IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 17, Issue 1 Ser. 1 (January. 2024), PP 28-32
www.iosrjournals.org

Sustained-release properties of sodium alginate microcapsules loaded with resveratrol

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Abstract
The experiment used resveratrol, sodium alginate, cyclodextrin, saccharifying enzyme, acetic acid, calcium chloride, and other raw materials to prepare sodium alginate resveratrol microcapsules using a dropwise method. Study the release kinetics curves of resveratrol from microcapsules under different pH and temperature conditions, and determine their photothermal stability.

Keywords: *microcapsules, resveratrol, sodium alginate, sustained-release*

Date of Submission: 26-12-2023 Date of Acceptance: 06-01-2024

I. Introduction

Microcapsules are a type of microcapsule or package with a polymer wall shell that can provide protection to the embedded material[1]. They are formed by encapsulating dispersed solids, gases, or liquids with a core-shell structure through the wall material. There are various types of containers or packages, depending on the material and method used. When the embedded material is solid, the shape of the microcapsule formed is the same as that of the embedded solid[2]. When the embedded material is gas or liquid, the shape of the microcapsule formed is the same as that of the embedded solid, The shape of microcapsules can vary, but they are generally spherical or elliptical[3]. Microcapsules are derived from natural marine polysaccharides as carriers and have the advantages of good biocompatibility, biodegradability, and low toxicity. They are widely used in various industries and fields of the food industry and medical and health products. The materials used for film-forming are generally referred to as capsule walls or wall materials, while those that are wrapped and covered are called core materials or capsule cores. The size of microcapsules is generally between 5-1000 μ m. Microcapsules can encapsulate solids, liquids, and gases in small sealed capsules, and control the release time and rate under certain conditions[4]. Microcapsule embedding technology can be used to mask some unfriendly odors and change the physical properties of the embedded material, making it easier to process and transport. Microcapsules can be mononuclear or multi-core.

II. Material and Methods

Material

Table 1 Material

Material	Manufacturer
Sodium alginate	(Shanghai Aladdin Chemical Co., Ltd.)
Saccharifying enzyme	Shanghai Chenyi Biotechnology Co., Ltd
Resveratrol	(Shaanxi Haoyang Biological and Biochemical Technology Co., Ltd.)
Cyclodextrin	(Shanghai Aladdin Chemical Co., Ltd.)
Anhydrous calcium chloride	(Shanghai Chenyi Biochemical Technology Co., Ltd.)
Glacial acetic acid	(Hubei Xinghe Chemical Reagent Co., Ltd.)
distilled water	(Self made distilled water in the laboratory of Shandong University of Technology)

Preparation process of microcapsules

Making microcapsules: Accurately measure (or weigh) 100 mL of distilled water and 1.5 g of sodium alginate, accurately weigh 0.4 g of resveratrol and dissolve it in 10 mL of acetic acid solution, add 100 mL of 1% cyclodextrin, filter and measure 10 mL of clear liquid, then add 5 mL of 1% saccharifying enzyme, mix the above solution and stir on a magnetic stirrer for 30 minutes. The microcapsule samples are divided into two types: those with added glycosylase and those without added glycosylase[5].

Hand drip the stirred microcapsule stock solution using a 1 mL medical syringe. Slowly drip the suspension into a slowly stirred mixture of calcium chloride, acetic acid, and cyclodextrin. After dripping, continue to stir slowly with a magnetic stirrer for one hour. Filter and spread the formed microcapsules with gauze, and place them in a constant temperature drying oven for drying.

Determination of Resveratrol Release under Different pH Conditions

According to the production method of the microcapsules mentioned above, a batch of microcapsules will be dropped to determine the release of resveratrol under different pH conditions. Prepare buffer solutions with pH values of 3, 4, 5, 6, 7, and 8 using disodium hydrogen phosphate and citric acid. Accurately weigh six portions of the prepared microcapsules, each weighing 0.2 g, and place them in 5 ml of different pH buffer solutions.

Determination of Resveratrol Release at Different Temperatures

Prepare resveratrol microcapsules using the above method, accurately weigh 0.2 g each and add 5 mL of distilled water. Immerse them in a constant temperature drying oven at different temperatures and dry for 24 hours. The temperature of the constant temperature drying oven is 10℃, 30℃, and 50℃, and the release of resveratrol is measured every 24 hours for 5 consecutive days.

Determination of Resveratrol Release: Take 1 mL of each microcapsule extract and measure the release rate using a spectrophotometer. After each measurement, add 1 mL of distilled water.

Photostability experiment

Microcapsule sample: Weigh 30-50 g of microcapsule sample into a centrifuge tube. After being exposed to sunlight for 2 hours every day, take 1 g of sample and dissolve it in 25 mL of 80% ethanol. After continuous irradiation for six days, measure at a wavelength of 308 nm.

