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Role of hydrocolloids in food systems

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Abstract
Hydrocolloids are heterogeneous group of polymers. Presence of many hydroxyl groups prominently increases their affinity for binding water making them hydrophilic. Hydrocolloids have a magnificent array of functional properties in these food colloid systems. Traditionally, most of the hydrocolloids are classified as polysaccharides and grouped according to their sources (plant, animal and microbial). They function as thickeners, gelling agents, foaming agents, edible coatings, emulsifiers, stabilizers, etc. They are also able to change the rheology of food systems in terms of viscosity and texture by forming gel even when added at low concentrations. In addition to textural attributes hydrocolloids also contribute to the nutritional attributes of the foods. They act as dietary fiber and helps in regulating the appetite and improving the satiety by reducing problems of obesity.

Keywords: Hydrocolloids, hydrophilic, rheology, satiety

Introduction

The term ‘hydrocolloid’ is derived from the Greek term hydro ‘water’ and kolla ‘glue’. Hydrocolloids are colloidal substances with an affinity for water (Wustenberg T, 2015) [51].
Hydrocolloids as a heterogeneous group of long chain polymers made up of polysaccharides and proteins, which are characterized by their property of forming viscous dispersions and/or gels when diffused in water. The gel formation is the phenomenon allowing association of polymer chains forming a three dimensional network which traps the water making it immobilized to form a rigid structure that is resistant to flow (Saha & Battacharya, 2010) [42].
Hydrocolloids are extremely soluble in water, which dissolves quickly to produce highly hydrated colloidal particles. They form dispersion between a suspension and a real solution, which exhibit the properties of colloid (Razavi, Ed. 2019) [39].
Hydrocolloids are employed as significant food additives that aid in the change of physical properties of a solution to form gels, as a thickening agent, emulsifier and stabilizer (Li & Nie, 2015; Manzoor M *et al*., 2020) [30, 31]. Different forms of hydrocolloids are utilized in the food industry for various purposes. Some of them are gum arabic, gum karaya, gum ghatti, and gum tragacanth which are obtained from the tree gum exudates; Guar gum, locust bean gum, tara gum, and tamarind gum, for example, are derived from seeds of various plants; xanthan gum, curdlan, dextran, gellan gum, and cellulose are derived from microbial sources; while agar, carrageenan, and alginate are derived from algal sources (Karaman *et al*., 2014) [41]. The main rationale for the use of hydrocolloids in many food formulations is their ability to gel and produce a high viscosity formula at low inclusion levels. They're widely employed because they may change the rheology of a food system, which comprises two key properties: viscosity (flow behavior) and texture (mechanical solid particle) (Saha & Battacharya, 2010) [42]. These improvements have been shown to improve the organoleptic characteristics of the formulation in which they are employed. The usage of blended hydrocolloids has also been found to improve product quality and also provide potential advantages.
Hydrocolloid viscosity is affected by a combination of different parameters including shear rate, shearing time, temperature, and pressure. The viscosity of Newtonian fluids does not change with shear rate at constant temperature and pressure. The viscosity of most non-Newtonian fluids reduces as the shear rate increases, resulting in pseudo plasticity or shear-thinning behavior (Marcotte *et al*., 2001) [33]. In a Newtonian fluid, the relation between the shear stress and the shear rate is linear, passing through the origin, the constant of proportionality being the coefficient of viscosity. In a non-Newtonian fluid, the relation between the shear stress and the shear rate is different and can even be time-dependent (Kumbar *et al*., 2017) [28]
Hydrocolloids are employed in foodstuffs for one of two reasons: to increase physical functionality or to provide nutritional benefits.

A food system's physical functionality is usually to enhance viscosity or gelation. The ratio of stress to strain can be used to calculate viscosity (shear rate). Because of intermolecular entanglements, hydrocolloids can impart viscosity to a solution, resulting in resistance to flow under shearing forces. The concentration of hydrogels influences rheological characteristics. Non-Newtonian behavior can be observed as the concentration of hydrocolloid in the solution increases. The concentration of the hydrocolloid has a significant impact on viscosity (Goff & Guo, 2019) [19].

