Data Article

Dataset on the synthesis and physicochemical characterization of blank and curcumin encapsulated sericin nanoparticles obtained from *Philosamia ricini* silkworm cocoons

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**Abstract**

The dataset presents the synthesis and physicochemical characterization of blank and curcumin encapsulated sericin protein nanoparticles obtained from *Philosamia ricini* (also known as Ahimsa silk or Peace silk or Eri). Reports on application of sericin protein obtained from *P. ricini* are scanty at best. Sericin was extracted from the cocoons by high temperature and high pressure method. Synthesis of sericin nanoparticles was carried out by desolvation method using acetone as the desolvating agent. Curcumin was used as a hydrophobic model drug and was encapsulated into the sericin nanoparticles. Physicochemical characterization of the blank and curcumin encapsulated sericin nanoparticles were carried out by different instrumental analyses. The size and surface charges of sericin nanoparticles changed with the variation of applied sericin concentration. Encapsulation efficiency and loading capacity of the encapsulated sericin nanoparticles showed variation with curcumin concentration. The obtained data indicated the applicative potentials of sericin protein extracted from *Philosamia ricini* silkworm cocoons.

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1. Data

Sericin protein is a waste product of silk industry and about 25–30% of waste sericin is generated during degumming process of silk [1]. The sericin protein used was extracted from *P. ricini* cocoons employing the high temperature and high pressure (HTHP) method (Fig. 1a–c). The molecular weight distribution of the extracted sericin was investigated using sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) analysis (Fig. 2). Synthesis of blank sericin nanoparticles was carried out by desolvation method using acetone as the desolvating agent. The physicochemical characteristics of the synthesized sericin nanoparticles were investigated through instrumental analyses viz, SEM (Figs. 3–6), Zetasizer (Fig. 7) and FTIR (Fig. 8). Curcumin was used as the model hydrophobic drug for investigating the applicability of the sericin nanoparticles as nano drug carrier. Curcumin encapsulated nanoparticles were prepared by desolvation method with varying concentrations of curcumin solubilized in acetone of (Fig. 9). The encapsulation efficiency (EE %) and loading capacity (LC %) were calculated using standard methods (Tables 3 and 4).

2. Experimental design, materials, and methods

2.1. Extraction of sericin protein from silkworm cocoons

The autoclave method or high temperature and high pressure (HTHP) method of degumming was used for sericin extraction from Eri silkworm cocoons [3]. The cocoons were manually cleaned and cut
into smaller pieces and autoclaved (60 mins, 15 psi, 121 ± 1 °C) at 1:50 ratio of sericin to water (w/v). The autoclaved solution containing sericin was filtered to remove any debris or stray fibers through Whatman filter paper no. 42 (Fig. 1a). The filtrate was lyophilized to obtain pure sericin powder and stored at 4 °C until further use (Table 1).

2.2. Molecular weight distribution (MWD) of sericin

The MWD of the extracted sericin was investigated for fractionation due to the HTHP method of sericin extraction by SDS-PAGE [4] (Fig. 2).

2.3. Preparation of sericin nanoparticles

Sericin nanoparticles were synthesized by a one-step desolvation method using acetone as the desolvating agent [5]. 20 mL of varying concentrations of sericin solution (0.5, 1.0, 1.5 and 2.0 mg mL⁻¹)
was prepared to which 6 mL of acetone (30% v/v) was added dropwise while on constant stirring at 700–800 rpm. The suspension was kept under stirring condition for about 6 hours to volatilize the acetone. The sericin nanoparticles were collected and washed by centrifugation and used for further experiments.

2.4. Physicochemical characterization of blank and curcumin encapsulated sericin nanoparticles

The physicochemical characterization of blank and curcumin encapsulated sericin nanoparticles were carried out by different instrumental analyses. Morphological details (size, shape and aggregation) of the blank and encapsulated sericin nanoparticles were investigated by scanning electron microscopy (SEM, ZEISS Evo MA 10) (Figs. 3–6). The SEM samples for both the blank and curcumin...
encapsulated sericin nanoparticles were prepared according to standard procedures [6]. UV–Vis spectrophotometry confirmed presence of in the curcumin encapsulated nanoparticle suspension. Zetasizer (Malvern, ZEN3690) was used to determine the hydrodynamic size range and surface charge (zeta potential) of the blank sericin nanoparticles (Table 2, Fig. 7). Fourier transform infrared (FTIR) analysis of sericin monomer and blank sericin nanoparticles was performed (FTIR, Thermo Scientific, Nicolet 6700 FT-IR) under attenuated total reflection (ATR) mode as described in literature [7] (Fig. 8).

2.5. Curcumin encapsulation

Curcumin encapsulation was done with a constant sericin concentration of 1.0 mg mL\(^{-1}\) and varying concentrations of curcumin \textit{viz.} 25 \(\mu\text{M}\), 50 \(\mu\text{M}\), 100 \(\mu\text{M}\), 200 \(\mu\text{M}\), 400 \(\mu\text{M}\) by desolvation method using acetone as the desolvating agent (Fig. 9).
2.6. Encapsulation efficiency and loading capacity

Encapsulation efficiency (EE %) and Loading capacity (LC %) were calculated (µg/mg) using standard methods \[8,9\] (Table 3 and Table 4).

