Microfluidic control preparation of phoxim microemulsion and its permeation on the epidermis of *Spodoptera litura*

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Abstract

Microemulsion is a nanometer drug carrier mainly used in medicine. In this study, a microfluidic device was used to prepare the insecticide phoxim microemulsion. The result showed that the microemulsion composition was Tween 80, agricultural emulsifier 500, N-hexyl acetate, N-propanol and water. In microfluidic system the formula was used, the water phase and the oil phase were set as the upper and lower phases, and the flow rate was 5 and 20 μL/min respectively. Microemulsion's boiling point/cloud point was 109 °C, particle size was 21.5±0.8 nm, and the potential value was -18.7±0.6 mV. The release amount of microemulsion in vitro was 33.2-52.4 mg/L, the penetration amount to *Spodoptera litura* was 0.9-4.2 mg, and the penetration rate was 8.7-90.7%. These results highlight the potential of microfluidic technology to produce pesticide microemulsions.

Methods

Under microfluidic droplet system, the best microemulsion system (oil phase + surfactant + co-surfactant) was used as the oil phase, phoxim addition was 50% (w/w) of the oil, and ultrapure water was used as the oil phase. The water phase and the two phases were respectively connected to the T-shaped chip. First, the oil phase was used as the upper phase and the water phase was connected to the chip as the lower phase. Then, the flow rate of the upper and lower phases was continuously adjusted, and the phoxim microemulsion formed under different flow rate conditions was collected and observed whether it is turbid or the liquid is layered. Afterwards, the upper and lower phases were switched, the water phase was the upper phase and the oil phase was the lower phase. The flow rates of the upper and lower phases were also continuously adjusted. The collection and observation methods were the same as above. Turbid and layered microemulsions were eliminated, and other microemulsions were subject to the next experiment.

Results & Discussion

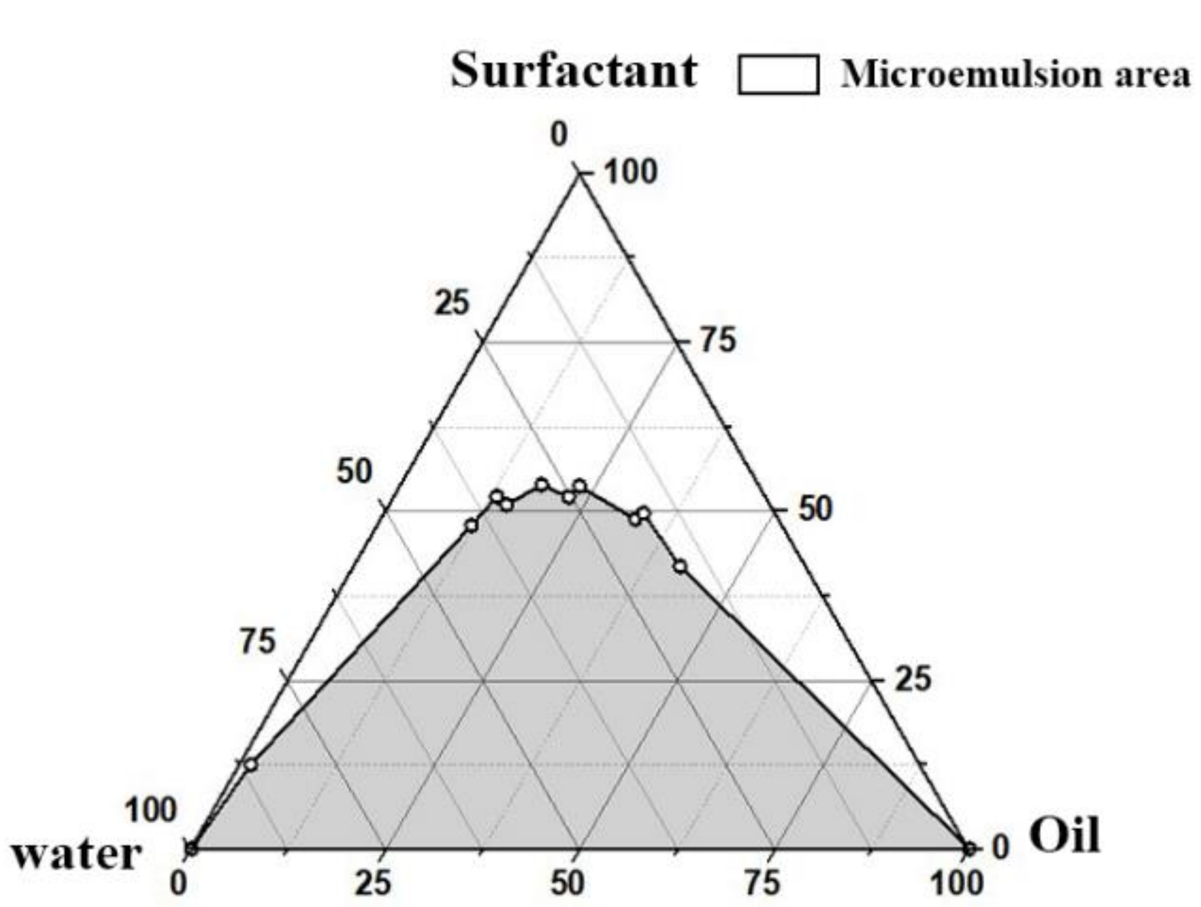

Fig.1. Microemulsion area and non-microemulsion area formed by Tween 80 and agricultural emulsifier 500.

Table 1 Influence of different flow velocity on the formation of microemulsion when the oil phase and water phase pass through two channels in a microfluidic system.

