Edible surfactants promote the preparation of silkworm sericin food 3D printing by emulsion gel method

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At present, 3D printing technology has been widely used in medical, industrial manufacturing, biological tissue, construction, aerospace, education, clothing and packaging industries[1-4].When this technology is applied to the field of food production, it is called food 3D printing technology. Although the application of 3D printing technology in the food industry is still in its infancy, since Yang et al. first used extrusion-based technology to produce complex 3D cakes in 2001, the development of 3D printing technology in the food industry has gradually accelerated, indicating its wide application potential in the field of food manufacturing. The core of food 3D printing is the use of edible bio-ink as a printing material. This edible bio-ink not only determines the main components of food 3D printing products, but also its properties, such as rheological properties, hydration properties and printability, play a vital role in the feasibility of the printing process[5]. At present, many food materials are not compatible with 3D printing, because inappropriate structure or composition leads to poor printing accuracy[6] and low resolution of finished products. This is a problem that still needs to be solved in the customization of food 3D printing.

In the biological 3D printing, which is closely related to food 3D printing and has been fully studied at present, silk protein has a good research foundation. As a protein polymer, it has been studied in the biomedical field.Its low cost, adjustable mechanical properties and high printing accuracy indicate that it is an excellent biological 3D printing material[7]. In addition, both silk fibroin and sericin are rich in 18 kinds of amino acids necessary for the human body. The edible bread and beverage made of silk fibroin as a protein raw material have received extensive attention from the market. Therefore, silk fibroin has considerable potential as a food 3D printing material.

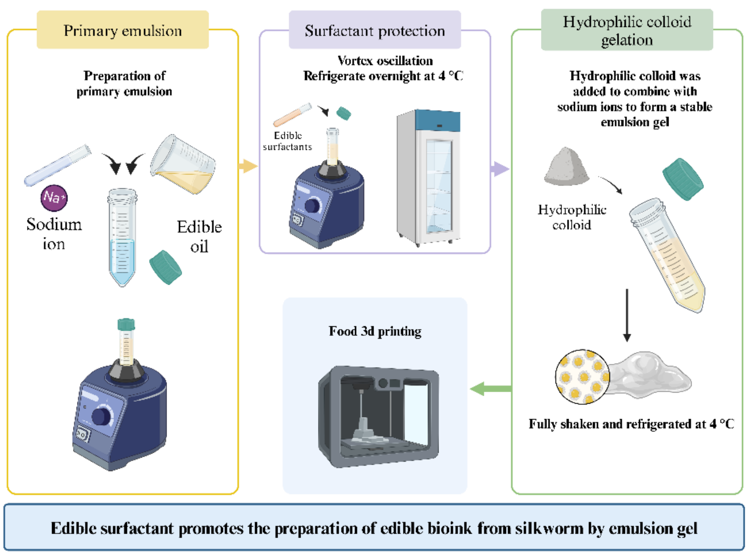

Figure 1 Edible surfactant promotes the preparation of edible bioink from silkworm by emulsion gel

Food surfactants have high safety and functionality, which can make the dispersed phase better distributed in the continuous phase and improve the affinity and stability of the dispersed phase relative to the continuous phase. The surfactant gelatin for food was added to the primary emulsion to reduce the surface tension of the O / W emulsion liquid and increase the liquid interface area to form a more uniform emulsion and enhance the stability of the emulsion.

In this study, the addition amount of sericin protein was 5 %, the addition amount of soybean protein isolate was 3 %, 40 % soybean oil and sodium salt were added after shaking low temperature hydration, and low temperature preservation was carried out. Adding 0.5 % ~ 1 % surfactant (Gelatin), ultrasonic treatment for 20 min, and overnight treatment at 4 °C without adding hydrocolloids, the samples with low concentration of gelatin can still maintain the emulsion state, and the samples with higher gelatin addition have a significant gelation trend. Subsequently, 3 % hydrophilic colloid was added, shocked and mixed, and placed at room temperature for 2 h.

The emulsion gel prepared in this study by Fig.2 (A) has good viscosity and can maintain a certain mechanical strength during the preset printing time of 600 seconds. In figure 2 (C), the storage modulus G ' and the loss modulus G ' in the modulus curve have no cross-linking points, and satisfy G ' > G ', indicating that it has been fully gelatinized. The storage modulus reflects the elastic ability, reflects good mechanical properties, and is sufficient to support 3D printing.

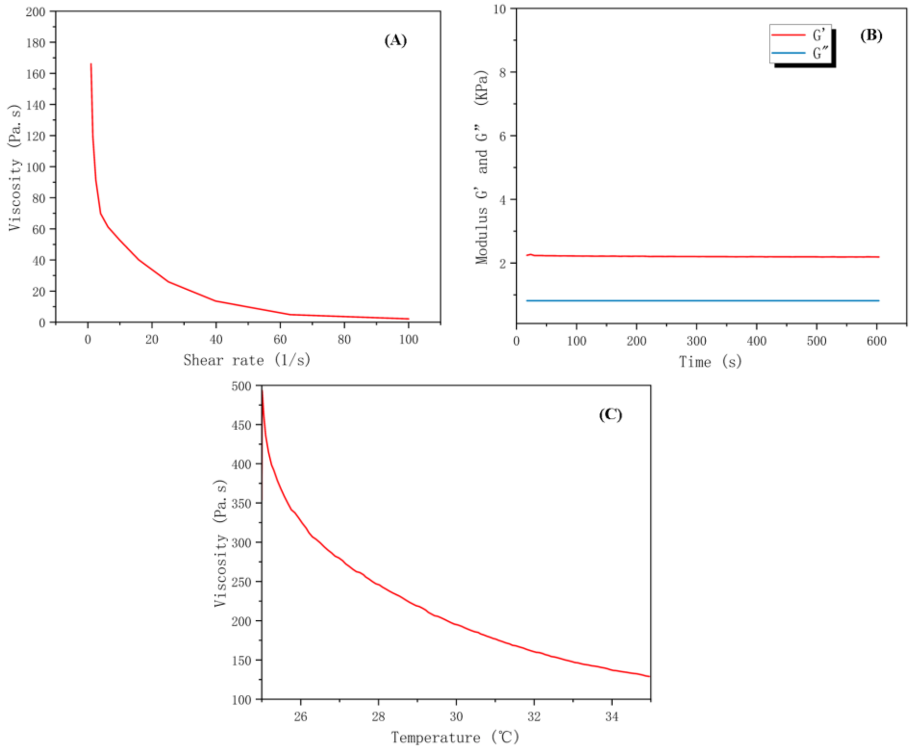

Figure 2 Viscosity and shear rate curve (A) ; Viscosity and temperature curve (B) ; Modulus curve (C)

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