Role of Hydrocolloids in Dairy Food Applications

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Hydrocolloids may be defined as the non-digestible, long complex chain of polymers (polysaccharides and protein), originated from the Greek word by combining "hydro+kolla" which means "water+ glue". These are hydrophilic in nature and among the most commonly used ingredients in the food industry because it can readily dispersed, are partial or fully soluble in cold as well as in hot water (Phillips and Williams, 2020). Due to their hydrophilic nature it is able to form colloidal solution in an aqueous phase. It provide thickening or viscosity building effect after dissolving or dispersing in water. Hydrocolloids used as functional ingredients in food formulation to increase consistency, gelling effect of food and also to control the microstructure, texture, flavor, and shelf life of food. It can also able to reduce or inhibits the formation of sugar or ice crystals in ice cream. Also, hydrocolloids provide some nutritional benefits hence it is also called as healthy food additives and protect us from various diseases such as CVD, colon cancer and diabetes mellitus (Liu et al., 2014).

Various functions of hydrocolloids making it to be in market demand. Increasing the consumers demand for convenience food and low calorie food, contributing indirectly to increase the demand of hydrocolloids as fat replacer, stabilizer, thickening agent and binding agent as well. The global hydrocolloids market size accounted for USD 9.07 billion in 2019. The market projected to grow from USD 9.37 billion in 2020 to 13.37 billion in 2027 at CARG of 5.13% during the 2020-2027 period. India food hydrocolloids market is projected to grow at a CAGR of 7.2% during the forecast period.

Classification of hydrocolloids

A wide list of hydrocolloids is given in the Table 1 and 2. Each of the hydrocolloids are listed here having their own functions and applications.

Traditionally, it is classified as polysaccharides and grouped according to their source. It can be also be classified based on their chemical structure.

Table 1. Classification based on their source/ origin

Source of hydrocolloids	Examples
Plant	Pectin, inulin, gum Arabic, gum ghatti, gum tragacanth, gum karaya, cassia seed gum, basil seed gum, mesquite seed gum, fenugreek gum, chicle gum, oat gum, rye gum, konjac, psyllium, guar gum, locust bean gum, flaxseed gum, wattle gum, starches
Animal	Chitin, chitosan, gelatin

Seaweed	Agar, carrageenan, alginic acid, alginate, furcellaran, ulvan, fucoidan, red alga xylan
Microbial	Xanthan, gellan gum, tara gum, dextran, pullulan, welan gum, curdlan, levan
Synthetic	Methyl cellulose, methyl ethyl cellulose, carboxy methyl cellulose, hydroxyethyl cellulose, hydroxyl propyl cellulose, hydroxypropyl methyl cellulose, microcrystalline cellulose

Table 2. Classification based on their chemical structure

Class	Examples
Glucan	Starch, oat gum, barley gum, curdlan, welan gum, pullulan, dextran
Fructan	Inulin, levan
Xylan	Red alga xylan
Rhamnan	Ulvan
Galactomannan	Guar gum, locust bean gum, tara gum, cassia seed gum, basil seed gum, mesquite seed gum, fenugreek gum
Glucomannan	Konjac, alginate
Arabinoxylan	Psyllium, flaxseed gum (containing another galacturonan fraction), rye gum, wheat gum
Galactan	Agar, carrageenan, fucoidan, furcellaran
Arabinogalactan	Gum Arabic
Galacturonan	Pectin
Glycano-rhamnogalacturonan	Gum karaya, gum tragacanth (containing another arabinogalactan fraction)
Glycano-glucuronomannoglycan	Gum ghatti
Glucosamine polymer	Chitin, chitosan
Protein	Gelatin

Role of hydrocolloids in Dairy Products

Hydrocolloids are widely used in dairy and food industries due to its vast application. These are having high molecular weight and play various roles in food matrices such as thickeners, gelling agents, emulsifiers, foam stabilizers, fat replacers, coating agents, adhesives, clarifying, clouding, flocculating, clarifying and encapsulating agents. Hydrocolloids can able to improve the shelf life of dairy products by increasing the water holding capacity as well as reducing the whey syneresis, suspending dispersed particles or by inhibiting flocculation of protein micelles. Sahan et al. (2008) reported that addition of β-glucan in non-fat yogurt led to reduce whey syneresis. Studies reported that addition of hydrocolloids in dairy products will reduces the amount of whey separation from free fat, low-fat and full fat dairy products such as yoghurt (Emine and Ihsan, 2017), cheese (Rubel, 2019) and ice-cream (Sharma et al., 2009).

