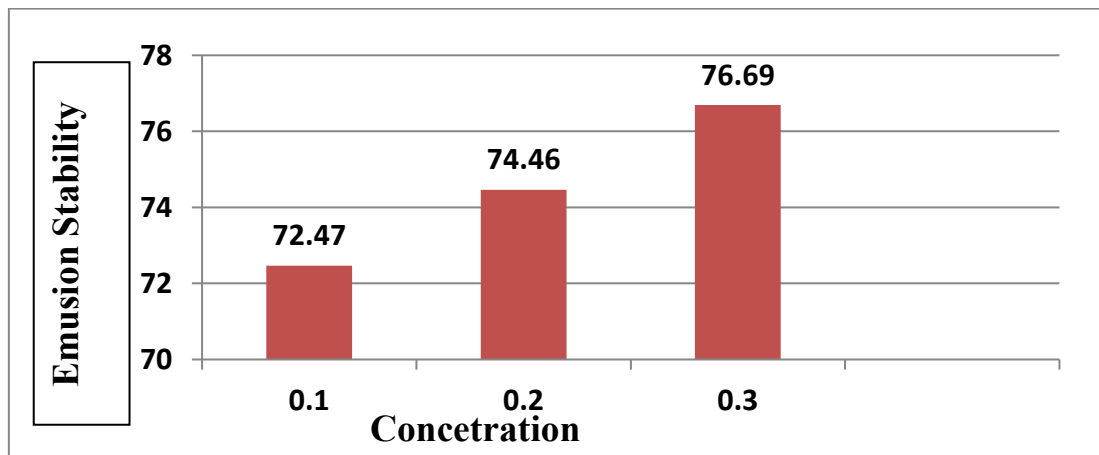


Figure 1. Effect of *Cordia myxa* gum concentration on emulsifying stability in the studied samples

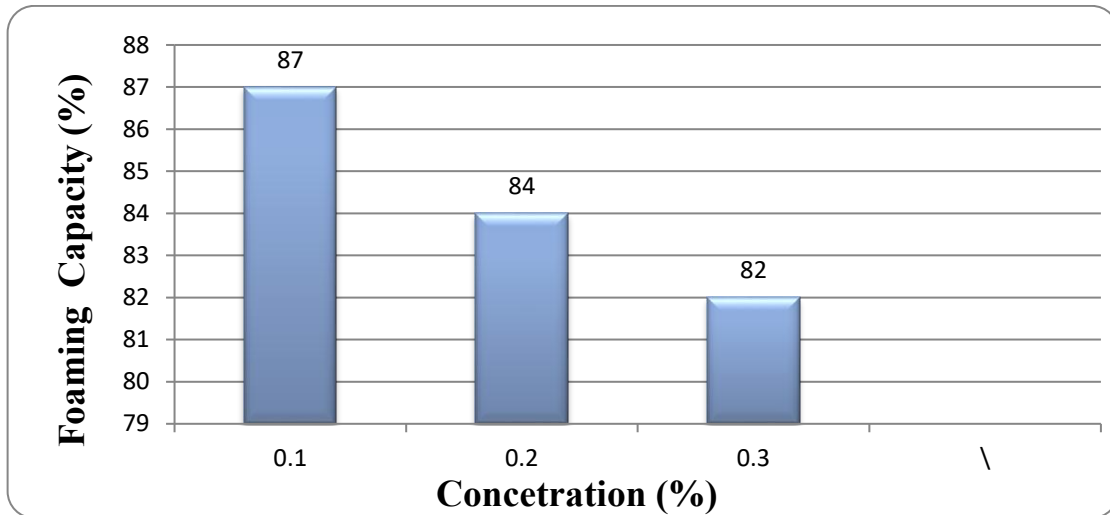


Figure 2. Effect of *Cordia myxa* gum concentration on foam capacity at room temperature in the studied samples

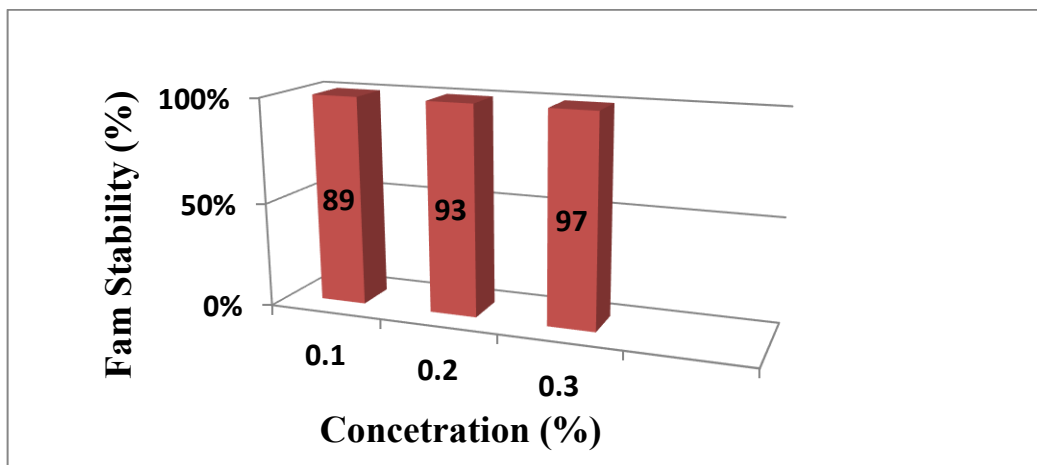


Figure 3. Effect of *Cordia myxa* gum concentration on foam stability at 25 °C in the studied samples

