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A Mini-Review on the Recent Food Applications of Major Exudates

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ABSTRACT

Exudate gums play an important role in the day to day life application from food to non-food applications. Due to advancement in the technology and interest has been devoted to modifying the natural structure, development of new product, or enhancement of existing properties to achieve desired end quality. It also improves the eating quality, increases in the shelf life of food commodity beside 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 instance are least accepted by the consumer. Plant gum being polysaccharide and hydrocolloids, it offers numerous commercial application in cosmetic, pharmaceutical and non-food. This review summarizes recent food applications and their importance in food system of major exudates.

Keywords: Exudate, Arabic gum, Karaya gum, Tragacanth gum, Food application

INTRODUCTION

Exudate gums are the natural gum, released from the plants due to external stress, turgor pressure, injury caused by insect borer or deliberate anthropogenic actions and solidify upon exposure to air and heat of the sun which hardens them into different shapes including tears, semisolid nodules, and lumps [1]. Colours and shapes of the exudates vary significantly. The Phenomenon of exudation does not happen in normal trees [2]. It is believed that production of exudates can be protective mechanism resulting in seal infected areas of plants or overcoming of stress of tree. Mechanism of gum secretion is still not understood completely. It is believed that ethylene molecule (ethepheon) or ethylene releasing compound are the sole compounds for the gummosis process in the stone fruit or stone trees [3]. Gum yield is influenced by various controlling factors such as tapping intensity, rainfall, and temperature. Production of gum is usually correlated with the temperature, higher the temperature more will be yield with limited moisture content [4]. 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 [3,5,6]. In other study, Vilela and Ravetta, 2005, reported late summer has positive influence on the production of the gums from wounded trees of Prosopis. Earlier studies have been revealed that exudate gums are safe for human consumption as being used as pharmaceutical substances or as food additives in addition to other industrial uses [7]. They vary in their physicochemical and functional properties to a great deal which is due to source specificity and most importantly governed by the discrepancy of agro-climatic conditions [8]. Since ancient period exudate gums were already being used as a thickening and stabilizing agent. Due to increase concern regard safety about additive and idea of exploitation of the natural resources possessing unique characteristics to replace the additives, in that hydrocolloids are the common one, which includes non-starch polysaccharides. Hydrocolloids are biodegradable materials which exhibit peculiar physicochemical properties and applications. Therefore, a growing quest is developing among food scientists for new sources of biopolymers to be used in food industry. Earlier studies have been revealed that 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 RVA profile of the gels made from them, improve cold storage stability, syneresis, increase water holding capacity, oil absorption properties, control of water mobility because native starches don't possess ideal properties that can be utilized in food products [9-16].

Role of gum in foods

Exudate gums is being used as emulsifier, thickener and stabilizer for many years. Dissolution is hydrated, which expedited by reducing the size of the particles involved. Coarse powder for good dispersion used where short hydration time is not important (As in the case of stock solutions).

In such cases, the powder introduced into the vortex of a solution, using a high-speed or high-shear mixer, for viscosity build up and for better hydration [17]. Gum arabic, tragacanth and karaya gums are safe for human consumption, Tree gum exudates also used in non-food applications, such as pharmaceuticals, cosmetics, textiles, lithography and minor forest products [16]. Gum Arabic utilized in five main food areas: confectionery, soft lozenges and pastilles to hard gums [18,19], beverages and emulsions, flavor encapsulation, baked goods and brewing [20]. Furthermore, as a multi-functional food additive being also used as emulsifier, flavoring agent, humectant, stabilizer, thickener, surface-finishing agent, and in addition, retards sugar crystallization, which is an important property in typical applications. Uses of gum Arabic fall in three categories: Food, pharmaceutical and technical.