Resveratrol standard: Weigh an appropriate amount of resveratrol into a centrifuge tube, and measure the content of resveratrol after being exposed to sunlight for 2 hours every day for 6 consecutive days. Dissolve the test resveratrol in 20 mL of ethanol and mix well. Dilute it to 50 mg/L and measure it at a wavelength of 308 nm

Thermal stability experiment

Microcapsule samples: Weigh multiple 1 g microcapsules into centrifuge tubes, place them in a 70℃ constant temperature drying oven, and measure the content of resveratrol every 24 hours, continuously measuring 6 times.

Resveratrol standard: Accurately weigh multiple portions of 0.1 g resveratrol into a centrifuge tube, place them in a 70℃ constant temperature drying oven, and measure the content of resveratrol every 24 hours, continuously measuring 6 times. Dissolve the test resveratrol in 20 mL of ethanol and mix well. Dilute it to 50 mg/L and measure at a wavelength of 308 nm.

III. Experimental Results and Discussion

Release amount of resveratrol under different pH conditions

By measuring the release of resveratrol under different pH conditions using a spectrophotometer, there was no significant difference in the release of resveratrol when measured for the first time in pH ranges of 3, 4, 5, 6, and 7 in different pH solutions. However, when immersed in a pH 8 solution, the release rate of resveratrol was almost ten times higher than before. The release of resveratrol from different soaking solutions was measured every two hours, and the sodium alginate showed good encapsulation performance for resveratrol. Obtain the release of resveratrol in solutions of different pH values and plot the curve[6].

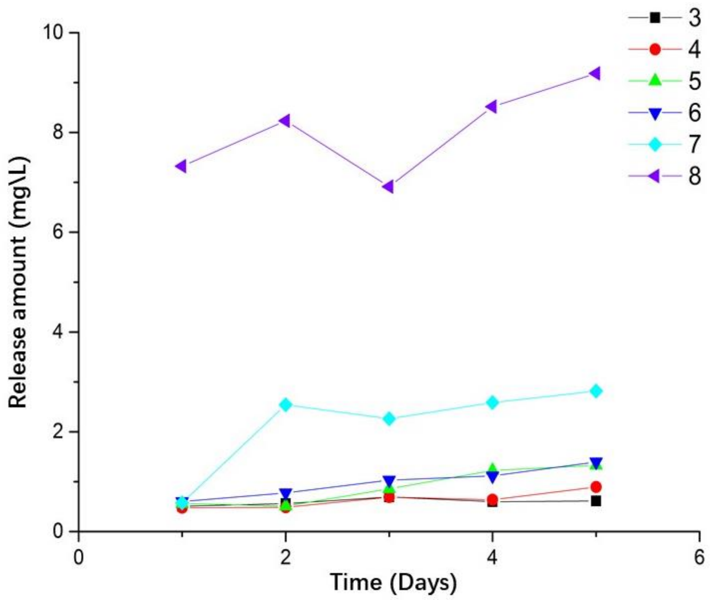

Figure 1. Release of Resveratrol in Solutions of Different pH

3.2 Release of Resveratrol at Different Temperatures

Accurately weigh three 0.2 g microcapsules and soak them in 5mL of distilled water. Place them in constant temperature drying boxes at 10 ℃, 30 ℃, and 50 ℃, and measure the absorbance value every 24 hours. Take out 1mL each time to measure the absorbance value. After measurement, add 1 mL of distilled water to the soaking solution and calculate the release of resveratrol over time as shown in the following figure[7].

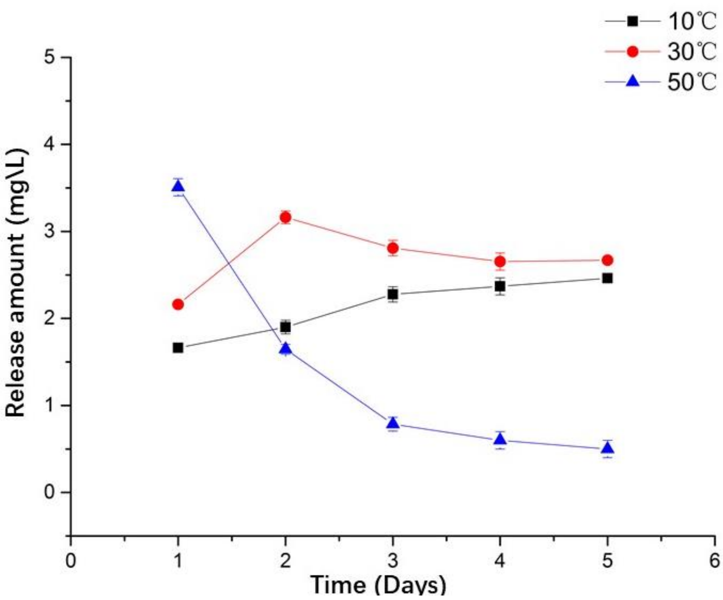

Figure 2. Release of Resveratrol at Different Temperatures

From the above figure, it can be observed that the release amount of resveratrol microcapsules slowly increases at 10 ℃ and gradually shows a stable trend[8]. At 20 ℃, there is a rapid increase, which then stabilizes. At 50 ℃, the first measurement reaches the highest value, and then rapidly decreases. Therefore, the release of resveratrol is better at 30 ℃, and the loss of resveratrol is less. It is beneficial for the sustained release of resveratrol at 10 ℃.