Upper phase-oil			Lower phase-oil		
Oil phase flow rate (μL/min)	Water flow rate (μL/min)	Microemulsion	Oil phase flow rate (μL/min)	Water flow rate (μL/min)	Microemulsion
1	1	√	5	5/10/15	√
5	5/10/15	√	5	20/25	×
5	20	×	10	5/10/15/20/30	√
10	5/10/15/50	√	10	40	×
10	20/30/40	×	20	5/10/15/20/30/40/60	√
20	5/10/20/40	√	20	65	×
20	60	×	30	5/10/20/30/40/60/65	√
30	5/30	√	30	75	×
40	5/40	√	40	35	√
50	5/50	√	40	40/45/50	×
55/60/65	5	√	50	40/45	√

√ This flow rate can form a microemulsion
× This flow rate can't form a microemulsion

Table 2 Screening results of cloud point/boiling point of phoxim microemulsion prepared by microfluidic system.

Microemulsion No.	Upper phase	Lower phase	Upper phase flow rate (μL/min)	Lower phase flow rate (μL/min)	Cloud point/boiling point (°C)
1	Oil	Water	20	5	103.3
2	Water	Oil	5	20	109
3	Water	Oil	5	15	105.5
4	Oil	Water	20	20	96.8
5	Oil	Water	20	40	94.3
6	Oil	Water	30	15	108.8

Table 4 Toxicity of blank microemulsion to 5th-instar *Spodoptera litura* larvae in three days.

Time (h)	Slope (±SE)	*LC_{50} (95% CI)	X^2	df	P
24	3.43±1.34	870.75 (591.46-12237.23)	1.69	4	0.640
48	1.41±0.56	1217.51 (616.93-152417.82)	1.65	4	0.648
72	-0.115±0.416	1948.99	1.11	4	0.775

*LC50 (μg/mL) value was determined by log-probit analysis. 95% CI means 95% confidence interval.

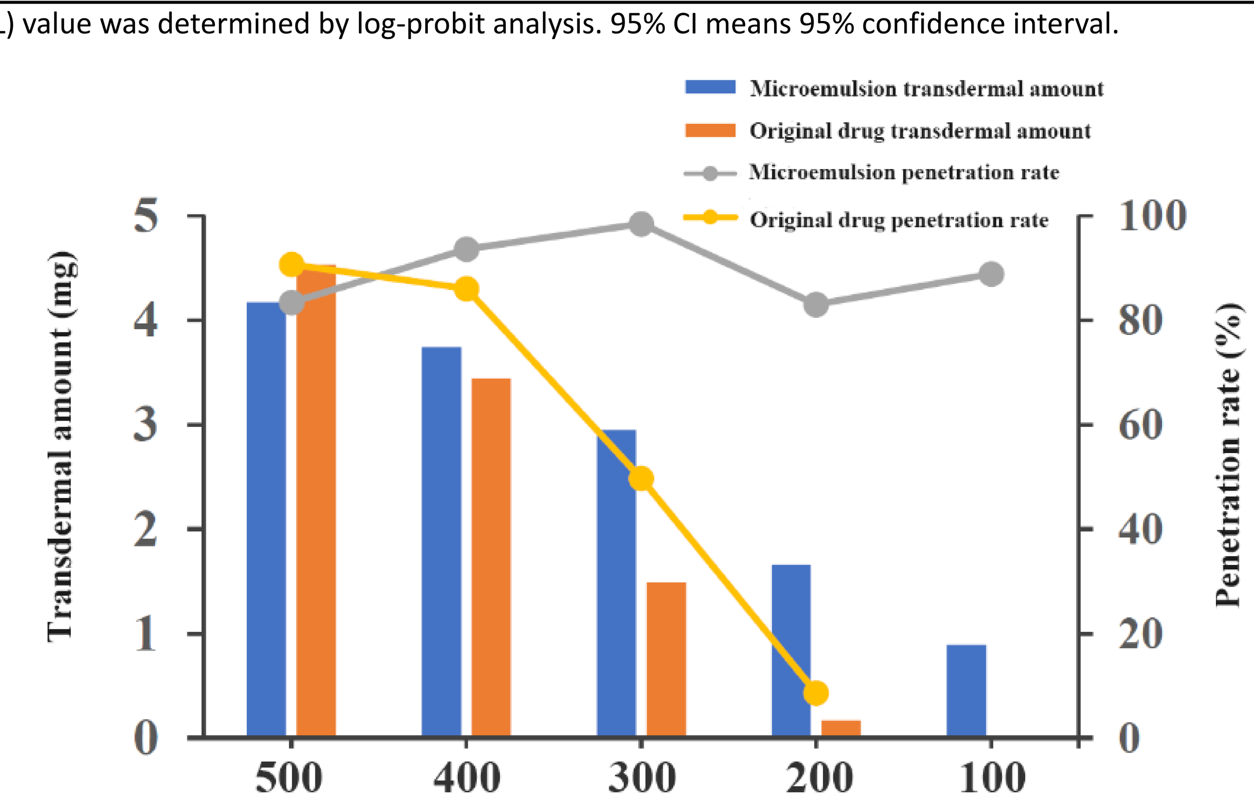

Fig. 2. The permeation rate and penetration rate of different concentrations of phoxim microemulsion and original medicine against *Spodoptera litura*.

Conclusion

Phoxim microemulsion was successfully prepared by adjusting various components and flow rate using a microfluidic device. When it was used to prepare pesticide microemulsions, the closed system covered the smell of pesticides and reduced the contact toxicity to human; besides, it controlled the preparation of pesticide samples in the microscale.

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References

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