Gum Arabic

It is used in fish-oil emulsions for dietary supplements or in health foods. Gum arabic is also used as an encapsulating agent for flavors used in dry foods, such as soups, beverages, dessert mixes formulation contains 7% oil-based flavor and 28% gum arabic and results in 20% flavor in the dried material [21]. Where oil droplets fully coated before spray-drying to prevent the oxidation of volatile oils. Concentrated gum arabic solutions sprayed or brushed for glossy appearance onto pastries or biscuits. In icings with high sugar content, humidity is controlled for better molding and rolling properties. Gum arabic maintains adhesion between the glazes and baked goods surfaces. In beers and lagers, enables adhering of stabilized foam (interaction between charged uronic acid residues and the proteins) and to eliminate cloudiness in high quality drink. In wines, sediment the proteins, followed by decantation. Low levels of gum arabic (up to 2.0%) are used in gelatin based chewy sweets to improve product adhesion, lessen elasticity with a smooth texture [17]. Since gum arabic is unique in the production of mouth-feel and low solution viscosities, it's difficult to replace them from the area of food applications [20,17].

Karaya gum

Texturizer and stabilizer in ice creams, and to prevent the formation of ice crystals in ice sherbets. It is suitable for salad dressings, sauces, cheese spreads as a stabilizer. It can be blended (powdered ingredients) or mixed (in oil, alcohol or glycerin) before dispersing in water. A high-shear mixer is used, for easy dispersion and slow hydration. It also partially replaces locust bean gum, because of its cohesive properties. In bakery it is used for coating and glazing also prevent staling in baked goods and extend shelf life. Comminuted meat products and sausages utilizes gum to achieve better adhesion (Between meat particles), binding (Water during processing and storage) and consistency, as well as to produce low-calorie burgers with soluble fibers [20,17].

Tragacanth

Main food applications of Tragacanth include dressings, sauces, icings and confections. In low-pH products such as salad dressings, condiments, as a stabilizer and provides a creamy oral sensation via its surface-active properties. In confections and icings:

i) Blends of tragacanth and gum Arabic is used to yield a chewy texture in chewy sweets;
ii) Tragacanth used as a binder in highly sweetened icings.

In frozen desserts, gum tragacanth (0.2-0.5%) is used to control ice-crystal growth, to reduce moisture migration and ice-crystal development during storage, and to prevent color and flavor migration during storage and consumption. In baked-good fillings, the acid stability of tragacanth exploited to yield a creamy texture with good clarity and gloss.

Application of exudates in different food

Confectionery

The term confectionery refers to food items that are (or at least are perceived to be) rich in sugar. Confectioneries include sweets, lollipops, candy bars, chocolate, hard candy, lemon drops, candy canes, licorice candy, gum/gelatin candies, lokum/turkish delight, jelly beans, marshmallow, chewing gum, halva, alfajor and dragees and other sweet snack foods. The term does not apply to cakes, biscuits, or puddings which require cutlery, although there are exceptions (Meringues, for example). As a thickener and an agent that prevents the crystallization of sugar, gum arabic used in products in which sugar content is high and moisture content comparatively low, as in jujubes and pastilles [22]. 'Jujube' refers to several types of candy, which vary on a regional basis and 'pastille' refer to a medicinal pill or flavored candy, or to any kind of incense that dissolves like candy. To manufacture jujubes and pastilles, gum arabic is dissolved in water, then filtered, and mixed with sugar and boiled followed by Flavor incorporation [23]. Being a colorless, odorless, non-toxic, tasteless and water soluble food additive, it influences both the viscosity and the texture of foods [22]. It is therefore used to produce a variety of confections, from soft lozenges to hard gums [18,19]. Gum arabic and other hydrocolloids influence crystallization in three different ways [24].

It attaches to a growing crystal surface and thus alter its normal growth pattern; It compete with the crystal for the same building blocks; It may combine with impurities that affect crystal growth [24,25].

