

## Development of Cinnamon Essential Oil Microcapsule

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**Abstract.** Cinnamon essential oil microcapsule was developed. Microcapsule was prepared with cinnamon oil embedded  $\beta$ -Cyclodextrin ( $\beta$ -CD). The influence of the ratio of core (Cinnamon essential oil) to wall ( $\beta$ -CD), temperature, reaction time and stirring speed on the embedding rate of cinnamon essential oil were studied through  $L_9(3^3)$  orthogonal test. The optimum preparation conditions of cinnamon essential oil microcapsules was as follows: the ratio of core (Cinnamon essential oil) to wall ( $\beta$ -CD) was 1:7, the temperature was 90°C, the reaction time was 1h and the stirring speed was 1000 r/min, under these conditions, the embedding rate of cinnamon essential oil can reach to 90.24%. When the dosage of cinnamon oil microcapsule was 0.03g/ml, the diameters of inhibition zone on *E. coli* and *Penicillium* were up to 36mm and 24mm.

### Introduction

Cinnamon oil has strong antibacterial activities with low boiling point, with the extension of storage time, the antimicrobial properties will gradually weaken or disappear. Microcapsules were spherical vesicles with a certain permeability. The outer layer was a semipermeable membrane, the inner core was a liquid, it can protect the core material from the environment influence, then the active ingredient was isolated and the evaporation rate was reduced. Cinnamon oil was embedded in  $\beta$ -cyclodextrin with  $\beta$ -cyclodextrin embedding technology, sustained antibacterial effect can be achieved [1].

### Experiment

**Experiment Materials and Equipments.** Materials:  $\beta$ -cyclodextrin, AR, Shanghai Boao Biotech Co., Ltd; Cinnamon oil, CP, Guangzhou Hengxin Spices Co., Ltd; Ethanol, AR, Tianjin Kermel Reagents Co., Ltd; *E. coli*, *Penicillium*, Henan University of animal husbandry and economics; Peptone, agar, AR, Beijing obo star biotechnology Co., Ltd; Beef extract, AR, Sinopharm chemical reagent Co., Ltd; Sodium chloride, AR, Guangdong Guanghua chemical factory Co., Ltd; Deionized water, homemade.

Equipment: SHZ-D circulating water pumps, Gongyi Yuhua Instrument Co., Ltd.; SW-CJ-2D clean bench, Changsha Ronglong Equipment Plant; U-3900 UV spectrophotometer, Hitachi; DHP-9082 electric incubator, Shanghai Yiheng chemical instrument Co., Ltd.; 101-3 blast electric oven, Shanghai Jinping instrument Co., Ltd.; HH-2 digital temperature water bath, Changzhou Macao instrument Co., Ltd.; BS223S electronic balance, Aoduolisi scientific instruments (Beijing) Co., Ltd.; JB90-S digital display mixer, Shanghai Biaoben model company; Siemens refrigerator, BSH Home Appliances Limited.

**Experimental Preparation.** Sodium chloride was 5g, beef extract was 5g, peptone was 10g, then mixed them together and added 1000ml water to prepare the bacterial culture medium, the pH was controlled between 7.2 to 7.6 [2].

200g potato pieces were added in 700ml water, then boiling 30min, 15g agar and 20g sugar were put into it, then made up the water to 1000ml, the entire mixture was sterilized for 30 min at 121°C, which was to prepare the *penicillium* medium.

Cinnamon oil  $\beta$ -cyclodextrin microcapsules were prepared as follow: a quantity of  $\beta$ -cyclodextrin was weighed, then it was dissolved in an appropriate amount of deionized water, heated and stirred to completely dissolve. According to the ratio of orthogonal experiment, the exact amount of cinnamon oil was dissolved in a suitable amount of ethanol, under the action of an electric mixer, cinnamon oil was dropped along the wall into  $\beta$ -cyclodextrin solution slowly, temperature, stirring speed and reaction time was strictly controlled. After completion of the reaction, it was cooled in a refrigerator at  $-4^{\circ}\text{C}$  for 24h, then filtered by vacuum pump and washed with a small amount of distilled water and ethanol. At last, dried at  $50^{\circ}\text{C}$  for 4h in an electric heated blast drying oven, the microcapsule product would be obtained [3].

**Test Results.** Determination of surface oil of microcapsules: 0.1g microcapsules was accurately weighed, washed with 30ml ethanol, the filtrate was added with anhydrous ethanol up to 50ml, 5ml solution was taken to dilute to 25ml with anhydrous ethanol, its absorbance was measured at a wavelength of 297nm, the oil content of surface was calculated according to the standard curve.

Determination of total oil of microcapsules: 0.1g microcapsules were dissolved in 0.5ml water, excess moisture was dried by anhydrous sodium sulfate, then extracted and filtered with ethanol, the filtrate was added with anhydrous ethanol up to 100ml. 1ml solution was taken to dilute to 50ml with anhydrous ethanol, its absorbance was measured at a wavelength of 297nm, the content of oil was calculated according to the standard curve [4].

$$\text{Embedding rate} = \left(1 - \frac{\text{surface oil}}{\text{total oil}}\right) \times 100\% \quad (1)$$

## Results and Discussion

**Orthogonal Experimental Design.** Based on the design principles of orthogonal experiment, the ratio of core (Cinnamon essential oil) to wall ( $\beta$ -CD) (A), temperature (B), reaction time (C) and stirring speed (D) were designed as the main factors, and each factor was given 3 levels [5], Orthogonal experiment was as shown in Table 1.

