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Role of Exudates in Food System: A Review

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Abstract: Exudate gums play an important role in day-to-day life application from food to non-food applications. Due to advancement in technology and interest has been devoted to modifying the natural structure, developing a new product, or enhancement of existing properties to achieve desired end quality. It also improves the eating quality, increases the shelf life of food commodities besides its functional, pharmacological, nutraceutical properties. Gums are cheap, non-toxic, easily biodegradable, and abundant availability quenches the thrust among the scientist. However, animal and microbial gum are also served better food application but in some instances are least accepted by the consumer. Plant gum being polysaccharide and hydrocolloids, offers numerous commercial applications in cosmetics, pharmaceuticals, and non-food. This review summarizes recent food applications and their importance in the food system of major exudates.

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1. Introduction

The exudate gums are the natural gum released from plants due to external stress, the turgor, insect borer damage, or deliberate anthropogenic behavior and solidify during exposure to sunlight and heat, which harden them into various types, such as tears, semisolid nodules, and lumps (Yao *et al.* 2015; Bashir and Haripriya, 2016). The colors and shapes of the exudates vary significantly. The phenomenon of exudation does not happen in normal trees (Miyamoto, 2015). It is believed that the production of exudates can be a protective mechanism resulting in seal infected areas of plants or overcoming of the stress of trees. The mechanism of gum secretion is still not understood completely. Ethylene molecule (ethephon) or ethylene releasing compound are the sole compounds for the gummosis process in the stone fruit or stone trees (Yao *et* *al.* 2015; Bouaziza *et al.* 2016). Gum yield is influenced by various controlling factors such as tapping intensity, rainfall, and temperature. Production of gum is usually correlated with the temperature, the higher the temperature more will be yield with limited moisture content (Nussinovitch, 2009; Yao *et al.* 2015). Seasonal influence has also been observed on the formation of gums, the formation will be rapid and in abundant quantity during summer, whilst formation will be very slow or nil in the winter (Bouaziza, 2016; Mostafavi *et al.* 2016; Tonyali *et al.* 2018). In other studies, Vilela and Ravetta (2005), reported late summer has a positive influence on the production of gums from wounded trees of Prosopis. Earlier studies have shown that exudate gums, besides other industrial uses, are safe for human consumption as pharmaceutical or food additives (Mahfoudhi, 2012; Mostafavi *et al.* 2016; Tonyali *et al.* 2018). They differ greatly in physical and functional properties, due to the specificity of the source and most importantly because the agro-climate conditions are different (Pachuau, 2012; Yao *et al.* 2015). Since the ancient period exudate gums were already being used as a thickening and stabilizing agent. Due to increase concern regard safety about additives and the idea of exploitation of the natural resources possessing unique characteristics to replace the additives, that hydrocolloids are the common one, which includes non-starch polysaccharides.

Hydrocolloids are biodegradable materials that exhibit peculiar physicochemical properties and applications. Thus, an increasing search for new bio-polymer sources for food industries is developing among food scientists. Earlier studies have been revealed that the aging of gums increases their emulsification properties and performance. It is used in the food system for the formulation or enhancing the properties of the foods. Hydrocolloids can be used alone or in a combination of the protein, starch, or lipids in confectionery starch-hydrocolloid system are popular to enhance their characteristics since at least about 1950. There are many reasons to use these along with native components (Starch, lipids, or proteins) includes gelatinization rate, viscosity, tolerance to processing such as shear, acidic, and heat. Generally, native starches are also treated or chemically modified to improve their processing properties, to improve the RVA profile of the gels made from them, improve cold storage stability, syneresis, increase water holding capacity, oil absorption properties, control water mobility because native starches don't possess ideal properties that can be utilized in food products (Mostafavi *et al.* 2016; Tonyali *et al.* 2018). Table 1. summarizes the various sources and constituents of major gum exudates.

This review presents the recent food applications of major exudates and their importance in the food systems.

