Research Article

Applications of Microbial Polysaccharides in Food Industry

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ABSTRACT

Microbial polysaccharides are important sources in food industry. Among the profound variety of polysaccharides some of them are approved by the FDA as food additives and are extensively used in food processing industry. This paper gives a review on some microbial polysaccharides that are most commonly used such as Xanthan gum, Gellan gum, Dextran and Pullulan. Most of these find their application as stabilize, thickener, emulsifier, texturizer and as gelling agents. The addition of these microbial polysaccharides as food additives enhances the overall food quality.

Keywords: FDA, Food industry, Food additives, Microbial polysaccharides.

INTRODUCTION

Polysaccharides are the carbon sources which are found in huge amount in the biosphere.[1] Most of these polysaccharides have found their importance in fields such as pharmaceutical industries, food industries, medical industries and various other related industries.[2] Microbial polysaccharides are secreted by the micro-organisms. They are of two types;

a) Capsular polysaccharides

b) Exo-polysaccharides

Capsular polysaccharides are the ones which form a protective capsule and thus prevent the pathogenic micro-organism from immune system defenses.[1] Exo-polysaccharides are the polysaccharides that are secreted out by the micro-organisms. They have the capacity to form solutions of high viscosity even at low concentrations.[1] Based on their position of polysaccharide secreted these microorganisms are termed exo-polysaccharides and capsular polysaccharides.[2] These exo-polysaccharides act as barrier in preventing the harmful intruders and capsular polysaccharides are however evolved to avoid any antibody responses.[2] As extracting these polysaccharides at low cost in larger quantities makes it more useful in any research industries. Bulk amount of these microbial polysaccharides are used in food industry such as xanthan to dextran.[2] Some of the microbial polysaccharides play an important role in the food industry. Due to their unique structure and physical properties they are widely used as emulsifiers, stabilizers, thickeners, viscosifiers, film-formers and gelling agents.[4]

Mentioned below are some of the microbial polysaccharides that are commonly used in the food industry and the organisms from which they are obtained.

Table 1: Microbial polysaccharides and their sources

Microbial Polysaccharide	Organism(s)
Xanthan	*Xanthomonas Campestris*
Gellan	*Sphingomonas paucimobilis*
Pullulan	*Aureobasidium pullulans*
Dextran	*Leuconostoc Mesenteroides and Leuconostoc Dextranicum*
Xylinan/Acetobacter xylinum cellulose	*Acetobacter xylinum*
Alginates	*Azotobacter chroococcum and Azotobacter vinelandii*
Curdlan	Alcaligenes faecalis

Brief Description of Major Microbial Polysaccharides in Food Industry

Xanthan gum

Xanthan is a microbial polysaccharide secreted by organism *Xanthomonas campestris* (Table 1). Xanthan *is* produced in tones in aerobic fermentation process for commercial uses in food and pharmaceutical industries.[2] The high viscosity at very low concentrations makes it an excellent agent as food additive for syruping, stabilizer and as a thickening agent. Another property that makes xanthan so suitable in food industry is the high shear thinning i.e. good pourability.[2] Xanthan is replaced in many low calorie drinks which increase the thinning consistency where the total or partial sugars are replaced by artificial sweetners.[3] Xanthan acts like a stabilizer in most liquid and semi-liquid foods and gives a body form to most dairy products.[3] Since xanthan suspension have freeze thaw stability its major food additive in frozen food industries.[3] Xanthan is extensively used in bakery products to help retention of water in baking food and therefore increases the shelf life of the food.[3] It's used in low fat food to increase the viscosity of the aqueous phase and stabilize the food system.[3] Such as

mayonnaise, cheese, ready-to-eat meals etc.[3] Xanthan was approved by FDA as food additive few decades ago and since then it's widely used in commercial food industry.

Gellan

Gellan is a microbial polysaccharide synthesized by bacterium *Sphingomonas paucimobilis* (Table 1) and also by different strains of the same bacteria. It's majorly manufactured by C.P KELCO in Japan.[4] It was approved by FDA as a food additive in the year 1992.[4] It is basically used as stabilizer, gelling agent and as thickening agent in many food sources. It provides structure; texture and mouth feel in many food substances rather than gelatin. It's mostly used in confectionary units to reduce the set time of gelling such as starch jellies.[4] In addition it gives a suitable structure, mouth feel and also prevents the moisture loss in these sugary foods. Gellan gums are also used in dessert gels to bring out the high clarity and increase in melting temperature to keep these foods soft and juicy.[4] Gellan can replace pectin in jams with low concentrations use when compared to pectins. Gellan are used in modified starch food to increase the stability as stabilizer and water binding agent preventing the "blunting effect" of the starch can have on food flavor.[4] It is also used in many fabricated food to provide matrix and structure after heating and cooling. Fabricated food like meat, fruits, confectioneries fall into this category. Its potential use in food industry replacing gelatin makes it an important polysaccharide.[4]