**Table 1 Experimental factors and levels**

Level	Factor			
	(A)	(B)/[ $^{\circ}\text{C}$ ]	(C)/[h]	(D)/[r/min]
1	1 : 6	70	1	800
2	1 : 7	80	1.5	1000
3	1 : 8	90	2	1200

**Orthogonal Experimental Results.** The embedding rate were tested under different conditions, the results were shown in Table 2.

**Table 2 Experimental schemes and results of  $L_9(3^3)$  orthogonal experiment**

NO.	A	B	C	D	Embedding rate (%)
1	1	1	1	1	74.37
2	1	2	2	2	77.50
3	1	3	3	3	86.67
4	2	1	2	3	83.88
5	2	2	3	1	73.87
6	2	3	1	2	90.24
7	3	1	3	2	81.97
8	3	2	1	3	85.67
9	3	3	2	1	88.85

The embedding rate was taken as the index, the impact of different factors on the experimental results can be determined by visual analysis, the visual results were as shown in Table 3.

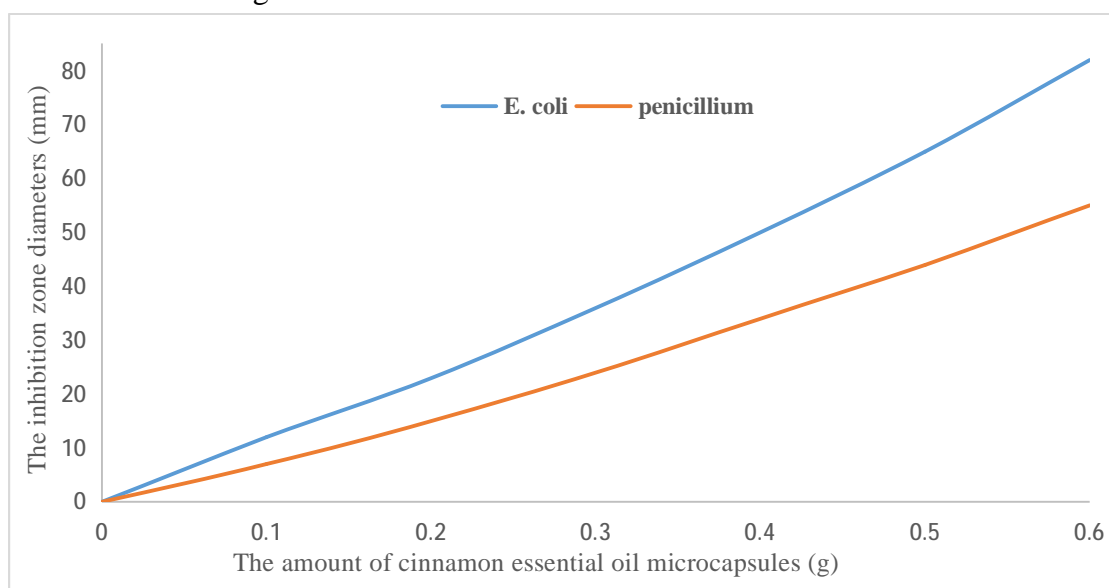
**Table 3 Intuitive analysis results**

Factors	Embedding rate (%)			R
	Level 1	Level 2	Level 3	
A	79.51	82.67	85.50	5.99
B	80.07	79.01	88.59	9.58
C	83.43	83.41	80.84	2.59
D	79.03	83.24	85.41	6.38

R=maximum – minimum

As can be seen from Table 3, the most obvious factor in the selected four factors was the reaction temperature, followed was the stirring speed, the next was the ratio of the core to wall, the last was reaction time. From the orthogonal experiments, the optimum conditions to prepare cinnamon essential oil microcapsules was A<sub>2</sub>B<sub>3</sub>C<sub>1</sub>D<sub>2</sub>, namely, when the ratio of core to wall was 1: 7, temperature was 90°C, the reaction time was 1h, the stirring speed was 1000 r/min, under this condition, the embedding rate was up to 90.24%.

**Antibacterial Properties.** Different amounts of microcapsules were respectively dissolved in 10ml ethanol solution, then coated on the preservative paper, a single factor experiment was used, the results were as shown in Fig. 1.



**Fig. 1 Influence of microcapsules on the inhibition zone diameters of different bacterial**

As shown in Fig. 1, the inhibition zone diameter gradually increased with the increasing amount of cinnamon essential oil microcapsules. Wherein, the inhibition of cinnamon oil microcapsules on E. coli was stronger than that on Penicillium. When the amount of the microcapsules increased from 0 to 0.3g, the inhibition zone diameter on E. coli and Penicillium were 36 mm and 24 mm. Thus, given the economic factors, the proposed dosage of cinnamon oil microcapsule was 0.03g/ml.

## Conclusions

The optimum conditions of preparing microcapsules of cinnamon essential oil with  $\beta$ -cyclodextrin embedding technique was: the ratio of core (Cinnamon essential oil) to wall ( $\beta$ -CD) was 1:7, the temperature was 90°C, the reaction time was 1h and the stirring speed was 1000 r/min, under these conditions, the embedding rate of cinnamon essential oil can reach to 90.24%. When the dosage of cinnamon oil microcapsule was 0.03g/ml, the antibacterial agent had a significant inhibition on E.

coli and Penicillium. Which can provide a theoretical guidance to the research and development of antibacterial technology.

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