2. Role of Exudate gum in Foods

Exudate gums are being used as emulsifiers, thickeners, and stabilizers for many years. Dissolution will be hydrated, which will accelerate by reducing the particle size. The coarse powder used when short hydration time is not important for a good distribution (As in the case of stock solutions). In such cases, the powder is injected through a high-speed or high-shear blender in the vortex of the solution to increase viscosity and improve hydration. (Nussinovitch, 1997; 2009; Yao *et al.* 2015; Mostafavi *et al.* 2016; Tonyali *et al.* 2018). Gum Arabic, tragacanth, and karaya gums are and used healthy in food-related applications, such as medicines, cosmetics, textiles, and lithography as well as small wooded items and are used for human consumption (Anderson, 1994). Gum Arabic is used in five primary food sectors: pastries, soft clothes, and hard-gum pastilles (Yao *et al.* 2015; Tonyali *et al.* 2018) beverages and emulsions, flavor encapsulation, baked goods, and brewing (Imeson, 2012). Moreover, the emulsifying agent, flavoring agent, humectant, stabilizer, thickener, and surface finishing agent is used as a multi-functional food adjuvant and retards sugar crystallization, which in typical applications is an important characteristic. Gum Arabic uses fall into three categories: food, medicinal products, and technical.

Table 1: Commercial exudate gums, their sources, and constituents (Source: Barak *et al.* 2020)

Exudate gum	*Source*	*Constituents*
Acacia gum	*Acacia senegal* *Acacia seyal*	4-O-Methyl-D-glucuronic acid, D-glucuronic acid, D-galactose, L-arabinose, L-rhamnose
Karaya gum	*Sterculia urens* *Sterculia setigera* *Sterculia villosa*	D-Galacturonic acid, D-galactose, L-rhamnose, D-glucuronic acid
Ghatti gum	*Anogeissus latifolia* *Anogeissus acuminata* *Anogeissus bentii* *Anogeissus dhofarica*	L-Arabinose, D-galactose, D-mannose, D-xylose, D-glucuronic acid
Tragacanth gum	*Astragalus gummifer* *Astragalus microcephalus* *Astragalus kurdicus* *Astragalus gossypinus*	Galactose, arabinose, fucose, α-D-galacturonic acid, β-D-xylopyranosyl

2.1. Gum Arabic

It is used in fish-oil emulsions for dietary supplements or in healthy foods. Gum Arabic is also used as an encapsulation agent for flavored foods, such as soups, drinks, dessert blends, which contain 7% oil-flavored flavor and 28% Gum Arabic, and 20% flavor in a dried content. (Sahari *et al.* 2014; Bashir and Haripriya, 2016), where oil droplets are completely covered before spray-drying to prevent volatile oils from being oxidized. Arabic gum condensed solutions sprayed or rubbed on pastries or biscuits for a shiny look. Moisture is monitored for improved molding and rolling characteristics in icings with high sugar content. Gum Arabic maintains hold between glazing and surfaces of baked goods. For beers and lagers, stabilized foam (interaction between loaded uronic acid residues and proteins) is adhered and high-quality beverages remove the cloudiness. In wines, sediment the proteins, followed by decantation. In gelatine-based chewy sweets, low Gum Arabic levels (up to 2.0 percent) are used to boost product adhesion and minimize elasticity by smooth texture (Sahari *et al.* 2014; Bashir and Haripriya, 2016). Gum Arabic is unique in mouth-feel and low solution viscosity, so replacing it from the field of foodstuffs is difficult (Imeson, 2012).

2.2. Karaya Gum

Texturizer and ice cream stabilizer and to avoid ice crystal formation in ice sherbets. It's perfect as a stabilizer for dressings for salads, sauces, cheese. Before it is dispersed in water, it can be blended (powdered ingredients) with oil, alcohol, or glycerine. For fast dispersion and mild hydration, a high shear mixer is used. It also partially replaces locust bean gum, because of its cohesive properties. In a bakery it is used for coating and glazing also prevents staling in baked goods and extends shelf life. Gum is used for improved adhesion (between particles of meat) binding (Water during processing and storage) and consistency and also for the manufacture of lowly-calorie burgers with soluble fibers (Imeson, 2012; Mostafavi *et al.* 2016).

2.3. Tragacanth Gum

Tragacanth gum (TG) was commonly used as a polysaccharide food coating for food processing (Jafari *et al.* 2018). TG as food coatings contributes to lower absorption, dehydration, and enzyme browning. TG is a semi-permeable buffer against gas and steam, which leads foods like fresh-cut apple slices to an improved time of conservation (Soto *et al.* 2017). TG is often widely applied as a thickening agent to improve the viscosity and ease of food emulsification.

TG stabilizes and increases the viscosity of food systems due to its excellent stability of heat and acidity and an efficient emulsifier (Phillips and Williams, 2009; Mostafavi *et al.* 2016; Tonyali *et al.* 2018)

Dressings, sauces, icings, and candies are the primary food applications of Tragacanth. As a stabilizer and provide a creamy oral feel through surface-active properties, it is used with low-pH products such as salad dressings.