Origin and Classification

Plants, primarily terrestrial plants and seaweeds, provide the largest bulk of food polysaccharides. Furthermore, some polysaccharides, such as chitin and chitosan, are derived from animals. Glycogen, heparin, chondroitin sulphate, hyaluronic acid, keratin sulphate, acid mucopolysaccharide, and glycosaminoglycan are examples of other animal polysaccharides; however they are rarely employed in the food sector due to their high cost and limited availability. Furthermore, several microorganisms have been discovered secreting polysaccharides as secondary metabolites, which are commonly referred to as microbial polysaccharides. Microbial polysaccharides have a shorter production cycle than plant- or animal-derived polysaccharides, and the end products are more quality-controlled. As a result, they've gained a lot of interest in the areas of food science and other sectors (Yang Xi *et al*., 2020) [52].

Several parts of plant including plant cell walls, tree exudates, seeds, tuber/roots, and seaweeds have surface cells containing gums, fiber, and mucilage and protein compounds. Plant gum exudates are produced by various plants as a result of the protection mechanisms against mechanical or microbial injury (Hamed M & Bahareh T A, 2012) [23]. Gums obtained from plants either after the natural exudation process or employing extraction of tissues from different botanical parts are called vegetable gums. Plant gums are divided into two types: exudate and non-exudate gums. Plants develop exudate gums in response to mechanical injury or as a defence against microbial attack. Gummosis is the common name for this process. Seed and mucilaginous gums are non-exudate gums that can be obtained from plant tissues after an appropriate extraction method (Hamdani *et al*., 2019) [22]. Natural exudate gums are polysaccharides that plants exude in response to stressors like physical injury (cuts and incisions) and fungal infection. Trees and bushes emit gums in the form of tear-like, smeared buds, lumps, or masses that are amorphous in nature when stressed. They dry into glassy, hard exudates of varied hues when exposed to the light (Barak Shwetha *et al*., 2020) [4].

Polysaccharides from seaweeds include carrageenans which are a type of sulfated galactan found in red seaweeds (Rhodophyceae), where they have a key structure. Agarose (the major component of agar) is also obtained from red seaweeds notably *Gelidium* and *Gracilaria* species. Alginate is obtained from brown seaweeds (Phaeophyceae). Microbial polysaccharides include xanthan which is extracted from the genus *Xanthomonas*, notably *X. campestris*, by aerobic fermentation; Gellan gum, obtained from *Pseudomonas elodea* by aerobic fermentation (Williams, 2016) [49].

Hydrocolloids can be divided into four categories based on their origin and method of manufacture: 1) hydrocolloids derived solely from plants (no chemical modifications); 2) hydrocolloids obtained by fermentation; 3) chemically modified hydrocolloids generated from plants 4) animal-derived hydrocolloids (Wustenberg, 2015) [51].

