DEVELOPMENTS IN FOOD SCIENCE 19

# FOOD EMULSIFIERS

## Chemistry, Technology, Functional Properties and Applications

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recommended in reconstituted products.

3.8.2.4 Sauces and salad dressings

The flow characteristics and stabilization of ingredients in sauces and salad dressings are improved with the addition of ι-carrageenan. However, some degree of gelation is required in order to reduce the hydrolysis of the hydrocolloid due to the low pH of the product. ι-Carrageenan is used as an emulsifier, thickener and dispersion agent in dry mixes of salad dressing, at concentrations of 0.3 to 0.5% (65), and diverse types of sauces such as cocktail, spaghetti, barbecue, ketchup and Mexican.

3.8.2.5 Syrups and toppings

In chocolate syrup formulations, λ-carrageenan is used to enhance the body of the syrup when mixed with milk at concentrations of 0.5 to 1.0% (65). Furthermore, the use of λ-carrageenan at a level of 0.15% produces syrups with a narrow range of viscosities between room and refrigerated temperatures.

λ-Carrageenan is thicker than other gums used at room temperature but thinner at refrigerated temperatures which counteracts the tendency of syrups to thicken under refrigeration. This unique flow control characteristic enables the addition of up to 20% more cocoa without changing the flow properties thus yielding a more chocolate-tasting syrup (78). κ-Carrageenan can also be added to chocolate syrups to help keep cocoa particles in suspension throughout the syrup.

In reduced sugar fruit toppings for ice cream, puddings, and yogurts mixtures of κ- and ι-carrageenan are used to impart body, mouthfeel, and to maintain ingredients in suspension (2, 65).

In pancake syrups, mouthfeel and body are attained by the addition of λ-carrageenan. For particular applications, λ-carrageenan is the choice due to its non-gelling characteristics (2).

3.8.2.6 Meat, meat analogs, fish, and pet food products

Carrageenans, particularly the κ and ι types, are added to diverse meat, meat analog, fish, and pet food products to protect their flavor and nutritional value, to modify the strength and melting point of the existing gel, and to allow the easy release of the product from the can. These functions are attained by taking advantage of the gelling characteristics of carrageenans. Typical concentrations in these products range from 0.2 to 0.5% (2). In some cases, the use of other gums such as locust bean gum, at concentrations of 0.25 to 0.50%, and potassium salts enhances the aforementioned properties (2).

Duxbury (79) reported that cooking losses in poultry and pork products can be reduced to only 2% and 3% respectively with the addition of 0.5% carrageenan. The combination of starch and carrageenans is reported to produce yields of 98 to 100%.

Tokaev et al. (80) used carrageenan and sodium caseinate to stabilize, for up to a month, the refrigerated emulsion used in the manufacture of soft sausage. A concentration of 1.0% carrageenans increased the sausage yield by 1.5 to 2.5% and the moisture content by 1.4 to 2.0%.

Recently, Foegeding and Ramsey (81, 82) have used $\kappa$- and $\iota$-carrageenans, at a concentration of 0.1% (w/w), as textural aids in low fat meat binders for the manufacture of frankfurters. The use of $\kappa$-carrageenan increases the hardness of the finished product since a reduction of the fat content in meat batters produces soft-textured products. On the other hand, the addition of $\iota$-carrageenan reduces cooking losses.

$\iota$-Carrageenan has recently been used in the manufacture of minced fish products, especially cod fish sticks, at a concentration of 0.5%. Its addition to these products resulted in a cryoprotective effect during frozen storage at temperatures below -30°C, as well as an increase in their water holding capacity (WHC), and a reduction in fat uptake during deep-frying (83). Water holding capacity is increased through the formation of a gel by $\iota$-carrageenan upon cooling and an increase of the fish fluid during deep-frying. On the other hand, the film-forming characteristics of $\iota$-carrageenan keep the product-coating interface wet, thus diminishing the absorption of fat (83).

In the manufacture of meat analogs, carrageenans have been used as a binder, protectant, tenderizer, and texturizer of the protein fibers. Carrageenans interact with the proteins of various sources (e.g., peanut, soy, casein, wheat gluten) to impart the product a meat-like texture and functionality. Usual concentrations are in the order of 1.0% (2).

In the production of pet food, $\kappa$- and $\iota$-carrageenans produce a thick, rich-looking gravy with sheen, and enable the whole product to be removed from the can at once. Typical concentrations are less than 1%, although in Europe higher concentrations are used to suspend meat chunks throughout the can and to avoid the penetration of the gelled gravy into the meat chunks. The addition of guar gum, locust bean gum, and phosphate salts in these products enhances the functional properties of the carrageenans (37). Typical levels of gums used in different types of canned pet food are contained in Table 6.

3.8.2.7 Dairy analogs

Carrageenans are used in powdered non-dairy coffee creamers to emulsify

TABLE 6

Typical concentration of gums and phosphates in canned pet foods (37)[a].

| Ingredient | Meat Loaf (sliceable) | Meat Chunks (in jelly) | Meat Chunks (in sauce) |
|---|---|---|---|
| Carrageenans[b] | 0.2 - 0.3 | 0.3 - 0.5 | 0.05 - 0.1 |
| Guar gum | - | - | 0.2 - 0.3 |
| Locust bean gum | 0.5 - 0.6 | 0.7 - 1.0 | - |
| Phosphates | 0.2 - 0.4 | 0.2 - 0.4 | 0.2 - 0.4 |

[a] In percent of total weight

[b] κ and ι types

milk proteins, soy proteins, and vegetable fat. On the other hand, their addition to frozen non-dairy coffee creamers imparts excellent freeze-thaw stability and mouthfeel. Concentrations used range from 0.1 to 0.2% (2).

In liquid non-dairy coffee creamers, κ- and λ-carrageenans are used along with CMC, sodium alginate, or refined galactomannan to improve the colloidal dispersion of proteins. This effect increases the shelf-life of the product under refrigerated conditions. Carrageenan levels of 0.3% are common for this application (39).

In imitation RTE frozen milk puddings, κ- and ι-carrageenans are added to stabilize the fat emulsion and to form a suitable gelling system for a desirable mouthfeel and texture (2).

κ-Carrageenan, added to whipped topping mix products at concentrations ranging from 0.15 to 0.5% imparts emulsion and freeze-thaw stability, as well as provide high emulsion overruns (2). On the other hand, κ- and ι-carrageenans in frozen whipped toppings impart body, while providing freeze/thaw stability (2).

κ- and ι-carrageenans, at concentrations of 0.02 to 0.4% stabilize the vegetable fat emulsion and impart body and texture in imitation milk beverages. The formulation of these products also contains sodium caseinate, soy protein, and vegetable oil in dispersion (2).