Polymeric Hydrocolloids for Functional Food: A Review

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Abstract: - Nutraceuticals add healthier options to food, helping consumers reach health and wellness goals. Evidence-based research on nutraceuticals and functional foods will reassure consumers and reinforce regulators. This nutraceutical's preparation, stability, and safety are key. Due to growing demand in the Indian and international markets, scientists are developing nutraceuticals. The review finds natural polymers effective for nutraceuticals and functional foods, which needs more validation. Nutritional research on these polymers shows promise for treating non-communicable and chronic diseases. These natural polymers would improve the nutraceuticals needed worldwide for disease management and prevention.

Key Words: — ***Functional food, Nutraceuticals, Gelatin, Chitosan.***

I. INTRODUCTION

The advantage of natural hydrocolloids in the food and pharmaceutical industry is their abundant accessibility in nature and minimal cost of processing (González-Henríquez et al., 2019). The hydrocolloids are uniquely employed in pharmaceutical, food, and nutraceutical products due to their rheological and structural functionalities. These factors play a pivotal role in improving the shelf life and quality attributes relative to thickening and gelling properties (Razavi, 2019). Hydrocolloids are heterogeneous polymeric compounds with substantial hydroxyl groups (OH) with an intensified affinity for binding water molecules, making them hydrophilic compounds. This hydrophilic nature renders the property of constituting viscous dispersions or gels when dispersed in water (Li and Nie, 2016). The hydrocolloid interaction and the resulting thickened or gelled crosslinked polymer is majorly due to intermolecular forces like hydrogen bonds, electrostatic forces, Van der Waals forces, and hydrophobic interactions (Banerjee and Bhattacharya, 2012).

Manuscript revised July 25, 2022; accepted July 26, 2022. Date of publication July 27, 2022.

This paper available online at www.ijprse.com

ISSN (Online): 2582-7898; SJIF: 5.59

These hydrocolloids are sourced from plants, animals, microbes (fermented products), and chemically modified plant-driven (synthetic gum) resources prevalently from nature. These hydrocolloids have a wide range of physicochemical features structural and metabolic functionalities in their natural form, which is explicitly tailored to a specific application. Despite their application in food industry, they are also considered a potential element in the nutraceutical and pharmaceutic industry. The gelling and thickening properties are vital functions required in pharma or nutraceutical products. Apart from these properties, hydrocolloids also accredit therapeutic properties such as antioxidative (Ai et al., 2017, Hamdani et al., 2021), antihypertension (Bouaziz et al., 2017, Kolsi et al., 2016, Ali et al., 2011), anti-diabetic (Rosa-Sibakov et al., 2016, Wang et al., 2016), anticancer (Milani and Golkar, 2019), antimicrobial (Bilal et al., 2017, Roohinejad et al., 2017), and many more due to their chemical composition (Manzoor et al., 2020).

II. HYDROCOLLOIDS

Hydrocolloids as solid, liquid, and semisolid forms are also extensively used in drug formulation for drug delivery systems (Manzoor et al., 2020). They are widely used in pharma products due to their reduced price, nontoxic nature, biodegradability, and effective drug compatibility (Medina-López et al., 2022).

They are crucial elements of numerous pharmaceutical formulations and impart various functionalities in the delivery of drugs. Thickening and gelling is the significant reason for the inclusive utility of hydrocolloids in pharmaceuticals and nutraceuticals (Williams and Phillips, 2021b). It involves the interaction of the polymer with the solvent that includes a non-specific entanglement of polymer chains that are conformationally disoriented, resulting in a discontinuous rise in viscosity (Mahmood et al., 2017). They are utilized as dental adhesives and as bulk laxatives where these products are vicious specifically applicable (Munir et al., 2021). These hydrocolloids are hydrophilic and valuable in the formulation and preparation of tablets (Zuleger and Lippold, 2001), disintegrants (Jin et al., 2015), emulsifying agents, suspension aids, stabilizers, and thickening additives (Tanna and Mishra, 2019). These hydrocolloids are distinctly are exercised as protective colloids in suspension and sustaining agents in tablets (Li and Nie, 2016). They are also exerted as adjuvants in pharmaceutical formulations to obtain various functionalities such as encapsulation, sustained release of drugs, mucoadhesiveness (Cook et al., 2017), and transdermal delivery (Zou et al., 2021).

The utility of nutraceuticals has risen over the recent decades, and it has been a choice of preventive prerequisite for its various therapeutic outcomes. Due to its salubrious properties, the nutraceutical market has grown enormously concerning the rising population and health trends. The potentiality of these nutraceutical products is leading to a new era of medicine and health forecasted towards significant demand in the upcoming years. These nutraceuticals have evolved into dietary supplements, functional food, medicinal food, and pharmaceuticals in the past three decades. Despite the prominence, there are challenges in formulation approaches to optimize treatment outcomes and disease prevention. The major challenge in the formulation is the bioavailability of the bioactive nutrient, which could be vitamins, minerals, phytoconstituent, proteins, peptides, animal tissues, glandular, and metabolites that possess the therapeutic value. These bioactive elements bioavailability is often jeopardized by the insignificant solubility, stability, and permeability of the bioactive component in the gastrointestinal tract. Several polysaccharides and synthetic polymers are used as matrices where the bioactive compound is encapsulated or entrapped to overcome these problems. Nutraceuticals as functional food are stabilized by microencapsulation that facilitates the efficient delivery of nutrients (Augustin and Sanguansri, 2015). The delivery methods can contribute a potential way to enhance the functionality and bio efficacy of the nutraceutical. The choice of biomaterials, solubility, biocompatibility, nontoxicity, and appropriate technique is predominant in formulating nutraceuticals (Williams and Phillips, 2021a).