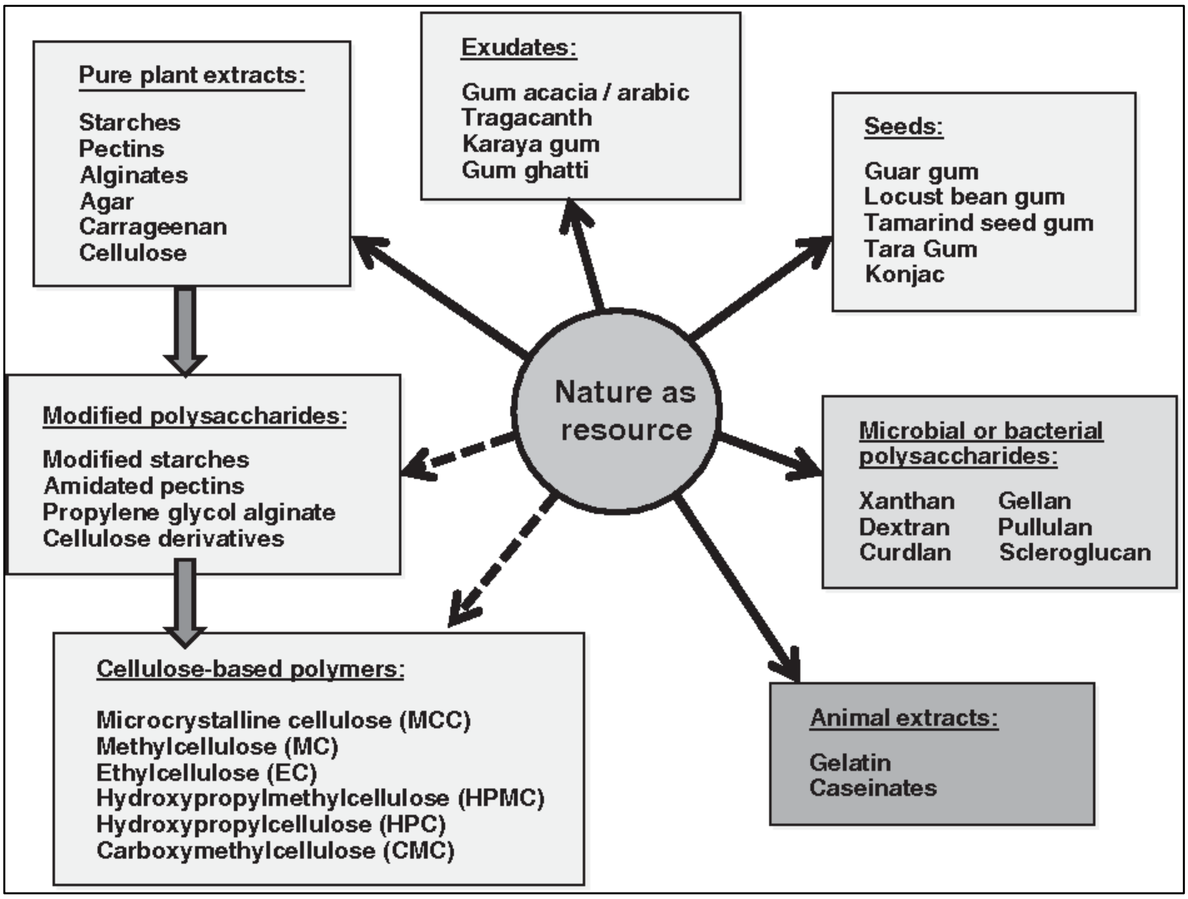

Fig 1: Origin and Classification of Hydrocolloids (Wustenberg T, (2105) General overview of food hydrocolloids)

Structurally, polysaccharides can be of linear or branched architecture, charged or neutral, depending on their origins, chemical structures and environmental factors. In some cases, polysaccharides with both hydrophobic and hydrophilic groups in the same molecular chains are referred to as amphiphilic polysaccharides (Phillips & Williams, 2009) [38].

Properties of hydrocolloids

Functional Properties

All food commodities contain moisture, which is one of their main components, which bonds in bulk with the hydrocolloids due to their hydrophilicity. These properties increase their application in products when binding of free water may prevent the organoleptic defects (Hamdani A M *et al*., 2019) [22]. Mixtures of gums are commonly used in food preparations to impart novel textural properties, and the reduction of costs is an added incentive (Williams P A, 2016) [49].

Hydrocolloids are applied in various processed foods for their different functional properties. A few applications illustrated are: they are used as thickeners in soups, gravies, salad dressings, sauces and toppings (Krystyjan, Sikora, Adamczyk, & Tomasik, 2012) [27]; gelling agents in puddings, jellies and mousses; emulsifiers in yoghourt, ice cream and butter (Kiani, Mousavi, Razavi, & Morris, 2010) [26]; fat replacers in meat and dairy products (Pinero *et al*., 2008) [54]; water binding agents in gluten free foods (Mohammadi M *et al*., 2014; Gambus H *et al*., 2001) [34, 17]; bulking agents in dietetic foods; foam stabilizers in whipping cream toppings; clarifying agents and foam stabilizers in beer; crystallization inhibitors in ice creams and sugar syrups; flocculating agents in wine; coating agents in confectionery; adhesives in bakery glazes; encapsulating agents in powdered fixed flavors; film formers in sausage casings; syneresis inhibitors in cheese and frozen foods (Nussinovitch, A & Hirashima, M, 2014) [36].

