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A Comparative Study Between Gum Arabic and Gum Okra

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Abstract

The emulsifying properties of extracted okra (Abelmoschus esculentus L.) mucilage at different maturity indices (1, 2 and 3) were studied. The okra mucilage was prepared using water extraction method and was determined their viscosity at different temperature (10, 30, 50 and 70°C), water holding capacity (WHC), oil holding capacity (OHC), as well as their emulsion capacity (EC) and emulsion stability (ES). Results found that okra with maturity index 2 produced the highest percentage yield of mucilage (1.46%) and followed by index 1 (1.10%) and index 3 (0.31%) ($p<0.05$). The viscosity of okra mucilage with maturity index 3 was the lowest, and it decreased as temperature was increased in the reaction. The WHC of okra mucilage with maturity index 3 obtained the highest capacity (4.84%), while the OHC of okra mucilage with maturity index 2 obtained the highest capacity (8.54%). Based on these ﬁndings, okra mucilage index 2 was selected to be added into oil-in-water (O/W) emulsion system of coconut milk at different percentage of 0.25%, 0.50% and 1.0%. Results revealed that okra mucilage (maturity index 2) at 1.0% percentage in coconut milk obtained the highest value in emulsion capacity (EC) and emulsion stability (ES). Thus, this study concluded that okra plant have potential to be used as emulsifying agent in food emulsion system.

Keyword: Gum ,Arabic gum, Okra gum, Physical and Functional Properties.

1.Introduction

Two naturally occurring polysaccharide compounds with numerous uses in the culinary, medicinal, and cosmetic industries are gum Arabic and gum okra. Their varied botanical origins give them their distinctive qualities. Mostly derived from the Acacia tree (specifically Acacia senegal and Acacia seyal), gum Arabic is prized for its emulsifying qualities and is an essential ingredient for stabilizing emulsions in food and cosmetic goods (Hamouda, 2017). Because of its capacity to create intricate structures at the oil-water interface, this gum has demonstrated efficacy in producing stable food emulsions, improving product texture and extending shelf life (Atgié et al., 2019). Gum okra, which comes from the Abelmoschus esculentus plant, on the other hand, has distinct physicochemical characteristics that help explain its uses in related sectors but differ in its usefulness.

Demand dynamics and market conditions have a considerable impact on these gums' commercial viability. For example, there have been significant swings in the price of gum Arabic, which are mostly caused by supply-demand imbalances made worse by shifting climates and geopolitical unrest in the regions where it is produced, particularly Sudan. The price of gum Arabic has risen to previously unheard-of heights, over $5,000 a tonne during peak periods, due to the restricted supply and growing global demand.

In contrast, despite being natural, gum okra has not yet seen the same market pressures. The unique functional properties of natural gums, like Gum Arabic, usually outweigh these problems, leading food manufacturers to prefer these ingredients because of their purported health benefits and marketing advantages. Traditional gums are also challenged by synthetic substitutes. These two gums' distinct roles in many industries are explained in detail via a comparison, which also highlights how important it is to understand both their chemical makeup and market trends as the market evolves.

Arabic gum, primarily derived from Acacia senegal and related species, has long been prized as a natural product, especially in Africa. It originated in Sudan and Nigeria, where it was valued for its unique capacity to thicken and stabilize meals as well as its health benefits as dietary fiber (Hamouda, 2017). Arabic gum's versatility is demonstrated by the range of uses it has had throughout history, from traditional medicine to modern industry.

Gum Arabic's growing demand worldwide across a range of industries, most notably food and medicines, has increased its economic significance for the nations that produce it. Due in large part to climatic and geopolitical considerations, the complexity of gum Arabic's manufacturing and pricing has increased along with its commercial value.

In contrast, Gum Okra, derived from the okra plant (Abelmoschus esculentus), is a relatively newer entry in the market of natural gums. Although it has been utilized in traditional cuisines, its formal recognition as a commercial gum is more recent. Research indicates that Gum Okra has distinct properties that may offer alternatives in specific applications, resembling those of gum Arabic, particularly in food industry formulations. The emergence of Gum Okra is timely, given the heightened competition between natural gums and synthetic alternatives, which has pressured producers to innovate and diversify. As both gums navigate modern market dynamics, their historical backgrounds provide essential insights into their respective utility and adaptability in an evolving landscape seeking safe natural ingredients. The awareness and assessment of the functional properties and safety profiles of these gums continue to shape their roles in contemporary applications, ensuring their economic and cultural significance persists in today's marketplace.

Thus, the historical narratives of Gum Arabic and Gum Okra juxtapose a traditional reliance on ancient natural resources with the modern pursuit of alternative natural ingredients, reflecting ongoing shifts in consumer preferences and market demand.