Natural gums are used in the confectionery industry. Once, agar used for the production of jellies (candies) and marshmallows, and gum arabic used in gumdrops, it served to form the "jelly", but additionally prevent sugar crystallization and emulsify fat, also evenly distributed within the product [26]. In food preparations, glaze is a coating of a glossy, glazing agents is food additives that provide the food with a shiny appearance or a protective coating for which Gum Arabic is used or as a component in chewing gum, cough drops and candy lozenges [22]. A throat lozenge or cough drop is a small, medicated candy dissolved slowly in the mouth in order to lubricate and soothe irritated tissues of the throat (usually due to a sore throat), from a common cold or influenza. Gum arabic is used in the production of lozenges as a paste binder with fine mixing of powdered sugar [27]. Which in combination of fruit flavors and mixed to form stiff dough that can be rolled into sheets and pressed [23]. The term halva, originally derived from the Arabic root halwā (sweet), it can be regarded as an emulsion, and emulsion instability is therefore a major problem that affects quality upon storage. Which results in toughness, and packaging materials contamination by the separated oil. The effectiveness of incorporating non-hydrogenated palm oil, glycerol, soy protein concentrate, gelatin, lecithin, pectin, gum arabic, sugar powder, or calcium chloride in improving halva quality was studied [28]. However, gum arabic, pectin, calcium chloride and sugar powder minimized emulsion instability [28]. Other exudates, such as apricot, prune and sweet cherry, also have effective emulsification abilities but limited commercial availability.

Salad dressings and sauces

A salad is a mixture of foods, usually including vegetables or fruits, often with a dressing or sauce. The primary ingredient in salad dressing is oil-most commonly, soybean, canola, olive, peanut or sunflower oils and Other ingredients such as eggs, vinegar, salt, honey, sugar, spices and

herbs, tomato, vegetable bits, sherry, and lemon or lime juice also incorporated. Xanthan gum as a stabilizer and gum arabic as emulsifiers (In various combinations) were used to stabilize/emulsify an olive oil-lemon juice Greek salad dressing [29]. Samples having xanthan and gum arabic were more stable in terms of coalescence but less stable in terms of creaming, use of propylene glycol alginate in place of gum arabic gives higher creaming stability [29]. Lipid oxidation is a major cause of quality deterioration in salad dressings. The oxidative stability of an olive oil-lemon juice emulsion (50:50, v/v), with gum arabic in admixture with xanthan, was investigated [29]. Gum karaya can also be used in dressings as a stabilizer, sometimes with gum arabic, which acts as a protective colloid [22]. Gum tragacanth used in the preparation of various salad dressings due to its acid resistance, and also thicken the water phase of the emulsion at low gum concentrations (on the order of 0.4-0.75%). To eliminate lumping, the gum should be dispersed in the oil then further mixed with the water phase, followed by heat treatment and homogenization [22]. The gum tragacanth is used by adding the gum to the condiment at the end of the boiling phase, then rapidly cooling the mixture; the product should be prepared in two parts, by first mixing the ingredients, without the gum, with water and sugar fraction and then preparing a smooth mucilage consisting of gum, sugar and fluid to get a smooth consistency [30]. In low-calorie dressings, less oil is used and a higher level of gum is required to deal with the higher water content. The inclusion of gum tragacanth (0.4 to 0.8% of the total weight of the sauce or condiment) in dressings yields creamier and more stable products when pH is low and the vinegar content high [22].

Frozen products

Freezing is a unit operation in which the temperature of a food is reduced below its freezing point and a proportion of the water undergoes a change in state to form ice crystals [31]. Preservation achieved by combining reduced water activity and low temperatures.

Frozen dough

Dough is a soft, thick mixture of dry ingredients, such as flour or meal, and liquid, such as water, that is kneaded, shaped, and baked. It increases the storage life of different bakery products. Shelf life can be enhanced by the incorporation of different hydrocolloids in the flour, but there nevertheless remains a decreasing trend in the quality of the frozen dough bakery [32]. When gum arabic and Carboxymethylcellulose (CMC) were added to wheat flour destined for use in frozen dough pizzas. The use of gum arabic and CMC, both at 3% on a flour weight basis, improved the quality of the frozen pizza dough also had the lowest amount of residual proteins, but still higher than the control doughs. Frozen dough stabilizers have great potential for improving the overall baking quality of wheat flour which has been stored frozen [32]. Another study investigated the effect of gums on the starch and protein characteristics of frozen doughs: these supplemented with three levels of gum arabic, CMC, κ-carrageenan, and locust bean gum. Scanning electron micrographs of unfrozen doughs showed starch granules securely embedded in the gluten matrix. After 8 and 16 weeks of frozen storage, the frozen control dough without gum additives showed damage to the gluten network, and separated starch granules from the gluten. Doughs with locust bean gum and gum arabic showed better maintenance of the gluten network [33]. Thus, hydrophilic gums can improve the shelf-life stability of frozen dough during long periods of frozen storage [33].