Photostability

It can be clearly seen from the figure that resveratrol is very sensitive to sunlight exposure. The standard substance of resveratrol is rapidly released and decomposed after sunlight exposure, and continues to decompose with the continuous exposure to sunlight, indicating that light has a significant impact on resveratrol[9]. Under light conditions, resveratrol is unstable and easily decomposed, while the release and decomposition rate of sodium alginate resveratrol microcapsules is slow and stable, After embedding, the photostability of resveratrol is good.

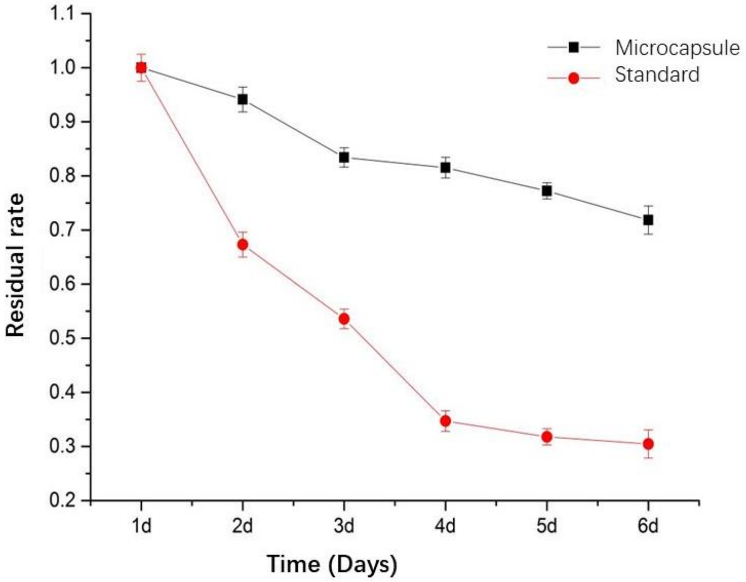

Figure 3. Changes in photostability of resveratrol

Thermal stability of resveratrol

Soak the prepared microcapsules and resveratrol standard in ethanol and place them in a constant temperature drying oven at 70 ℃. Measure the content of resveratrol every 24 hours and obtain the data to determine the stability of resveratrol at 70 ℃.

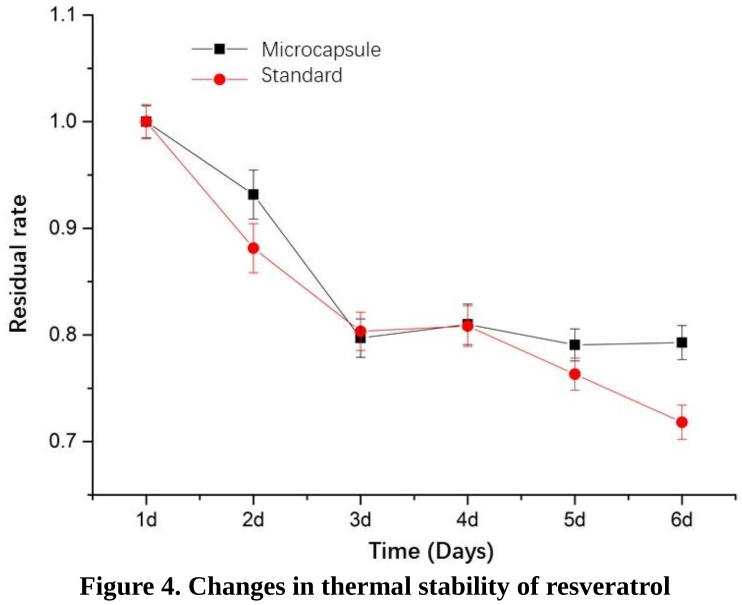

Figure 4. Changes in thermal stability of resveratrol

It can be clearly seen that at 70 ℃, the content of resveratrol microcapsules and standards will undergo a small decomposition, but gradually flatten out. The effect of temperature on the stability of resveratrol is much smaller than that of light on its structure. The above two experiments indicate that under the action of light and heat, resveratrol is unstable, but its thermal stability is much higher than that of light stability[10].

IV. Conclusion

The composite microcapsules of resveratrol sodium alginate starch significantly increased the release rate of resveratrol after the addition of amylase, with the highest release rate at around 30 degrees Celsius and an optimal pH of 8.0. The encapsulation of sodium alginate improved the photostability of resveratrol, but had little effect on its thermal stability.

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