Fabrication of Gelatin Microspheres 1 Containing Ammonium Hydrogen Carbonate for the Tunable Release of Herbicide

He Liu

Dalian University of Technology

Zheng Zhang

Dalian University of Technology

jun yang (✉ junyang@dlut.edu.cn)

Dalian University of Technology <https://orcid.org/0000-0002-4409-3099>

Wanyu Zang

Dalian University of Technology

Qing Yang

Dalian University of Technology

Research Article

Keywords: gelatin microspheres, controlled release, temperature responsive, NH_4HCO_3 , herbicide

Posted Date: March 26th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-326872/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published at Biotechnology Letters on July 18th, 2021.

See the published version at <https://doi.org/10.1007/s10529-021-03163-5>.

Abstract

The major challenge in utilizing pesticides lies in identifying the precise application that would improve the efficiency of these pesticides and reduce their environmental and health hazards at the same time. Such application requires the development of specific formulations that enable controlled, stimuli-responsive release of the pesticides. Gelatin is a relatively cheap material characterized by temperature-sensitivity and abundant amino acid groups, which makes it suitable for the storage and controlled release of pesticides. In this study, gelatin microspheres were prepared by emulsion and cross-linking, then they were loaded with 2,4-dichlorophenoxyacetic acid sodium (2,4-D Na) as a model herbicide. To achieve temperature-tunable release of 2,4-D Na from the microspheres, NH_4HCO_3 was added to the formulations at different concentrations. The prepared formulations were characterized by SEM, FTIR, and size distribution analyses, and their drug loading capacities were determined. Based on bioassay experiments, the 2,4-D Na- NH_4HCO_3 -loaded gelatin microspheres can effectively control the spread of dicotyledonous weeds. Therefore, the strategy proposed herein can be used to develop novel, effective herbicide formulations.

Full-text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Tables

Table 1 Average particle sizes of unloaded and 2,4-D Na-loaded gelatin microspheres.

	Gelatin microspheres	2,4-D Na-loaded gelatin microspheres
Particle size (μm)	253.61 ± 11.27	525.49 ± 18.02

Table 2 Drug loading capacity and embedding ratio of microspheres with different concentrations of NH_4HCO_3 .

	2,4-D Na-loaded gelatin microspheres	2,4-D Na-3% NH_4HCO_3 -loaded gelatin microspheres	2,4-D Na-6% NH_4HCO_3 -loaded gelatin microspheres
Drug loading capacity (mg/g)	77.95 ± 2.40	43.96 ± 1.25	39.1 ± 1.11
Embedding ratio (%)	61.76 ± 2.89	37.88 ± 1.12	36.4 ± 1.03

Table 3 Rootlength and weight on the 5th day.

	Group 1	Group 2	Group 3	Group 4
Root length (cm)	7.32 ± 0.81	3.81 ± 0.34	3.39 ± 0.23	3.23 ± 0.25
Weight (g)	0.29 ± 0.0200	0.16 ± 0.0049	0.09 ± 0.0052	0.06 ± 0.0018

Figures

Figure 1

Infrared spectra of 2,4-D Na-loaded gelatin microspheres and unloaded gelatin microspheres in the range of 700–950 cm-1

Figure 2

SEM images of (a) unloaded and (b) 2,4-D Na-loaded gelatin microspheres

Figure 3

Sustained release curves of (a) 2,4-D Na-loaded gelatin microspheres (2-GM), (b) 2,4-D Na-3% NH₄HCO₃-loaded gelatin microspheres (2-3% N-GM), and (c) 2,4-D Na-6% NH₄HCO₃-loaded gelatin microspheres (2-6% N-GM) at 25, 35, and 45°C. (d) Release curves of different materials at 35°C

Figure 4

Inhibitory effects of the tested formulations on cucumber seedlings at 33°C after (a) 1 (b) 2 (c) 3 (d) 5 days of treatment. The numbers 1–4 refer to different groups. Group 1 is blank control; Groups 2, 3 and 4 are treated with 2,4-D Na-, 2,4-D Na-3% NH_4HCO_3 and 2,4-D Na-6% NH_4HCO_3 -loaded gelatin microspheres, respectively