Mixtures of tragacanth and Gum Arabic in pastries and icings are used to produce a chewy texture in chewy sweets. In heavily sweetened icing, Tragacanth is used as a binder. Gum tragacanth (0.2-0.5%) is used in frozen desserts for the control of ice-crystal growth, moisture migrations, and storage of Ice Crystal production and color and aroma migration during storage and consumption. For storage purposes. In baked goods, tragacanth's acid stability was utilized to give good clarity and gloss to a creamy texture.

2.4. *Rosaceae Gum Exudates*

Gum exudates consist mostly of polysaccharides, so thickening or gelling effects, and complex interfacial features. These characteristics allow their application in stable emulsion formulation as emulsifying and stabilizing agents, particularly because they can shape structured interfacial films (Orozco *et al.* 2003). The use of almond gum among the strong food applications as a coating agent to minimize and increase oil absorption and the moisture contents of fried chips have been recently investigated (Bouaziz *et al.* 2016). The use of peach gum has also been studied in food applications. The effect of peach gums polysaccharides (*Penaeus vannamei*), for example, has been studied on changes in the quality of white shrimp. Peach gum polysaccharides were employed as delay agents for quality changes in white shrimp during cool storage because of their antibacterial and antioxidant activity (Yao *et al.* 2015). Another research showed effective potential for preventing or minimizing lipid oxidation and for microbial growth inhibition in ground beef meat during storage at 4°C in the oligosaccharides extracted from almond gum polysaccharides (Bouaziz *et al.* 2015).

2.5. *Persian Gum*

Persian gum (PG) is the natural exudate from blossoms or trees of mountain or wild almonds (*Amygdalus scoparia*). In addition to the conventional applications, it has been investigated its ability to stabilize milk orange juice (Abbasi and Mohammadi, 2013) and milk–sour cherry juice blends. These reports allow PG and SFPG to be used for acid-based milk stabilization drinks where thermally stable treatment (pasteurization) is appropriate (Teimouri *et al.* 2018). PG at different concentrations (0,5, 1, 5, 3% w/w) showed a random impact on the dough, dough baking properties, stalling, and sensorial properties in terms of its applicability in the bakery industry. At 3% (w/w), the absorption of mass water and extensibility decreased significantly while the sensory score was much better than the control (Sahari *et al.* 2014).

2.6. Almond Gum

Almond Gum is another abundant gum that is extracted after mechanical damage and/or microorganism contamination from the trunk, branches, and fruit of *Prunus dulcis* trees. Earlier research found that almond gum consists predominantly of 92.36% polysaccharides (dry weight basis). Arabinose (46.83%), galactose (35.49%), and uronic acid (5.97%) are the main sugar constituents and low protein (2.45%) were the primary components (Mahfoudhi *et al.* 2012 a,b). The high polysaccharide content and the protein content in almond gum have been demonstrated to contribute to gum functionality (foaming, emulsifying, and gelling) and to the control of the viscosity of aqueous gum solutions (Mahfoudhi *et al.* 2012).

2.7. Apricot Gum

The likelihood of using Rosaceae gums in the medicinal sector has also been seen. The gum Apricot, for example, can be used in antidote, expectorant, and anthelmintic agents (*Prunus armeniaca* L). In traditional medicinal products, it is used to treat fever, cold, cushion, asthma, bronchitis, laryngitis, constipation, anemia, bleeding, some tumors and is often believed to improve fertility (Azam *et al.* 2012). The efficacy of apricot gum as a binder was investigated in tablet formulations (Şensoy *et al.* 2006). Apricot gum from *Prunus armeniaca* has been assessed as a wet granulation process tablet binder. Compared to the Gum Arabic and polyvinyl pyrrolidone, the binding properties and compression pressures were achieved. The findings indicate that apricot gum in tablet formulations represents a promising pharmaceutical binding agent.