Hydration

Polysaccharides that are commercially available are mostly transported and sold need to be stored as a dry powder form. It is necessary to disperse the polysaccharide powder in water prior to any application. Polysaccharide can then interact with water instantly, generating agglomeration of the powder and, as a result, wetting, dispersion, and dissolution (Einhorn-Stoll, 2018) [11]. Dissolution is a two-step process for the majority of polysaccharides. Water molecules diffuse or penetrate into the powder particles in the first step, causing the powder to swell and form a gel-like layer around the particle surfaces; in the second step, polysaccharide molecules gradually separate from the gel-like layer's surfaces and disperse into water, allowing them to exist as single molecules. Both intrinsic and external factors influence the dissolution process. The intrinsic variables include amount and distribution of hydrophilic groups, average molecular mass, and particle and powder characteristics. Temperature and mechanical energy input (ex: agitation) are included under extrinsic influences (Yang *et al*., 2020) [52].

Gelation

A gel, which is an intermediate state of hydration between solid and sol, comprises a continuous three-dimensional network with a solid matrix containing a finely divided liquid phase and immobilizing the liquid inside it to produce a hard, flow-resistant structure (Li & Nie, 2015) [30]. Gelation is an important functionality of food hydrocolloids in terms of texture modifier. Hydrocolloid-induced gelation (i.e. network formation by hydrocolloids) usually involves the close association of polymer molecules or bundles of polymer molecules held together by hydrogen bonds or the cross-linking of anionic molecules by multivalent cations (most often calcium ions or protein molecules) over portions of their lengths. These associations are called junction zones. (BeMiller, 2008) [6]. In the gelling of hydrocolloids, junction zones are extremely significant. They also have a significant impact on the properties and functional behaviour of a gel. The amount of molecules that make up a junction zone is an essential factor of gel properties. The more molecules in the junction zone, the more stiff the gel will be. A set gel's features are determined by the number of junction zones, the amount of molecules in the junction zones, and the flexibility of the interrupting segments. Because of the connection zones, the thermal behaviour of gels varies. The length of junction zones is one of the most important elements impacting their strength. Calcium bridging is cooperative, meaning that the binding strength increases more than proportionately as the junction length increases. Another important factor is the solvent quality. Hydrocolloid gel formation is influenced by a number of parameters, including gelling agent concentration, medium pH, molar mass/degree of polymerization, temperature, ionic composition, and solvent quality. Rheological characterization of gels entails determining a gel's modulus of elasticity, yield stress, shear modulus, storage and loss modulus, complicated viscosity, gel strength, and compliance using a variety of factors. These parameters are normally determined by using instruments such as a universal texture measuring system and a controlled stress rheometer to conduct experiments such as compression tests, dynamic oscillatory rheometry, creep and texture profile analysis, etc. (Saha & Bhattacharya, 2010; Bayyari *et al*., 2006) [42].

As far as known, the network created by any hydrocolloid is fibrillar in nature. Hydrogen bonding, cationic cross-linking, and, in a few situations, hydrophobic interactions are all involved in the creation of hydrocolloid fibrils. Different hydrocolloids and mixtures of hydrocolloids can be used to create diverse gels with different properties, such as modulus, elasticity, hardness (strength), brittleness, cohesiveness, and adhesiveness. The hydrocolloids and hydrocolloid systems not only have different means of gelation, but also the properties of the gels formed from them can vary (BeMiller, 2008) [6].

The gelling type hydrocolloids include agar, alginate, carrageenan, pectin, gelatin, gellan, furcellaran, modified starch, methyl cellulose, etc. Food manufacturers are utilizing them in production of jams, jellies, puddings as well as restructured foods and bakery fillings (Saha, & Bhattacharya, 2010; Soultani *et al*., 2014) [42, 44].