Frozen sugar solutions

Hydrocolloids added to frozen desserts to produce a smooth texture and to protect the product during storage. High-pressure freezing techniques also aimed at enhancing product quality [34]. Sugar is used to make most candies, and in frostings and icings, among many other products [36]. Sugar solutions can be used as model solutions for frozen foods [37]. To study the structure of complicated food systems under freezing, solutions having sucrose, lactose, milk salts, protein from skim milk powder and hydrocolloids must be examined [38]. One example of a study involved hydrocolloid addition and its effect on ice-crystal characteristics of frozen sucrose solutions. Freezing was done by High-Pressure Assisted Freezing (HPAF) at 100 MPa and by High-Pressure Shift Freezing (HPSF) from 210 MPa to 0.1 and 100 MPa. In this, Ice crystals were found to be smaller when a hydrocolloid mixture (Locust bean and xanthan gums) was added, irrespective of the freezing method [35]. The influence of dextran, pullulan and gum arabic and with respect to physical properties of frozen sucrose solutions (Added to 57.5 and 67.5%, w/w) was also studied. At 10% addition, pullulan was the only polysaccharide that increased the viscosity of the sucrose solution. The viscoelastic behavior remains unaffected by the presence of dextran, gum arabic or pullulan. These results were confirmed by Differential Scanning Calorimetry (DSC) [39].

Frozen dairy products, ice pops and sherbets

The most common frozen dessert is ice cream. Which desire small ice crystals, enabling smooth sensory evaluation of the product [36]. Commercial frozen desserts use gums to provide body and bind water [36]. Gum Arabic can be used as a stabilizer in ice creams and other frozen products. In such products, it prevents the formation of ice crystals by water absorption. The water is present as hydration water and thus a smoother, finer texture is. Which also changes the melting behavior of the product. In another process, gum Arabic was mixed with milk or cream under mild heating and then cooled and packaged, producing products that are better kept under refrigeration and easily dissolve in hot beverages [22]. Gum tragacanth (Concentration of 0.2 to 0.35%) was used as a stabilizer for ice cream mixtures and also ices, ice pops and sherbets, at a concentration of ∼0.5% for the prevention of syrup separation [22]. In the manufacture of ice pops and sherbets, gum karaya used at concentrations of ∼0.2 to 0.4% both to eliminate the formation of large ice crystals and to prevent "bleeding" of free water [22].

Wine

Gum arabic is used regularly in the wine industry in incredibly variable proportions. Gum arabic is seen by wine-makers as a natural stabilizer used post-filtration, just prior to bottling. Its use has several aims: stabilization of red wine color in young wines, increasing the perception of volume; reducing the perception of acidity and tannin harshness [40]. GC-MS analyses of the different recovered fractions allowed differentiating between gum arabic and wine polysaccharides by identifying the glucose and mannose, present only in wine polysaccharides [40]. Gum arabic was determined in a ratio of 1/10 (w/w) with wine polysaccharides, with a detection limit of 0.074 mg/ml, which is lower than the lowest gum Arabic amount usually added to wines which is suitable for semi-quantitative analysis [40].

Adhesives

Gums (Gum arabic and apple pectin), and mixtures of gums and aqueous sugar solutions used as adhesives and edible glues also contribute to viscosity and thickening, as well as accelerating gelation [41]. Gum arabic used as part of a breadcrumb composition for adhesion to moistened comestibles in chicken pieces, pork chops, fish fillets or vegetable strips, during coating and cooking, without batter coating. The formulation included breadcrumbs, and an edible adhesive, applied to the surface of the crumbs. The adhesive contained a protein at somewhat more than 1% by weight of the crumbs and (optionally) a starch and/or gum. An example of such a composition contained (g): Bread crumbs (75), egg white solids (10), gum arabic (0.9), water (17.1) and a spice blend (10) [42]. Wheat gluten, dextrin, modified starches and gum arabic coating also been invented to improve the adherence of salt and flavorings to nuts [43].