3. Role of Major Exudates in the Different Food System

3.1. Emulsion and Sauces

A salad is a variety of foods, typically vegetables or fruit, frequently dressed with a sauce. Oils, most commonly soybean, canola, olive, peanut or sunflower oils are the primary ingredient in dressing, along with other ingredients like oeufs, vinegar, salt, honey, sugar, spices and herbs, onions, vegetable parts, sherries and lemon or lime juice. Xanthan Gum was used as an emulsifier for stabilizing and emulsifying Greek salad dressing (in different combinations) (Paraskevopoulou *et al.* 2005). The use of propylene glycol Alginate in place of Gum Arabic gives more cream stable stability in samples with xanthan and Gum Arabic in coalescence, but less stable in creaming terms (Paraskevopoulou *et al.* 2005). The degradation of quality in the salad dressings is mainly due to lipid oxidation. The oxidative stability with Gum Arabic in admixture with xanthan was investigated of an olive oil-lemon (50:50, v/v) juice emulsion (Paraskevopoulou *et al.* 2007). Gum karaya can also be used as a stabilizer in dressings, sometimes with Gum Arabic, which serves as a protective colloid (Verbeken *et al.* 2003). Gum tragacanth is used to prepare different salad dressings due to its acid tolerance and also thickens the water process at low concentrations of gum emulsions (on the order of 0.4-0.75 percent).

3.2. Frozen Products

Freezing is a unit operation that reduces the temperature of food beneath its freezing point and changes a proportion of water into ice crystals (Sharadanant and Khan, 2006). Conservation is achieved by combining low temperatures with reduced activity of water.

The dough is a dense, fluffy blend of dry ingredients, such as meal or meal and water kneaded, shaped, and baked. The dough is a liquid composition. The life cycle of various bakery items is increased. Shelf life can be improved by the addition of various hydrocolloids to the flour, but the consistency of the frozen dough bakery is still decreasing (Asghar *et al.* 2007). Besides, wheat flour was introduced for frozen pasta use in Gum Arabic and carboxymethylcellulose (CMC). The use of gum arabic and CMC, at a weight of 3 percent for both the flour, increased the consistency but was still higher than the control packs, of the frozen pizza dough. The overall baking consistency of frozen wheat flour has great possibilities for frozen pasta stabilizers (Asghar *et al.* 2007).

To create a smooth texture and secure the product during storage, hydrocolloids added to the frozen desserts. Techniques for high-pressure freezing aimed also to increase the consistency of goods (Fernández *et al.* 2007). As templates for frozen food products, sugar solutions can be used (Gülseren and Coupland, 2007). Solutions of sucrose, lactose, milk salts, skim milk powder protein and hydrocolloids should be investigated for studying the structure of complicated food systems under freezing (Rogers *et al.* 2006).

The physical properties of frozen sucrose solutions (increased by 57.5 and 67.5%, w/w) in dextran, pullulan, and Gum Arabic were also studied. Pullulan was the only polysaccharide that improved the sucrose solution's viscosity by 10 percent. Dextran, Gum Arabic or pullulan remain unaffected by the viscoelastic behavior. The findings were verified by differential calorimetry scanning (DSC) (Lopez *et al.* 2005).

In ice creams and other frozen goods, Gum Arabic can be used as a stabilizer. It prevents ice crystals from forming by water absorption in these materials. The water has a smoother, fine feel than hydration water. In ice cream mixtures and ices, ice creams and sherbet, gum tragacanth (concentration between 0.2 and 0.35%) are used as a stabilizer at a concentration of 0.5% to avoid the separation of syrup (Verbeken *et al.* 2003). Gum karaya is used in the manufacture of ice pops and sherbet at concentrations of 0.2 to 0.4 percent to both prevent large ice crystals from forming and prevent free water from "bleeding" (Yao *et al.* 2015).

3.3. Adhesives

The mixtures and aqueous sugar solutions used for adhesives and food glues also contribute to the thickening, viscidation, and accelerating gelation of gums and apple pectins (Mazurkiewicz *et al.* 1993). The adhesive salt and aromas were also invented with wheat gluten, dextrin, modified starches, and Gum Arabic coating (Lin and Zhao, 2007).

3.4. Confectionery

Gum Arabic is used for products that have high sugar content and comparatively low moisture levels, such as jujubes and pastels, as the thickener and to prevent sugar crystallization. It affects viscosity and food texture as a colorless, odorless, non-toxic, tasteless, and water-soluble food additive (Montenegro, 2012). Therefore, it is used to make a number of candies from soft to hard gums. Gum Arabic and other hydrocolloids have three different effects on crystallization (Bouaziz *et al.* 2015).

Agar used in the production of jellies and marshmallows, and Gum Arabic used in gum, once formed the "jell" and further prevented the crystallization of sugar and emulsified fat, which was also distributed uniformly within the product. Glazing agents are food additives that make your food look bright or protective, or are used to make it part of chewing gum, cough drops (Montenegro, 2012). Gum Arabic is used for paste binders with a fine blending of powdered sugar in the manufacture of lozenges (Williams *et al.* 2006).