Thickening

The thickening property, i.e., viscosity enhancement, is the key feature for the use of hydrocolloids as emulsifying, stabilizing, and bodying agents in foods. The thickening or viscosity-producing effect of hydrocolloids is achieved by dispersing them in water. All hydrocolloids have this water thickening effect, which is the primary reason for their widespread use. The degree of thickening varies by hydrocolloid type and nature, with a few generating low viscosities at high concentrations but the majority giving high viscosities at low concentrations (below 1%) (Saha &

Bhattacharya, 2010) [42]. Thickening occurs above a critical concentration known as overlap concentration (C*). The hydrocolloid dispersion behaves as a Newtonian fluid below this concentration but as a non-Newtonian fluid beyond this concentration (Li & Nie, 2015) [30].

Starch, xanthan gum, guar gum, locust bean gum, gum karaya, gum tragacanth, gum Arabic, and cellulose derivatives are all hydrocolloids that are often employed as thickeners. Starch is the most commonly used hydrocolloid thickener, the reason being it is abundant, relatively cheap and possibly it does not contribute to any remarkable taste if used at a low concentration of 2 to 5% (Saha & Bhattacharya, 2010) [42].

Hydrocolloids in rheology of foods

Rheology is the study of flow and deformation of matter which is observed in day to day life. For example, when we bite or chew deformation of food takes place (Zhong & Daubert, 2013) [53].

Polysaccharide gums have wide functional properties including thickening, emulsifying, gelling, stabilization, and controlling the crystal growth of ice and sugar. The behavior of polysaccharides helps modifying different properties of products in food (Farzi *et al*., 2015) [12]. Hydrocolloids are often used to thicken food systems, and over the last thirty years or so, we've gained a lot more knowledge about their rheological behaviour, especially with the introduction of controlled stress and controlled strain rheometers that can measure to very low shear rates (< 10^3 /s). At a critical polymer concentration, generally referred to as C*, the viscosity of polymer solutions increases dramatically, indicating the shift from the 'dilute zone,' where polymer molecules are free to move independently in solution without interpenetration, to the 'semi dilute region.' The slopes of the lines in the dilute and semi-dilute areas are typically 1.4 and 3.3, respectively. At concentrations much below C*, polysaccharide solutions often display Newtonian behaviour, in which their viscosity is independent of the rate of shear; however, at C*, non-Newtonian behaviour is prevalent. For a polymer solution above C*, a typical viscosity-shear rate profile is shown.

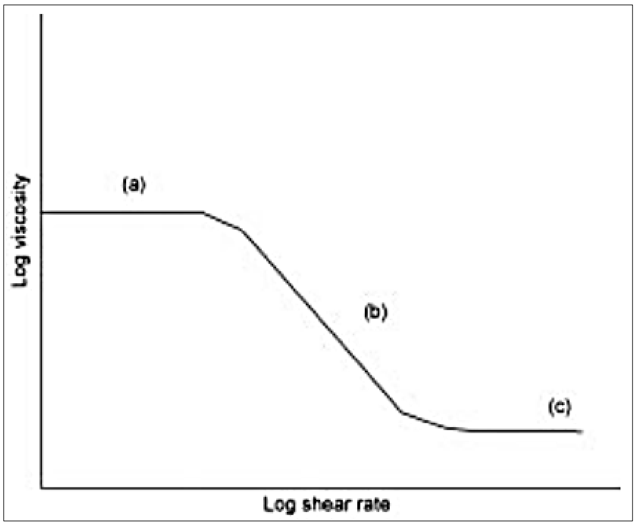

Fig 1: Viscosity- shear rate profile for a polymer solution above C* (Williams & Phillips, (2021) [50]. Introduction to food hydrocolloids)

The rheological behavior of hydrocolloids is of unique importance when they are used to modify textural attributes. It is also well recognized that rheological properties play an important role in process design, analysis and modeling. These properties are generally measured as an indicator of product quality. (Marcotte *et al*., 2001) [33]. The rheological properties of hydrocolloids can be classified as shear thinning (pseudoplastic), shear thickening (dilatant), or Newtonian flow behavior, in which apparent viscosity is decreased, increased, and constant, respectively, with the applied shear rate (Goff HD & Guo Q, 2019) [19].

