**Hydrocolloids for enhanced gelation and colloidal stability of precision fermentation-derived β-lactoglobulin**

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Dairy proteins have long been appreciated for their techno-functional and nutritional properties. With precision fermentation already established as a viable technology for ingredient production, there is growing interest in producing recombinant analogues of dairy proteins. This approach allows for the development of isolates containing specific protein variants, which can be bioequivalent to their milk-derived counterparts, or engineered for enhanced functionality. The functionality of such recombinant dairy protein isolate is primarily determined by the protein’s molecular characteristics and the isolate’s purity. This study explores the use of various hydrocolloid – protein combinations to improve heat-set gelation behaviour and colloidal stability in beverage systems. Fermentation-derived β-lactoglobulin (BLG) was combined with κ-carrageenan, high methoxyl pectin (HMP), low acyl gellan gum (LAGG) and locust bean gum (LBG) at different ratios and the gelation behaviour and gel properties of these combinations were evaluated. Texture analysis revealed that hydrocolloids could work synergistically or antagonistically with BLG in terms of gel hardness, depending on their concentration, and related to that, the occurrence and type of phase separation. Additionally, small and large amplitude oscillatory shear (SAOS & LAOS) rheology was used to characterize specific hydrocolloid – BLG combinations. Significant differences were observed under non-linear deformation, indicating the formation of distinct gel network structures. The role of hydrocolloids in model protein beverages was also examined. Consistent with other dairy protein ingredients, and despite of some physicochemical differences with milk-derived BLG, it was confirmed that HMP could improve the heat stability of fermentation-derived BLG at acidic pH conditions. Our findings demonstrate that selecting the right hydrocolloid and concentration can unlock specific gelation functionalities or stability at challenging pH conditions where β-lactoglobulin tends to aggregate during UHT processing. These insights may guide formulators in developing animal-free dairy foods with tailored textures and inspire academics to explore hydrocolloids in food texture design.