Thickening property

Hydrocolloids widely used to improve the thickening property of which is due to increase in viscosity of the products. Increase in viscosity after addition of hydrocolloids is due to intermolecular entanglement, which leads to resists the flow. Improving the thickening properties will leads to improve the sensory properties of the products. The thickening behavior of hydrocolloids generally depends on the type of hydrocolloid used, its concentration, pH of the food system and temperature.

Gelation

In addition to thickening, many hydrocolloids possess gelling effect. Gels may be defined as the mechanical rigid network between the liquids and solid state involving the cross linkage of

polymer molecules that forms 3D-network in an aqueous solution, trapping water within it and finally increases the viscosity. Hydrocolloids gels are also called physical gel because linkage of gels composed of hydrogen bond, hydrophobic association and cation mediated cross links. Hydrocolloids such as gelatin, gellan, carrageenan, pectin, agar, hydroxylpropyl methylcellulose and methyl cellulose is widely used as gelling agent. The above gelling agents were widely used in dairy dessert, milk shakes and milk-based desserts.

Fat replacer

As fat is the major contributor to calorie, hence reduced fat or free-fat foods products are gaining interest in the markets. Dairy products such as cheese, ice-cream, yoghurt, etc. are widely used to produce low-fat products. Fats and oils generally replaced with 'structured water' to give healthy, reduced-calorie foods with excellent eating quality. Removing fat from food will impair the sensory and textural properties of foods. Addition of hydrocolloid will bind the water and give better mouthfeel and textural properties similar the fat-rich foods. Inulin is the most common hydrocolloids added into reduced fat dairy and meat products.

Reduces whey syneresis

Shrinkage of gel is known as whey syneresis. It is very common defect in gels mainly in cheese and yoghurt occurs during storage. Addition of hydrocolloid leads to reduce the whey syneresis from gels. Many author reported that addition of Hydrocolloids in dairy products will reduces the amount of whey separation from dairy products such as yoghurt, cheese and ice cream. Adding hydrocolloids in cheese and yoghurt leads to increases the viscosity and decreases the syneresis. Many authors reported that gelatin and inulin have quite prominent effect in reduction of whey syneresis.

Edible films and coatings

A thin coating that can be eaten, coated on food, or used as a barrier between food and its surroundings is referred to as an edible film. Hydrocolloids are now widely used to produce edible films on food surfaces and between food components. Such films aid as inhibitors of moisture, gas, aroma and lipid migration. Many gums and derivatives have been used for coating proposes which include carrageenan, alginate, cellulose and its derivatives, pectin, starch and its derivatives, and others. Because of their hydrophilic nature, the coatings they produce have limited moisture barrier properties. However, if they are used in a gel form, they can reduce moisture loss during short term storage where the gel acts as sacrificing agent rather than a barrier to moisture transmission. In addition, in some cases an inverse relationship exhibited between water vapor and oxygen permeability, such films acts as barrier to oxidation of lipid and other susceptible food ingredient.

Stability

Often, the function of the hydrocolloid is to stabilize the emulsion, to prevent separation and, in the case of frozen foods, to control ice crystal formation. Though, new technology and new ingredients have been developed specifically to report the problem of ice crystals in frozen foods, but hydrocolloids will continue to play a vital role. Virtually every ice cream product is stabilized with carrageenan, locust bean gum and/or guar gum.

Conclusion

Hydrocolloids are the non-digestible polymers possess vast function such as thickeners, gelling agents, emulsifiers, stabilizers, fat replacers,

clarifying agents, flocculating agents, clouding agents and whipping agents which make it the most common ingredient to be used in the dairy industry. Hydrocolloids are now widely used in due to increase in demand on low-fat or free-fat dairy products. Hydrocolloids not only improve the textural property of the dairy products but also improve the shelf life of the products by reducing the whey syneresis and increasing the water holding capacity. In addition to the above properties hydrocolloids can also improve the nutritional value, and also improve the emulsifying characteristics of dairy products.

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