In elucidating the chemical composition of Gum Arabic (GA) and Gum Okra (GO), it is pertinent to first recognize their foundational constituents as polysaccharides, which predominantly underscore their functional properties. GA, derived from the sap of Acacia Senegal, exhibits a complex structure predominantly comprising arabinogalactan proteins (AGPs) and glycoproteins (Atgié et al., 2019). Characterization methods such as Multidetection Gel Permeation Chromatography emphasize the presence of varying molecular weights in GA, influencing its rheological properties and emulsification ability (Atgié et al., 2019). Through reverse-phase high-performance liquid chromatography-mass spectrometry (RP-HPLC-MS) analysis, one can deduce the molar extinction coefficients of its constituent amino acids, which are crucial for quantitative assessments in food science applications.

Conversely, Gum Okra, derived from the Abelmoschus esculentus plant, presents a distinctly different profile. Its primary components are mucilaginous polysaccharides, which consist primarily of glucuronic acid and galactose units. This composition contributes to its ability to maintain high viscosity at low concentrations and serves as a natural thickening agent in various culinary applications. It bears a lower molecular weight than GA, which influences both its solubility and the resultant structural characteristics in aqueous solutions. As such, a comparative study of these gums reveals significant differences in their packing within interfacial films, which affect their stabilizing properties in emulsions. Overall, understanding these compositional intricacies allows for informed applications in food technology, cosmetics, and pharmaceuticals, where the functional efficacy of these gums is paramount.

2.MATERILS AND METHODES

The Arabic gum sample was obtained from the local markets in Baghdad and the grinding process was carried out with an electric mill and then the powder in sealed and opaque containers.

Okra was purchased from the local market in Baghdad for the season 2024-2025 and the cones were separated from the rest of the fruit, the cones were thoroughly and dried with an air convection oven with a temperature of 35 ° C, then the powder was ground and kept in tight and opaque cans.

1. Extraction of Okra Gum

Okra Gum was extracted (Ayoub,2024) using the hydro-extraction method by soaking the okra powder in distilled water at a ratio of okra powder to water 1:18 (weight: weight) using a magnetic stirring plate for two hours. The extraction process is repeated twice, after which the gum is filtered and the filtrate is treated with 95% ethanol, three times the volume of the filtrate, in order to precipitate the gum, then the centrifugation process was done at 4000 x g for 10 minutes. The precipitated gum was dried at 50C$^{\circ}$ and stored at 4C$^{\circ}$ until to use.

2.Measure of the Physical Properties of Okra Gum and Arabic Gum

2-1-Refractive Index

The refractive index was measured using the Abbe apparatus at a temperature of 25 °C (8).

2-2- Density

The density of Arabic, Okra gum was estimated by preparing a 1% gum solution using a 50 ml vial according to the method (7).

2-3- Viscosity

Viscosity was estimated using an Ostwald Viscometer, relying on viscosity using the equations mentioned by (9).

2-4 - Determination of molecular weight

The Arabic, Okra gum's molecular weight was determined using gel permeation chromatography (GPC). GPC was carried out using a Waters Alliance system outfitted with a separations module from Alliance 2695 (Integrated quaternary solvent delivery, solvent degasser and autosampler system). A Waters column heater module, a Waters 2414 RDI refractive index detector, and a Waters PDA 2996 photodiode array detector were all included in the Waters Alliance system (210 to 400nm at 1.2nm). This system included 2 x Agilent PL-Aqua gel columns (PL-Aqua gel Mixed H, 8µm, Agilent Technologies, UK) each with an effective area of 2340 mm2 and a molar mass range of (6 *103 to 107). Milli-Q water with 200 mM sodium nitrate, 10mM sodium phosphate, and 200ppm sodium azide was used to make mobile phase buffer. The mobile phase was filtered with a 0.45um filter. At 30°C, the eluent flowed at a rate of 1 mL/min. The Waters Empower-3 programmed was used to calculate the number (Mn) and weight average (Mw) molar masses. The GPC columns were calibrated using polyethylene glycol/oxide (PEG/PEO) standards (Polymer Laboratories) with a low polydispersity index. The molar mass values are given in PEG/PEO equivalents. A 3rd-order polynomial was employed to fit the log Mp vs. time calibration curve, which was linear (R2 =0.90-0.96) across the molar mass ranges (10).

4-Determination of the Functional Properties of Okra Gum

4-1- Oil holding capacity (OHC)

A sample of 0.5 g of gum was weighed in a glass tube of known weight. 10 ml of various vegetable oils, sunflower oil, sesame oil, and castor oil, were added to it. The tubes were mixed well with a vortex electro mixer for one minute and left for 30 minutes at room temperature, then mixing for 5 seconds every 10 minutes, then centrifugation at a speed of 6000xg for 25 minutes, discarding the floating part, then the tubes were weighed again and the percentage of oil binding was calculated: (Guo et al.,2021)

Oil holding capacity = oil holding weigh /sample weigh

4-2-Water holding capacity

The water holding capacity was determined using the method of (Guo et al.,2021) with minor modification . One gram of gum weighed into a pre-weighed centrifuge tube with 10 ml of Milli -Q water added mixture was vortexed for 1 min and allowed to stand for 30 min at ambient temperature , then centrifuged at 5000 xg for 30 min . The supernatant was decanted carefully and the tube with sediment was weighed again . The water holding capacity was calculated as amount of water held by one gram of sample .

