MODIFICATION WHEY PROTEIN PROPERTIES WITH USE CROSS-LINKING AGENT

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The most important physiological and biological properties, that reflect value of food, are compliance of the chemical structure its components, as well as the balance of nutrients, namely macro- and micronutrients, vitamins, amino acids, etc. Dietary proteins, in addition to being used as an energy source and provide the body with amino acids for protein synthesis, are important biological objects that help maintain overall human health, participate in the growth and development of the body, the functioning of cellular metabolism [1].

One of the high-quality sources of protein, which contains all essential amino acids, is a whey protein isolate (WPI). WPI is widely used as a functional ingredient in the food industry, as it is characterized by high emulsifying, foaming, gelling properties and the ability to holding water, thicken water systems, form stable structures of emulsion gels [2].

In the food industry, emulsion gel is a semi-solid food material with a gel-like structure, including drops of fat phase (oil) [3] used to create new foods or to improve the texture and functional properties of existing ones. The macroscopic physicochemical properties of emulsion gels (such as appearance, texture, and stability) depend on the type, concentration, organization, and interaction of their structural elements, such as oil droplets, proteins, polysaccharides, and crosslinking agents [3,4]. Thus, the functional properties of emulsion gels can be modified through the use of different structural elements and processing conditions in their production.

WPI-based emulsion gels are usually prepared by two gelation methods: heat-set or cold-set. As a result of thermal exposure, protein molecules associate with each other and form a gel structure, their strength depends on the solution conditions and the type of used cross-linking agents.

This material presents studies of the effect such crosslinking agents as divalent cations Ca^{2+} (75 mm) and the enzyme transglutaminase (TG – 0.05% wt./wt.), and their combinations on the formation and properties of WPI-emulsion gels. Cationic ions, such as Ca^{2+}, promote the formation of physical bonds between anionic groups of protein molecules through the formation of electrostatic salt bridges. This method of interaction is widely used in obtaining granules of whey protein hydrogel for probiotics encapsulation [5]. In turn, TG catalyzes the cross-linking of glutamine and lysine residues on protein molecules to form covalent bonds. Due to this, TG is used to modify the protein properties, such as solubility, emulsifying, gelling and moisture holding capacities [6].

In these studies, a high-energy homogenization method was used to obtain an oil-in-water emulsion and to form an emulsion gel by adding TG and/or Ca^{2+} (sunflower oil was used as the fat phase). We visually assessed the formed gels structure to establish the feasibility of using cross-linking agents (Ca and TG).

To visually assess the formed hydrogels and emulsion gels quality, they were kept for 12-24 hours at ambient temperature. In the absence of oil droplets, WPI hydrogels and WPI with TG hydrogels flowed slowly, when they were turning over. This indicates the absence of stable interactions and the formation of no-solid gels. WPI hydrogels, obtained when used as a cross-linking agent cations Ca^{2+} and combinations of TG + Ca^{2+}, are characterized by a stable strong structure and did not change when the test tubes were turning over. The obtained results suggest that Ca^{2+} and its combination with TG are most effective for the formation of stable solid WPI gels. The presence of fat phase droplets, which were added to obtain emulsion gels, improves the formed systems structure for all samples. This indicates the ability of fat molecules to influence the interactions in the gels formation, acting as active fillers, and thus increase gel strength.

The inclusion of the fat phase in the oil droplets form to the gel systems composition increases their strength by placing whey proteins around fat molecules and indicates about their ability to act as active fillers, which are included in the three-dimensional protein structure. The additional use of crosslinking agents (TG and Ca^{2+}) promotes the whey proteins aggregation, which improves the stability of the formed hydrogels and emulsion gels. This study leads to the development of new approaches to creating innovative food materials with new functional characteristics.

References

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