Jasmone controlled-release microcapsules with tannic acid-Fe^{3+} complex for silkworm feed induction

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Packaging is an effective solution to minimize product quality loss, with the advantages of reducing material loss and enhancing sustainability. At present, the application of packaging in controlled-release has been actively developed. There have been studies on the preparation of double-response linalool fragrance capsules, and the encapsulated linalool can be controlled through temperature and reoxidation stimulation, and has good antioxidant and antibacterial effects (Hu et al, 2020). Another study designed and synthesized a double-shell fluorescent mesoporous nanoparticle silica decoy for imidacloprid, which extended the validity period of the pesticide and had good insecticidal activity against aphids (Wang, et al, 2022). However, there are few studies on feed attractants, which often need to be added to feed, but due to the strong volatility of feed attractants, the sustainability is weak (Hu et al, 2020). Therefore, the sustained-release method can improve the duration of food attractants in feed, and greatly improve the application of food attractants.

Microcapsule sustained release is a relatively general method that has the advantage of separating the oil phase containing the active ingredient from the water phase as the substrate and inhibiting the adverse effects of environmental factors such as light, heat, microorganisms and other chemicals on the active ingredient (Schwartz et al., 2003). At present, there has been the use of citral for controlled-release technology, controlled-release effect increased by 8 times (Xu et al, 2022). However, the controlled-release effects in feed and the effects after feeding have not been reported. Therefore, it is of great significance to use the new material for controlled-release treatment and analyze the controlled-release effect in feed and the effect after feeding.

This study used tannic acid (TA) and Fe^{3+} for sustained-release treatment of citral and jasmone. Tannic acid, a plant polyphenol, is recognized as safe for food supplements by the FDA (Rahim et al, 2014). Because TA is rich in catechol and gallic groups, it can react with ions through hydrogen, covalent and coordination bonds, and generally adhere to various physical materials, thus successfully forming supramolecular structures (Zhou et al., 2020). Fe^{3+} is also recognized as safe for food supplements (Ejima et al, 2013). Polyphenols and Fe^{3+} complex are good sources of iron nutrition supplement and has no adverse effects on human health (Tang et al., 2013). Citral and jasmone have been reported as attractants in silkworm feed (Tanaka et al.,2009), so we obtained reliable controlled-release particles by encapsulated them, and expected to analyze the controlled-release effects in feed and the effects after feeding.

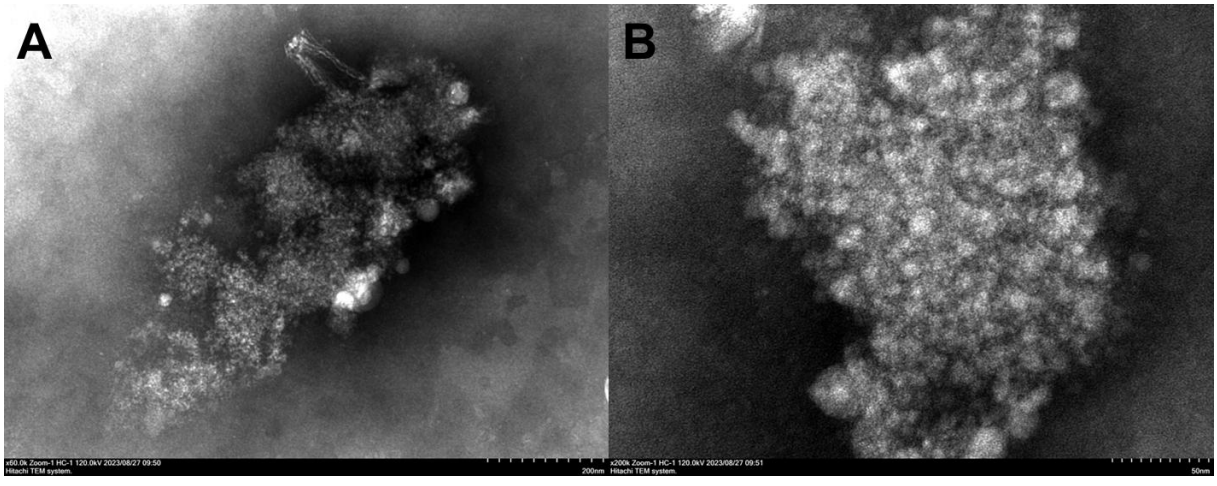

Figure 1. Transmission Electron Microscope (TEM) image of jasmone@TA-Fe^{3+}. The scale is 200 nm (A) and 50nm (B).

Jasmone@TA-Fe^{3+} microcapsules were obtained by the ligation-driven assembly between TA and Fe^{3+} using jasmone milk drops as a template. TA as an organic ligand and Fe^{3+} as an inorganic crosslinking agent. These complexes aggregate at the liquid/liquid interface, forming a shell around the citral emulsion droplets. The shell structure is one of the most stable and robust structures among the TA-Fe^{3+} complexes. Figure 1 shows that TEM images of jasmone@TA-Fe^{3+} respectively. Capsules with stable shell structure are generated in the images, and the average diameter of microcapsules is about 300-400nm.

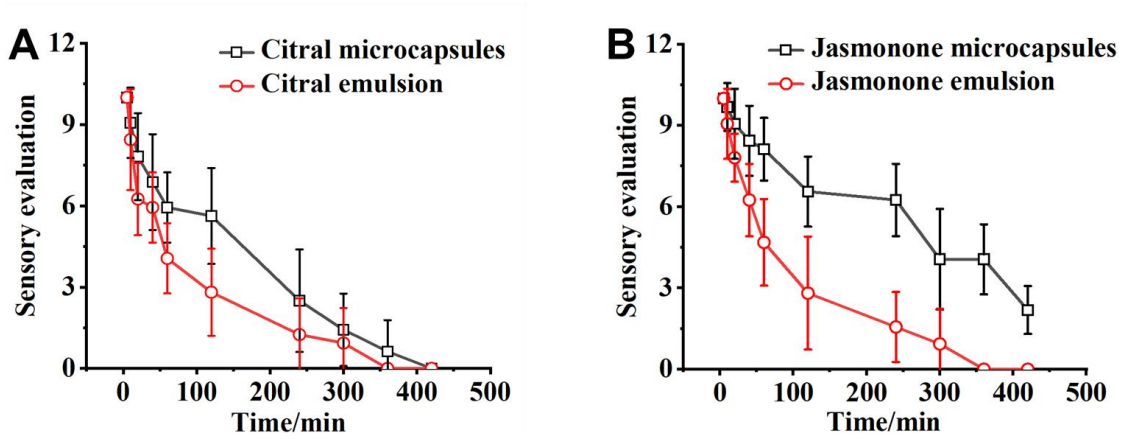

Figure 2. Sensory evaluation of microcapsules and emulsions containing citral (A) and jasmone (B).

Using equal amounts of emulsion and microcapsule prepared as samples, and analyzed them through sensory evaluation of 8 people. The evaluation was divided into 5 grades: very rich, relatively rich, rich, slightly rich and not rich, corresponding to the scores of 10, 7.5, 5, 2.5 and 0 respectively. As shown in Figure 2, it was found that the sustained-release effect of the prepared sustained-release microcapsules was significantly stronger than that of the emulsion. This result indicated that the microcapsules formed by using TA and Fe^{3+} as phenolic ligands and inorganic crosslinking agents, respectively, had better sustained-release effect, similar to previous studies (Xu et al, 2022). And could be used for the sustained-release of feed attractants of silkworm and the protection of natural flavors, which had a good application prospect.

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