Conclusion: The results of our study showed that the gum extracted from the fruit of *Cordia myxa* is a promising natural hydrocolloid. Because it has favorable physicochemical and functional properties. The carbohydrate content of the studied gum was high and its bulk density was low. Its pH and swelling ability were also good. This gum had a strong binding capacity to water and oil. It also had effective emulsifying behavior and good foam stability even at low concentrations. Due to its plant-based origin, safety, and multifunctional characteristics, *Cordia myxa* gum has potential applications in various food systems. They include bakery products, sauces, beverages, dairy alternatives, and packaging materials. However, further studies are

recommended to evaluate its performance in real food formulations and to support its large-scale industrial application.

Author contributions

L. F. H. A. contributed to the study methodology and experimental design and performed data collection, F. K. H. A. assisted with data analysis and contributed to writing the initial draft and statistical analysis, and M. J. A. A. drafted the original manuscript and reviewed, discussed, and approved the final version of the manuscript.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Ethical approval

Not applicable.

Conflict of interest

The authors declare that they have no competing interests or financial conflicts of interest related to this study.

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استخراج صمغ از میوه *Cordia myxa* L. و ارزیابی ویژگی‌های عملکردی و

فیزیکوشیمیایی آن

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چکیده

هدف: هدف از این مطالعه استخراج صمغ از میوه *Cordia myxa* L. و ارزیابی ترکیب شیمیایی، ویژگی‌های فیزیکوشیمیایی و خصوصیات عملکردی آن بود. این صمغ گیاهی به دلیل منشأ طبیعی و رفتار عملکردی مناسب، می‌تواند کاربردهای بالقوه‌ای در صنایع غذایی و صنایع مرتبط داشته باشد.

مواد و روش‌ها: برای استخراج صمغ از میوه *Cordia myxa* L. از روش استخراج با آب استفاده شد. پودر صمغ به دست آمده از نظر ترکیب شیمیایی شامل رطوبت، پروتئین، چربی، خاکستر و کربوهیدرات کل مورد تجزیه قرار گرفت. ویژگی‌های فیزیکوشیمیایی از جمله pH، چگالی ظاهری، چگالی کوبیده شده و ضریب تورم با استفاده از روش‌های استاندارد آزمایشگاهی اندازه‌گیری شدند. همچنین ویژگی‌های عملکردی صمغ شامل ظرفیت نگهداری آب، ظرفیت نگهداری روغن، قابلیت امولسیون‌کنندگی در غلظت‌های مختلف (۰/۱، ۰/۲ و ۰/۳ درصد) و ظرفیت و پایداری کف در دمای اتاق (۲۵ درجه سانتی‌گراد) بررسی گردید.

نتایج: ترکیب شیمیایی صمغ میوه *Cordia myxa* L شامل ۴/۹۴٪ رطوبت، ۱/۴۳٪ پروتئین، ۸/۸۹٪ چربی، ۵/۳۳٪ خاکستر و ۷۹/۴۱٪ کربوهیدرات کل بود. مقدار pH صمغ ۶/۳۳ به دست آمد که نشان دهنده ماهیت تقریباً خنثی آن است. چگالی ظاهری و چگالی کوبیده شده به ترتیب ۰/۳۹ و ۰/۳۷ گرم بر سانتی متر مکعب بودند، در حالی که ضریب تورم به ۳/۹٪ رسید. نتایج آزمون‌های عملکردی نشان داد که صمغ دارای ظرفیت نگهداری آب و روغن مناسبی به ترتیب معادل ۱۳/۴۱ و ۴/۳۰ گرم به ازای هر گرم پودر صمغ است. قابلیت امولسیون کنندگی با افزایش غلظت افزایش یافت و به ترتیب به ۷۲/۴۷٪، ۷۴/۴۶٪ و ۷۶/۶۹٪ در غلظت‌های ۰/۱، ۰/۲ و ۰/۳ درصد رسید. ظرفیت کف با افزایش غلظت اندکی کاهش یافت، در حالی که پایداری کف بهبود پیدا کرد و در بالاترین غلظت به حدود ۹۷٪ رسید.

نتیجه گیری: نتایج نشان می‌دهد که صمغ میوه *Cordia myxa* L دارای ویژگی‌های فیزیکی شیمیایی و عملکردی مطلوبی است. با توجه به توانایی مناسب در نگهداری آب و روغن، قابلیت امولسیون کنندگی و پایداری کف، این صمغ طبیعی می‌تواند به عنوان یک ترکیب امیدبخش برای استفاده در صنایع غذایی و سایر کاربردهای صنعتی در نظر گرفته شود.

کلمات کلیدی: صمغ *Cordia myxa*، میوه *Cordia myxa*، ویژگی‌های عملکردی، ویژگی‌های فیزیکی شیمیایی

نوع مقاله: پژوهشی

استناد: لیث فرید حسن العبیدی، فاطمه کاظم حسین الصحاف، محمد جواد علوان الزرفی (۱۴۰۵) استخراج صمغ از میوه *Cordia myxa* L و ارزیابی ویژگی‌های عملکردی و فیزیکی شیمیایی آن. مجله بیوتکنولوژی کشاورزی، ۱۸(۲)، ۲۸۳-۲۹۶.

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