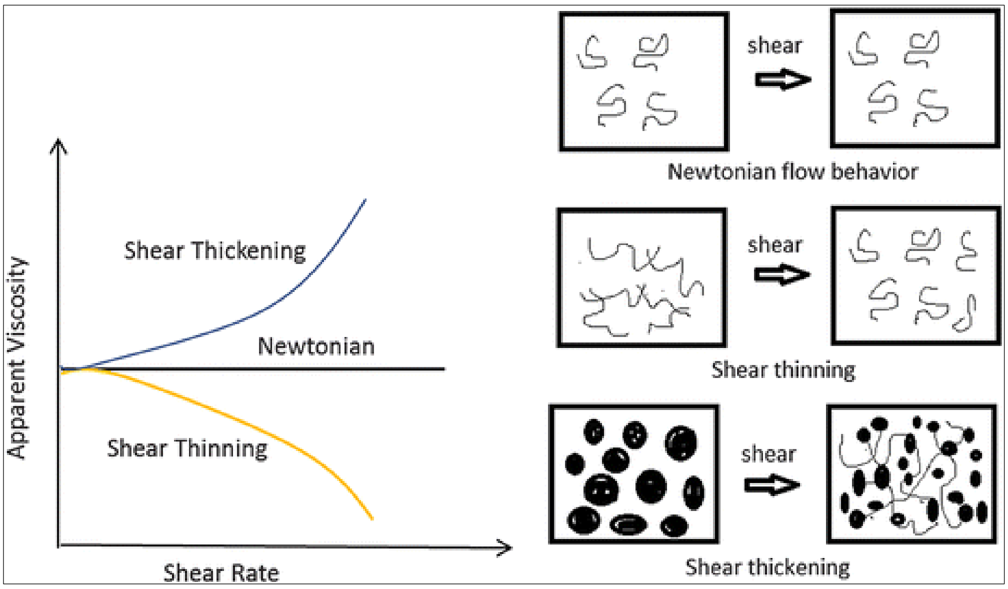

Fig 2: Shear flow behaviors of hydrocolloid solutions and the corresponding molecular interactions. (Goff & Guo, (2019) [19]. The role of hydrocolloids in the development of food structure)

The viscosity of the hydrocolloid system depends on 10 factors: concentration, temperature, solvation, electrical charge, degree of dispersion, previous thermal treatment, previous mechanical treatment, presence or absence of other lyophilic colloids, age of the lyophilic solution and presence of both electrolytes and non-electrolytes (Nussinovitch, A & Hirashima, M, 2014) [36].

Texture Optimization

Food texture is one of the organoleptic characteristics determining its palatability. Food's texture may be described as hardness, chewiness, gumminess, adhesiveness, cohesiveness, springiness and fracturability (Sahin, & Sumnu, 2006) [55]. Texture has a significant impact on consumer acceptability of food products because consumers enjoy eating more when they notice a difference in texture. Furthermore, texture is important to elders and patients with mastication and/or swallowing difficulties who must consume texture-controlled foods, such as thickened liquids, pastes, and soft gels containing essential food hydrocolloids (Funami T, 2011; Funami T *et al*., 2012) [15, 16].

The perception of food texture occurs during oral processing, during which a series of oral operations occurs in the right sequence, with several organs and muscles working simultaneously from the first bite to swallowing (Funami T, 2011) [15].

In terms of food textures, adding enhanced textural features to food products requires a thorough understanding of the components that can interact with one another and how these interactions occur (Dar & Light, 2014) [9]. Food textures are not only a major sensory component that consumers like, but they are also an important indicator for evaluating the quality of food products (Guimares, *et al*., 2020) [20].

The texture and flavor of food determine its palatability (i.e., scent and taste). Because solid foods undergo more dramatic textural changes during oral processing than liquid foods, texture is extremely important. Solid foods should be fragmented and combined with saliva before swallowing to minimize the degree of structure and increase the degree of lubrication. The primary purpose of expanding the research of food textures is to either improve the textural features of food products or to construct foods with distinctive textures to fulfill the needs of specific groups of individuals, such as those who have trouble consuming regular foods (Funami, Ishihara, Nakauma, Kohyama, & Nishinari, 2012) [16].