Table 2: Concentration usage of polysaccharides in food processing industry

Polysaccharide	Food in which it is used	Concentration required (%)	Functionality	References
Xanthan gum	Salad dressings	0.1-0.5	Emulsion stabilizer; suspending agent, dispersant	8
	Dry mixes	0.05-0.2	Eases dispersion in hot or cold water	
	Syrups, toppings, relishes, sauces	0.05-0.2	Thickener; heat stability and uniform viscosity	
	Beverages (fruit and non-fat dry milk)	0.05-0.2	Stabilizer	
	Dairy products	0.2-0.5	Stabilizer; viscosity control of mix	
	Baked foods	0.1-0.4	Stabilizer;	
	Frozen foods	0.05-0.2	Improves freeze thaw stability	
Gellan	Jellies Jams Confectionery Processed foods Processed meats Icings Pie fillings	0.15-0.2 0.12-0.3 0.8-1 0.2-0.3 0.1-1 0.05-0.12 0.25-0.35	Gelling-agent Low calorie spreads Gelling in fruits vegetables Texture modification Coating agent Texturizer	7
Pullulan	Edible Films in confectionary decoration Snack Foods	5-10	Edible films with low oxygen permeability, Bioadhesive Stability to high pH and NaCl Low viscosity	9
Dextran	Bakery products	2%	Unique dough mixing properties	10
	Ice cream, Frozen and dried foods	2-4%	Beneficial viscosity properties Film of dextran used in frozen foods	
Xylinan/Acetobacter xylinum cellulose	Confectionary product-Nata de coco		Gelling agent Viscocifier	2
Alginates	Confectionary, Dairy products Beverages, Jams, Soups, Sauces, Meat, Fish,	0.3	Thickener Stabilizer Gelling agent	6,9
Curdlan	Gellies	1-5	Gelling agent	7
	Processed foods	1-10	Gelling agent	
	Processed meats	0.1-1	Texture modification	
	Sauces	0.2-0.7	Improved viscosity	
	Freeze-dried foods	0.5-1	Improved rehydration	

Pullulan

Pullulan is a type of exo-polysaccharide which is derived from a fungus *Aureobasidium pullulans* (Table 1).[5] A white to off-white tasteless, odorless powder that forms a viscous non-hygroscopic solution when dissolved in water at 5-10%.[5] It can be made into films of high tensile strength and low oxygen permeability .It is mainly used as a matrix for edible flavored films (breath fresheners) and also used in the production of capsule shells as well as coated tablets for the preparation of dietary supplements.[5] It has particularly used to make snack foods in Japan which are based on cod roe and powdered cheese.[2] But it has to be used at low doses as it is slowly digested in humans. It is used to make packaging film for ham.[5]

Dextran

Dextran is a linear polysaccharide which is obtained from the *Leuconostoc Mesenteroides, Acetobacter Sp. and Streptococcus Mutans* (Table 1).[1] But it is commercially produced by the *L-Mesenteroides and L-Dextranicum.*[1] It is the first microbial polysaccharide that has got commercialized and approved for used in food. It is used in pudding mixes to provide them with texture and mouth feel.[1] It is used in confectionary for retaining moisture, viscosity and inhibits sugar crystallization. It also acts as a gelling agent in gums and gels.[1]

Xylinan/Acetobacter xylinum cellulose

Xylinan is the microbial exo-polysaccharide i.e. obtained from the *Acetobacter xylinum* (Table 1), gram-negative bacteria. This component has made its place in the food industry as viscosifying and gelling agent having high gel strength, water-holding capacity and is easy to mold. Actually, it is the major component in nata de coco, a confectionery which is widespread in Japan and Philippines.[2]

Alginates

Alginates are derived mainly from the liquid bacterial cultures such as *Pseudomonas aeruginosa, Azotobacter chroococcum and Azotobacter vinelandii* (Table 1).[6] Of the two bacteria, Azotobacter species are the more competent one as they can be used for large-scale industrial production of alginates.[2] And the other factor that aids to the use of Azotobacter is P. aeruginosa which is an infective agent which is found to be associated with respiratory disease and cystic fibrosis.[2] They have been implemented in food industry due to their thickening, stabilizing and gelling properties which can be applied to wide range of foods such as jams, soups, sauces, meat, fish, beverages, dairy products and confectionery.[6] Salts of alginate (Na, K, and Ca) and algenic acid are used in food as per GRAS (Generally Regarded as Safe). In addition they possess anti-inflammatory and detoxifying properties.[6]

Curdlan

Curdlan is a high molecular weight polysaccharide obtained from *Alcaligenes faecalis* (Table 1) but nowadays commercially produced by non-pathogenic strain of Agrobacterium i.e. *Agrobacterium* biobar.[2] The use of this polysaccharide is limited to the boundaries of Japan where they consider microbial polysaccharides as natural products and can be employed in food industry.[7] It is the improved version of the gums providing viscosity, rehydration, gelling and texture-modification properties.[7]

CONCLUSION

The family of polysaccharides derived from microbes plays a pivotal role in many industries and an inevitable role in food processing industries. These microbial polysaccharides enhance the quality, texture, mouth feel and flavor of the food as thickeners, stabilizers, and texturizer and also as a gelling agent. This ensures food processed packages available today in the market has uplifted the expectations of food quality from ready- to-eat meals to instant mix as boon to the mankind in today's era.

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