3.5. Flavor

The flavor is a mixture of taste and smell. In one food (e.g., coffee), a taste like bitterness may be appropriate and not acceptable in another food (e.g., milk). The unacceptable taste will result in food being rejected (Breslin, 2013). A food flavor is modified by natural or artificial flavorings. Many products, including essential oils and imitation aromas, can be encapsulated and other colloids or colloids can be used. The high cost or instability of natural aroma extracts means that the majority of industrial aromas are similar to nature, i.e., they conform to the natural aromas, but are chemically synthesized. Some artificial aromas have an E-number (i.e., the Codex Alimentarius Committee's number of codes for the food additives which are generally used on food labels in the European Union) and can be used as a fixative flavor to make a thin film around the aromas, protecting them from oxidation, evaporation and moisture absorption. It is also used in preparing many emulsions of flavor, mixtures of Gum Arabic, and gum tragacanth. Combinations of gum karaya and Gum Arabic are used for citrus oil emulsions (Williams *et al.* 2006).

4. Gums as an Encapsulating Agent

Sugars (galactoses, arabinose, and rhamnoses), glucuronic acid, and amino acids are the essential building blocks of Gum Arabic (primarily hydroxyproline and serine, with a significant content of aspartic acid, leucine, and glycine) (Williams and Phillips, 2009). The further properties of Gum Arabic are very high-water solubility, typically up to 50 percent, as well as low viscosities, which rise to 25 percent or more of solids relatively slowly (Sobel, 2012). In low shear, a gum solution has a viscosity below one-tenth that of a 10% Pectin solution and below one hundredth that of a 1% xanthan gum solution, with a 30 percent solid (Al-Assaf and Phillips, 2009). Gum Arabic forms therefore an encapsulating solution in which one can work much more effectively than with other, more viscous materials. This combination of properties makes it possible for Gum Arabic to select two separate encapsulation methods.

Alginic acid is a polymer present in brown algae and some bacterial cells in the cell's walls. It is functional as it is but is more often found for reasons of stability like one of its salts, with the most frequent sodium alginate (Brownlee *et al.* 2009). Alginates are best known for their tendency of forming gels. In the presence of di- or trivalent cations, a network of networks is formed among the guluronic acid blocks of one polymer chain (Prasad and Kadokawa, 2009). This makes it also ideal for gel applications to produce varieties with high guluronic-mannuronic acid levels and a widespread concentration of homopolymeric blocks. Alginates can undergo ionic gelation and are appealing wall materials for encapsulation. Although the kinetic characteristics of gel formation change with temperature, heat cannot be used to fix alginate gels and therefore is especially suitable for protecting heat-sensitive materials (Draget *et al.* 2005). Alginate gel is porous and thus is not a right option for especially small molecules like flavorings, but it has also been found to be successful in the encapsulation of sensitive bacteria or enzymes (Brownlee *et al.* 2009)

5. Microbial Contamination and Degradation Aspects of Natural gum

The equilibrium moisture content of the gums is usually 10% or higher, and they are structurally carbohydrates and exposed to the external environment during processing and are thus likely to cause microbial contamination. But careful handling and use of preservatives will avoid this (Jani *et al.* 2009). The unregulated rate of hydration, lower viscosity in storage and microbe contamination of guar gum, despite its wide pharmaceutical use. Guar synthesized derivatives, such as acetate guar, phthalate guar, phthalate guar acetate, succinate guar, guar benzoate, baby benzoate, guar oxidized gum, guar hydroxypropyl guar and guar sodium carboxymethyl. The solubility studies demonstrated that a transparent gel was given to sodium carboxymethyl guar. A water-powered 2% sodium carboxymethyl guar solution created a very fine, transparent and flexible film (Bhardwaj *et al.* 2000)

6. Conclusions

Exudate gums and solidify when subjected to heat by rubber phase. Gums are a possible source of a new application of foodstuffs, alteration of existing products, drug synthesis, etc. The manufacturing, storage, and handling of foods have an important role to play. Besides, the gum is a promising natural source for fruit, drug, and pharmacological use. It is worth mentioning that, low cost and biodegradability, and compact nature promote its application in the modification of properties. Deep economic studies have to be performed to postulate the global cost for harvesting and using gums in numerous applications at an industrial scale.

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