Polysaccharides are increasingly employed in the food sector as texture modifiers due to their non-toxicity, extensive accessibility and renewability, as well as health-promoting benefits (Bernaerts *et al*., 2019; Funami, *et al*., 2012) [7, 16]. Furthermore, several oligosaccharides have been shown to affect food textures (Guimares, *et al*., 2020) [20].

Effect of hydrocolloids on different foods

Bread

Gluten is the main protein complex which is responsible for the viscoelastic characteristics of wheat dough contributing to the crumb structure and appearance of many baked goods. The gluten matrix is the crucial determinant of dough's fundamental rheological properties, such as elasticity, extensibility, stretch resistance, mixing tolerance, and gas holding ability. Bakery products prepared for celiac patients' needs to be gluten free and possess the carbon dioxide holding capacity during fermentation by developing the complex matrices with sufficient viscoelastic properties and enable to keep the structure during the expansion throughout the baking. Incorporation of hydrocolloids is the established way to create a stable network during heating in baking. Addition of hydrocolloids into dough resulted in enhancement of elasticity; the magnitude of influence on the elasticity depends on type and concentration of polysaccharide, as well as the water content (Sabanis & Tzia, 2011; Lazaridou, 2007) [40, 29].

(Lazaridou *et al*., 2007) [29] reported that the incorporation of xanthan at 1% into the gluten-free breads did not change the loaf volume and at 2% supplementation level even decreased the volume. Thus, addition of Xanthum makes the dough system too rigid to incorporate gases.

Puri

Puri, also known as poori, is a South Asian unleavened bread which is made in a variety of nations. Fried meals are still popular, despite the fact that excessive fat consumption is linked to high blood cholesterol, high blood pressure, and coronary heart disease. Film-forming hydrocolloids like carboxymethylcellulose (CMC), hydroxypropyl cellulose (HPC), hydroxypropylmethylcellulose (HPMC), and methylcellulose (MC) are very effective for lowering oil content in deep-fat-fried foodstuffs. This is due to thermal gelation of these hydrocolloids which create a oil resistant film at the frying temperatures thereby lowering the oil uptake (Parimala & Sudha, 2012) [37].

(Sudha & Venkateshwar Rao, 2007) reported that addition of HPMC at 0.5% w/w level helped in improving the rheological parameters, marginally increased the oil uptake and resulted in softer and pliable puris with higher acceptability.

Eggless Cake

Wheat flour, eggs, sugar, and fat are the main ingredients in cake mix. The principle reason for using hydrocolloids and emulsifiers instead of eggs is due to their functional qualities. Water binding, viscosity, foaming, emulsifying, gelling, solubility, and textural enhancement are all features of hydrocolloids, while emulsifiers are recognised for their crumb softening and antistaling properties. According to (Ashwini *et al*., 2009) [1] stated that the inclusion of hydrocolloids enhanced batter viscosity and altered the wheat flour pasting qualities. The batter's specific gravity and moisture content were also raised.

Ketchup

Tomato is one of the most important vegetable products and is mainly marketed as a processed product, i.e. pastes, ketchup, salsa, etc. Viscosity is one of the most important quality parameters of such tomato products (Vercet *et al*., 2002) [47]. Tomato ketchup is a flavoured, diverse product made mostly from cold or hot extracted tomatoes, as well as concentrates, purees, and paste. Tomato ketchup acquires its viscosity from pectic substances found naturally in fruits. Consistency and viscosity of ketchup is an important attribute for designing and optimization of various unit operations (pumping, mixing, heating, etc.), and ensuring product acceptability (Sahin & Ozdemir, 2004) [36].

(Sahin & Ozdemir, 2004) [43] reported that the addition of hydrocolloids led to a significant increase in the consistency index, and thereby resulted in an increase in the apparent viscosity which is highest in guar gum and locust bean gums formulated ketchup due to their high-water binding capacity and high molecular weights followed by xanthum gum and tragacanth gum.

Hydrocolloids and Health Claims

Hydrocolloids contribute to the physical and chemical structure of foods, as well as the nutrient content of those foods, which is why they play a major role in determining the gastronomic and nutritional qualities of human diets (Gidley M J, 2013) [18]. The health effects of food hydrocolloids are dependent on how they are incorporated into foods and in the diet (Edwards C A, 2009) [10].

