



# Protein-based Emulsion Hydrogels and Their Application in the Development of Sustainable Food Products

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Accepted: 3 July 2024

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## Abstract

Consumers have become more conscious of their diet, resulting in an increased demand for low-calorie and nutrient-rich food. Therefore, finding alternative ways to develop food products with improved nutritional values has become necessary without compromising the textural and sensorial properties. In the last few years, emulsion gels have gained much popularity for oil structuring, delivery of bioactive compounds, and development of nutritious food products. Protein-stabilized emulsion hydrogels have the most significant potential to be utilized in the food industry as they contain natural ingredients that help with clean label tags. Different gelation methods can be used to fabricate emulsion gels depending on the requirements of end products. Emulsion hydrogels' rheological, textural, mechanical, and structural properties can be modified by altering their composition, oil concentration, gelation method, and gelling environment, such as pH, temperature, etc. This review addresses using protein-based emulsion gels to develop novel food products with reduced-calorie and nutrition-rich content.

**Keywords** Emulsion hydrogels · Sustainability · Saturated foods · Protein · 3D printing

## Introduction

Fats in food products directly influence the products' textural properties, taste, color, mouthfeel, and energy values. The melting profile of fat plays a significant role in the texture, spreadability, and mouthfeel. The melting profile of fat depends on its crystalline structure. Fats have crucial and specific roles in different food products in baked products, shortening aids in trapping as well as releasing the air, provides characteristic flavor, and mouthfeel; in chocolates, it is responsible for the rheology of melted chocolate, bloom in chocolate, melting characteristics and flavor; in ice cream it is responsible for characteristic flavor, color,

texture, and mouthfeel [1]. Therefore, replacing traditional food products with other ingredients is a complicated process. However, fat imposes negative health impacts due to saturated and trans fatty acids. According to WHO the trans, saturated, and total fat should be less than 1, 10, and 30% of the total calories in the diet [2]. Replacement of saturated fat with liquid plant-based oils is a healthier option but compromises the products' taste, texture, and oxidative stability. Consequently, food researchers and industries are working hard to pave the way to restructure oil into a gel-like substance with textural and rheological properties like that of solid fats. Emulsion hydrogels have also come up as a solution for these techno-functional issues. Emulsion hydrogels, also known as emulsion-filled gels, emulsion gels, and emulgels, are soft solid-like materials having emulsified droplets entrapped in the gel matrix (Fig. 1) [3, 4]. Emulsion gels are widely used to replace solid fat in bakery food and meat products without compromising much with the textural and sensorial properties [5–8]. Emulsion hydrogels not only help form reduced fat products but can also be used to improve the fatty acid profile. Different biopolymers, such as protein and polysaccharides, are used to stabilize the emulsion and to induce gelation. Various types of oil, like soybean oil, extra virgin olive oil, peanut oil,

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