Bakery products

Baking is a unit operation that applied to flour-based items uses heated air to alter the eating quality of foods. A secondary purpose of baking is preservation, via the destruction of microorganisms and the reduction of water activity at the surface of the food. Baking involves simultaneous heat and mass transfer [31]. Baked products includes pastries and pies, shortening cakes, sponge cakes, biscuits, yeast and quick breads [36]. In cooking, a glaze of sweet substance (icing or egg white), confectioner's sugar and water (for doughnuts), fruit based (for pastries) applied to foods. Gum Arabic used as glazes for confections and toppings for bakery products, due to its inherent viscosity and adhesive properties also maintains the stability of the glaze [22]. Gum tragacanth also used for the stabilization of bakery emulsions and fillings in which suspended fruit, fruit pieces, natural flavor extracts and other flavors are used [22].

Flavor fixatives and emulsifiers

Flavor is a combination of taste and smell. A flavor such as bitterness can be acceptable in one food (e.g. Coffee) and not acceptable in another (e.g. Milk). Unacceptable flavor will lead to rejection of food [36]. Natural or artificial flavorings are used to alter a food's flavor. Many materials can be encapsulated, including essential oils and imitation flavorings also other colloids or colloid combinations can be used [22]. Due to the high cost, or instability of natural flavor extracts, most commercial flavorings are nature-identical, i.e. they are equivalent of natural flavors but chemically synthesized. Certain artificial flavorings have an E number (i.e. Number codes for food additives that are usually found on food labels throughout the European Union by the Codex Alimentarius Committee), Used as a flavor fixative, spray dried gum arabic is able to form a thin film around the flavoring, protecting it from oxidation, evaporation and absorption of moisture. It also serves in the preparation of many flavor emulsions, blends of gum arabic and gum tragacanth is also used. For citrus-oil emulsions, combinations of gum arabic and gum karaya are used [22].

Beverages

Beverages are liquid foods, examples are juices (Alone or in a cocktail or punch), milk (with or without additional ingredients), fruit-milk drinks, carbonated beverages, coffee, tea, cocoa and chocolate beverages [36]. The number of alcoholic beverages is vast, but they can be grouped into three basic types: Beers, wines and ciders, and distilled products in which the alcohol content is increased by distillation. Aside from its roles in stabilization, perceived increase in body and volume and reduction in acidity and tannin harshness, gum Arabic is also used as a foam stabilizer in beverages. Combinations of vegetable oil and gum arabic in spray-drying are also beneficial in the production of clouding agents [22].

Meat products

Meat is animal muscle tissue. It is composed of different proportions of water, protein and fat. Structural components of lean tissue include muscle fiber, connective tissue, fat tissue, bone and pigment. Ground meat is prepared only from skeletal meat, and must be labeled in accordance with its proportion of lean to fat [36]. Meat in its bulk form is coarsely minced and a second mincing is performed before packaging for retail. In ground meat products, the addition of ~0.25% gum karaya provides efficient water-holding ability, giving products such as bologna a smooth appearance [22]. As stated earlier comminuted meat products and sausages utilizes gum to achieve better adhesion (Between meat particles), binding (Water during processing and storage) and consistency, as well as to produce low-calorie burgers with soluble fibers [17].

CONCLUSION

Exudate gums release by gummosis process and solidify upon the exposure of heat. Gums represent a potential source for the development of new food application, modification of existing products, synthesis of drug etc. It has significant role in the processing, preservation and handling of the foods. Beside these, gums are proven a promising natural source for food application, drug delivery and pharmacological. It is worth mentioning that, low cost and biodegradability and compact nature promotes its application in the modification of a properties. Deep economic studies have to be performed to postulate the global cost for harvesting and using gums in numerous applications at industrial scale.

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