Food hydrocolloids consists of large and diverse number of ingredients acquired from algae, bacterial, fruit and plant extracts. The fundamental property of hydrocolloids that lends them to be considered as a healthy food ingredient is that they are dietary fibers. There are numerous health benefits that have been linked with the consumption of food hydrocolloids, which include: lowering the risk factors for cardiovascular disease, immune function, weight management, and colon health. The positive benefits of hydrocolloids are assumed to be attributable to the hydrocolloid's solubility, viscosity (gelling ability), and fermentation capacity. Consumption of some hydrocolloids has also been shown to alter the composition of the gut bacterial flora, favoring beneficial bacteria such as *Bifidobacterium* and *Lactobacillus*. Food hydrocolloids have also been researched in the context of weight management, with the hypothesis that consuming these substances can assist to decrease energy intake by promoting satiety after a meal (Viebke C *et al*., 2014) [48].

Some hydrocolloids are used in food products to boost fibre content. Weight management, immunological regulation, colonic health, cardiovascular disease prevention, and glycemic and insulinemic control in type-2 diabetes are only a few of the health benefits associated with food hydrocolloid use. They also contribute to the development of high-satiating foods. Hydrocolloids have a satiety effect by slowing enzyme action effectiveness and/or delaying stomach emptying (Morell P *et al*., 2014) [35]. Several studies have found that consuming certain hydrocolloids might alter the composition of the gut bacterial flora, favouring beneficial bacteria like Bifidobacterium and Lactobacillus. It may also lead to an increase in fermentative activity as well as the formation of short-chain fatty acids (Viebke C *et al*., 2014) [48]. Psyllium and β-glucan, viscous soluble hydrocolloids, are clinically proven to lower serum cholesterol. U.S. Food and Drug Administration also recognized them for reducing the risk of cardiovascular disease (Feinglos *et al*., 2013) [13].

Satiety

Satiation and satiety are key concepts in appetite regulation since they both refer to the suppression of eating. Satiety starts after the end of eating and prevents further eating before the return of hunger (Bellisle *et al*., 2012) [5]. The obesogenic environment that has emerged in the Western world, particularly among adolescents, encourages the consumption of energy-dense, unhealthy snacks nowadays. If satiating items were easily available, eating behavior might be better controlled, and judicious intake would be encouraged. Proteins and fibers are usually acknowledged as the nutrients having the highest potential for satiating food growth (Hardy *et al*., 2012; Halford & Harrold, 2012) [24, 21]. In the case of foods that may be ingested rapidly and with little effort, such as liquid or semiliquid foods, perceived satiety is limited (Hogenkamp & Schiöth, 2013) [25].

Hydrocolloids add viscosity to foods and aid in the development of satiating foodstuffs. The satiating capability of a large list of soluble gums that are viscous in solution has been studied extensively. Most of these types of compounds that impart viscosity to their solutions have an effect on the feeling of satiety that is caused by mechanisms that are related to slowing down enzyme action efficacy and/or gastric antrum distension (as they absorb large amounts of liquid) and/or delaying gastric emptying, which, in turn, may increase or prolong satiety signals from the stomach (Fiszman & Varela, 2013) [14].

Conclusion

Hydrocolloids are water-soluble polysaccharides with a high molecular weight that are used in food to enhance viscosity, create gel structures, produce films, control crystallization, prevent synergies, improve texture, encapsulate tastes, and extend physical stability, among other things. These functional additives are commonly utilized to improve textural features, flavor, and shelf life of different food products such as dairy products, canned goods, bread items, salad dressings, drinks, sauces, soups, and other processed foods. Texture is vital for both the taste of food and the safety of eating. The addition of hydrocolloids to processed foods can change the texture of the food. Rheological qualities of liquid and semisolid foods are significant in the design of flow operations, quality control, storage and processing stability assessments, and texture comprehension and design. Rheological property is a characterization of the flow of matter, primarily in a liquid state, which is of great industrial importance and also defines the relationship between strain, stress and time.

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