Using a reactive emulsifier to construct simple and convenient nanocapsules loaded with lambda-cyhalothrin to achieve efficient foliar delivery and insecticidal synergies

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Material

Cyclohexanonel (analytical grade) were purchased from Kermel Chemical Reagent Co., Ltd. (Tianjin, China). Emulsifier 500# and 602# was purchased from Shandong Tiandao Biological Engineering Co., Ltd. (Shandong, China). Sodium lignosulfonate (relative molecular weight of 1.0×104 to 1.2×104; sulfonation degree of 0.85 mmol/g) was purchased from MeadWestvaco Inc. (America). Fluorescein5(6)-isothiocyanate (FITC) and dibutyltin dilaurate were purchased from Aladdin Industrial Corporation. (America). The water used throughout the study was distilled water.

Insect source

The tested insects were *Agrotis ipsilon* (Rottemberg). The insects were successively reared in the laboratory and fed artificial feed at 25±1 °C, 70±5% relative

humidity in 16:8 light/dark cycles. Fourth-instar larvae were selected for the bioassay and greenhouse experiments. Cabbage (Brassica oleracea L.) was cultivated artificially in the greenhouse without exposure to any chemicals.

Release properties

A sample (0.7 g) was weighed into a clean, dry glass bottle (150 mL). The volume of formulation in the bottle was calculated, and sufficient water was added to give a total volume of 6 mL. A hexane/ethanol (95:5, v/v) mixture (100 mL) was added to the bottle via pipette. The bottle was capped and immediately placed on a roller set to roll the bottle horizontally at 70 ± 10 rpm, and a timer was started. Note that the speed quoted is that of the bottle and not the roller. Subsequently, 0.5 mL of liquid was removed at various time intervals and immediately added to the same volume of release media. The amount of LC (A_t) was measured, and the amount of LC in the 0.7 g LC formulation (A_0) was also determined by HPLC.

The amount of lambda-cyhalothrin was determined using an Agilent 1200 HPLC system (Agilent 1200; Agilent Technologies; Santa Clara, CA), which was equipped with a UV detector. An Agilent Diamonsil C18 column (250 mm×4.6 mm i.d., 5 μm) was used to separate the analyte. An acetonitrile/water mixture (85:15, v/v) was used as the mobile phase at a flow rate of 1 mL/min. The injection volume was 20 μL. The column temperature was maintained at 30 °C, and the detection wavelength of the UV detector was set at 240 nm. The cumulative release ratio was calculated using the following equation:

$$\text{Cumulative release proportion (\%)} = (A_t / A_0) \times 100$$

Determination of A_0

The measurement of A_0 proceeded as follows: MC suspensions (0.7 g) were accurately weighed and transferred to glass bottles (100 mL). Acetonitrile was added to a volume of 100 mL. Subsequently, the glass bottles were placed in a 25 °C water bath with ultrasonic treatment at 100 Hz for 20 min, and the LC that was encapsulated in the microcapsules could completely diffuse into the acetonitrile solutions during this process. After that, the glass bottles were centrifuged at 3000 rpm for 5 min, and the upper acetonitrile solutions were extracted for measurement. The response value of LC in acetonitrile was measured using an HPLC system, and the amount of LC (A0) in the 0.7 g formulation was determined.

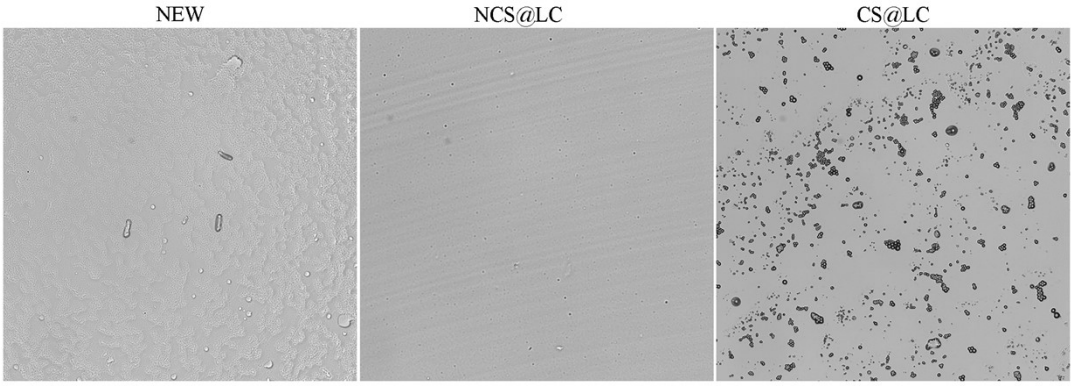
UV stability

Samples were diluted with distilled water to a concentration of 2000 mg/L. Then, 1 mL of each diluted solution was evenly applied to carrier glass(2*4cm). After the water was evaporated, the carrier glass was exposed to ultraviolet rays with an average irradiation intensity of 10 μW/cm2. Then, the carrier glass was removed at regular intervals. The residue in the carrier glass was washed with acetonitrile and transferred to a volumetric flask (100 mL). Then, the solution was filled to a constant volume of 100 mL using acetonitrile. The amount of LC was detected using an HPLC system. The residual content was calculated using the following equation :

$$\text{Residual content (\%)} = (c_r / c_1) \times 100$$

where c_1 is the initial concentration and c_r is the concentration after degradation.

Pesticide status after evaporation of water



S1. The pesticide status of NEW, NCS@LC and CS@LC after evaporation of water.