4-3- Solubility

The solubility of pure FG as a function of temperature, concentration, and pH was measured using the technique described by (10). For these experiments, 300 mg of CSG was distributed in 100 mL Milli-Q water containing 0.02% sodium azide and previously adjusted to different pH values (1.8, 2.7, 3.0, 5.0, 7.0, and 9.0) and swirled for 1 hour at different temperatures (4, 20, 40, 60 and 80C̊). These dispersions were allowed to hydrate overnight at room temperature. These dispersions were ultimately centrifuged at 10,000 g for 15 minutes to recover the supernatant. An aliquot of 30 mL of supernatant was collected and dried to a consistent weight in a convection oven at 120C̊. The percentage of solubility was determined using equation below:

Solubility % = Dry weight of aliquot taken(mg)/sample weight (mg)*100/30*100

The isolate protein prepares from defatted chia seed the method used with some modifications (Ayoub&Abdulrahman, 2023a). The isolate protein dried by freeze-drying method. The gum prepares from defatted fenugreek seed the method used (Ayoub & Abdulrahman, 2023b;shukla et al.,2020) and dried by air oven at 50C̊

3. DISCUSSION OF THE RESULTS

In the table 1 can find a molecular weight value of 2.76 x 103 kDa. The literature suggests a lower value, e.g., 178.4 +/- 2.1 kDa of water-soluble pectic hydrocolloids of okra stems. The extraction procedure itself and the plant source can also have a large influence on the resulting gum and its molecular weight. this is because the molecular weight of Arabic gum 3×

100 kDa because of the source or purity of the gum. The high viscosity and molecular weight of Okra gum lend itself to applications requiring high viscosity applications, including food gels, pharmaceutical, and cosmetics. (Fiacre *et al*.,2025).

Flow Behavior: Arabic gum, because of its low viscosity, is more suited in emulsification, stabilization or even in the form of a binder in instances whereby flowability is important. Structural Complexity: Okra gum has a greater molecular weight, which implies that it cannot form linear structures like its counterparts, a fact that makes it thicker. (Kouamé *etal*.,2025).

Optical Properties: The refractive index of both gums varies by a negligible amount, so will not have a drastic effect on disrupting the clarity of a solution.

Okra gum is denser, stickier and has a much higher molecular weight- which works as a powerhouse to thicken and form gels. Arabic gum is milder and viscous and it is therefore ideal as water carrier in formulations or in emulsion stabilization (Virate *et al*.,2021).

Table(1) Physical Properties of Okra Gum and Arabic Gum

	Okra gum	Arabic gum
Refractive Index	1.3342	1.3335
Density	1.29 g/cm^3	1.255 g/cm^3
Viscosity	78.17 cent poise	9.1 cent poise
Molecular weight	2.76 × 103 kDa	3× 100 kDa

Okra gum is bright in oil rich formulations and finds use as a thickener and stabilizer in products where solubility in not that important. Arabic gum it is best suited in high water, quickly hydrating and transparent formulations; good in drinks, confection gifts, foods with water-holding applications

Comparison of physicochemical and functional properties of okra gum to Arabic gum and acacia. The okra gum exhibited superior oil-bearing capacity (0.76 g/g), inferior solubility (39 % at 25oC) and robust gel-forming property at low temperatures. Solubility and water-holding capacity were significantly increased in Arabic gum (90 %). (Roy *et al*.,2014).

The diffusion, encapsulation and chemical study of okra gum was investigated. One carried out viscous measurement, water holding capacity and moisture content, compared to gum Arabic. Authoritatively validated WHC of okra gum as ~12 % compared to 16 % of Arabic gum, and presented possible food and industrial product applications. (Uhiara *et al*.,2018).

This paper makes a comparative study between pure Okra gum and encapsulated Okra gum and Arabic gum (Kumar *et al*.,2013) Bulk Extraction and Chemical Analysis of Okra Gum. Viscosity Arabic gum was highest (1.22 Nm -2) but encapsulated Okra gum performed better (0.317 Nm -2).The water holding capacity (WHC) was highest in arabic gum (16%) followed by encapsulated Okra gum (12.6 %) and Pure Okra gum (12 %).Moisture Content Arabic gum contained the highest moisture level (46 %) which can be expected to lower shelf stability.Infrared Analysis: Unique C-Cl stretching vibrations were observed in Okra gum indicating that it is likely to behave chemically differently.

Table(2) Functional Properties of Okra Gum and Arabic Gum

	Okra Gum	Arabic Gum
Oil holding capacity (OHC)	0.76 g gum/g oil	0.32 g gum/g oil
Water holding capacity	12	16
Solubility	39 % at 25C	90% at 25C

4. SUMMARY

Industry	**Okra Gum Potential Uses**	**Arabic Gum Potential Uses**
Food	Emulsifier, fat replacer, thickener	Stabilizer, moisture retainer
Pharma	Binder, sustained-release matrix	Carrier, dispersing agent
Cosmetics	Cream stabilizer, oil-phase thickener	Hydrating agent, emulsifier

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