III. NATURAL HYDROCOLLOIDS

Natural hydrocolloids have been a profound source for active biological encapsulation, controlled release, edible coating, carrier, and binding in nutraceuticals. The natural hydrocolloids may originate from proteins or carbohydrates as they are the two main macromolecules naturally available (Yemenicioğlu et al., 2020). These two macromolecules are significant food nutrients for human beings and are consumed as a staple food. While plant-based hydrocolloids have been gaining the spotlight for their advantage as a hydrocolloid, their availability differs based on climatic and seasonal conditions (Hamman et al., 2015). Moreover, the extraction and purification of the hydrocolloids are complex that requires significant expertise and capital (Amiri et al., 2021). These obstacles would hinder their utility commercially since these are complex processes that would have a negative impact on mass-level production. There are numerous limitations such as cost, utility, functionality, and scalability compared to conventional hydrocolloid materials. The other conventional hydrocolloids that majorly are resourced animal sources are reported to cause allergies and are susceptible to microbial contamination and putridity (Bisht et al., 2022).

IV. PEPTIDES

There are numerous uses for biological peptides. Among the most studied milk peptides, bioactive milk peptides are known to have immunomodulatory and antihypertensive opiod properties and increase mineral absorption (Wada and Lönnerdal, 2014). Functional food ingredients include bioactive peptides derived from various parent proteins (such as milk proteins or soy proteins). Encapsulation systems can help conceal the bitter taste of peptides and deal with any hygroscopicity difficulties they may have, making their delivery into food more successful. There was less hygroscopicity in encapsulated casein than in the free hydrolysate after complex coacervation with soybean protein isolate and pectin (Mendanha et al., 2009). Similar advantages were observed when a casein hydrolysate was spray dried and combined with carriers like gelatin and soy proteins (Fávaro-Trindade et al., 2010).

V. GELATIN

Gelatin, caseinates, and gellan gum are the most utilized as hydrocolloids in nutraceuticals. Gelatin is deficient in tryptophan and has a low-level content of methionine and a high level of lysine (4%) plus, it has excellent digestibility qualify gelatin as a good protein source (Baziwane and He, 2003). Therefore, it is often used to supplement other proteins to give a higher protein value than other components. The net protein value rises from 84% to 99% when mixed with beef protein. However, the caloric value of gelatin is only 3.5 kcal/g (Karim and Bhat, 2008). Although gelatin has high nutritional properties, it has several disadvantages as it is extracted from an animal source (Dille et al., 2018). Recently, a survey conducted was in the UK by an International meal delivery service reported that approximately 5.5 lakh people were following a vegan diet with an increase of the vegan population more than 3.5 times over the past decades. Meanwhile, in the USA, 5% of the population were identified as vegans, showing an increase of 500% since 2014, according to research data provided by Global Data. It can be contaminated with diseased animal tissues due to unsafe manufacturing practices (Ali et al., 2018). Gelatin which is used for nutraceutical applications, is found to be expensive. In addition, it can cause an unpleasant taste, heaviness sensation in the stomach and causes an allergic reaction. These challenges have led to identifying and exploring new hydrocolloid sources and evaluating their functionalities.

VI. CHITOSAN

Chitosan is obtained from chitin by deacetylation process has been widely used for many applications across healthcare and related products. Chitosan is a cationic linear copolymer of N-acetyl-D-glucosamine units, and when deacetylated, the functional acetyl group from the repeating chain is removed to obtain β-1,4-D-glucosamine. The potentials of the polymer as a drug delivery agent are extensively researched and have been used in many therapeutics. The polymer's degree of deacetylation and molecular weight are the two significant factors determining the polymer's functionality. The polymer's solubility is also based on the degree of deacetylation, and chitosan below 30 kDa is soluble in water without any acidification. Chitosan has been reported as an effective excipient in the pharmaceutical application for tablets' direct compression and has shown controlled release properties with many tablet formulations (Nigalaye et al., 1990, Nunthanid et al., 2004). Chitosan in nanosize improves the bioavailability and stability of bioactive ingredients. Moreover, there is evidence of enhanced cell uptake of these positively charged polymeric nanoparticles by epithelial cells (Akbari-Alavijeh et al., 2020). Chitosan has effectively exhibited antimicrobial and antioxidant activity in pristine and functionalized forms, making it a promising option for nutraceuticals due to its high capacity to bind fat in the gastrointestinal tract (Abd El-Hack et al., 2020).

VII. CONCLUSION

In the proposed system, we have implemented an organization-oriented system that would assist the human resource department in short listing the right candidate for a specific profile. The system could be used in many business sectors that will require expert candidates, thus reducing the workload of the human resource department.

Adding nutraceuticals to food provides consumers with a selection of healthier options that can help them meet some of their health and wellness goals. Nutraceuticals and functional foods will benefit from evidence-based research, which will help consumers feel more confident about purchasing these goods and strengthen regulations for these items. This nutraceutical product's preparation, stability, and safety are the primary considerations. Scientists and researchers are developing nutraceutical goods because of the high demand in the Indian and international markets. The natural polymers discussed in the review are effective for nutraceuticals and functional foods that require more validation. Studies are being conducted, and nutritional research on these polymers is beneficial for treating several non-communicable and chronic diseases. Therefore, we may conclude that these natural polymers would significantly improve the nutraceutical items that people all over the world require to manage and prevent diseases.

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