2.7. Statistical analysis

Data are presented as mean ± SD values of the three independent experiments conducted in triplicates.

Fig. 7. Hydrodynamic sizes and zeta potentials of sericin nanoparticle suspensions at varying sericin concentrations.

Fig. 8. FTIR analysis of silk sericin (SS) and sericin nanoparticles (SNP).
Table 1
Sericin extraction details.

| Dry weight of cocoons (g) | Dilution factor (cocoons:water) | Dry weight of cocoons after autoclaving (g) | Weight of lyophilized sericin (g) | Extraction efficiency (%) | Yield percentage (%) |
|--------------------------|--------------------------------|---------------------------------|---------------------------------|--------------------------|----------------------|
| 10                       | 50x                            | 8.86                            | 0.22                            | 11.4                     | 19.3                 |

Table 2
Zeta data of size and zeta potential of sericin nanoparticles.

| Sericin concentration (mg/mL) | Zeta avg. size (nm) | Poly dispersity Index (PDI) | Zeta potential (mV) |
|-------------------------------|---------------------|----------------------------|---------------------|
| 0.5                           | 213.1 ± 19.36       | 0.61 ± 0.12                | −22.02 ± 1.15       |
| 1.0                           | 278.15 ± 53         | 0.39 ± 0.21                | −22.03 ± 1.19       |
| 1.5                           | 484.13 ± 59         | 0.54 ± 0.09                | −23.0 ± 3.59        |
| 2.0                           | 829.41 ± 217        | 0.58 ± 0.11                | −18.17 ± 1.38       |

Table 3
Curcumin encapsulation efficiency at different concentrations of curcumin.

| Added curcumin (µg) | Free curcumin (µg) | Encapsulated amount (µg) | Encapsulation efficiency (%) |
|---------------------|--------------------|--------------------------|-----------------------------|
| 9.2                 | 5.60               | 3.6                      | 39.13                       |
| 18.4                | 7.63               | 10.77                    | 58.53                       |
| 36.8                | 11.02              | 25.78                    | 70.05                       |
| 73.6                | 10.85              | 62.75                    | 85.25                       |
| 147.2               | 22.45              | 124.75                   | 84.75                       |
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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] P. Aramwit, T. Siritientong, T. Srichana, Potential applications of silk sericin, a natural protein from textile industry by-products, Waste Manag. Res. 30 (2012) 217–224, https://doi.org/10.1177/0734242X11404733.
[2] H. Teramoto, A. Kakazu, K. Yamauchi, T. Asakura, Role of hydroxyl side chains in Bombyx mori silk sericin in stabilizing its solid structure, Macromolecules 40 (2007) 1562–1569. https://doi.org/10.1021/ma062604e.
[3] M.L. Gulrajani, R. Purwar, R.K. Prasad, M. Joshi, Studies on structural and functional properties of sericin recovered from silk degumming liquor by membrane technology, J. Appl. Polym. Sci. 113 (2009) 2796–2804. https://doi.org/10.1002/app.29925.
[4] D. Gupta, A. Agrawal, A. Rangi, Extraction and characterization of silk sericin, Indian J. Fibre Text. Res. 39 (2014) 364–372.
[5] R.C. Oppenheim, J.J. Marty, P. Speiser, Inventors; Pharmaceutical Society of Victoria, assignee. Injectable compositions, nanoparticles useful therein, and process of manufacturing same, United States patent US 4 (107) (1978) 288. Aug 15.
[6] R. Pulicharla, C. Marques, R.K. Das, T. Rouissi, S.K. Brar, Encapsulation and release studies of strawberry polyphenols in biodegradable chitosan nanoformulation, Int J Biol macromolecules 88 (2016) 171–178, https://doi.org/10.1016/j.ijbiomac.2016.03.036.
[7] J. Kundu, Y.I. Chung, Y.H. Kim, G. Tae, S.C. Kundu, Silk fibroin nanoparticles for cellular uptake and control release, Int. J. Pharm. 388 (2010) 242–250, https://doi.org/10.1016/j.ijpharm.2009.12.052.
[8] R.K. Das, A. Sett A, N. Kasoju, B. Sumithra, U. Bora, Encapsulation of curcumin into poly-ε-caprolactone nanoparticles and its physicochemical characterization, Int. J. Biomed. Sci. Eng. 02 (01–08) (2011). ISSN 0976–1519.
[9] S. Bish, G. Feldmann, S. Soni, R. Ravi, C. Karikar, A. Maitra, A. Maitra, Polymeric nanoparticle-encapsulated curcumin (“nanocurcumin”): a novel strategy for human cancer therapy, J. Nanobiotechnol. 5 (2007), https://doi.org/10.1186/1477-3155-5-3.

Table 4
Loading capacity of sericin nanoparticles.

| Weight of nanoparticles (mg) | Weight of encapsulated curcumin (mg) | Loading capacity (%) |
|------------------------------|-------------------------------------|----------------------|
| 12.63                        | 0.0036                              | 0.028                |
| 12.52                        | 0.01077                             | 0.086                |
| 12.43                        | 0.02578                             | 0.207                |
| 11.36                        | 0.06275                             | 0.5523               |
| 11.7                         | 0.12475                             | 1.066                |