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Lactoferrin-based nanohydrogel as a vehicle for iron delivery – preparation and release profile

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Abstract

Lactoferrin is a milk protein involved in numerous biological functions, such as regulation and transport of free iron levels, antioxidant and antimicrobial activities.
Nanosystems, such as nanohydrogels, may be a vehicle to enrich foods with essential nutrients. Once iron deficit is a major nutritional problem, its inclusion in lactoferrin nanohydrogels could be one of the approaches to improve their stability, protection and subsequent absorption. Moreover, understanding the release mechanisms involved during human consumption, recurring to mathematical modeling, is important for the design of nanohydrogels carriers allowing foreseeing if the developed systems are appropriated to food products.
The research conducted aims at developing bovine lactoferrin-based nanohydrogel, and understanding the transport mechanisms of the nanosystem used as iron vehicle.
Nanohydrogel were formed by thermal gelation of lactoferrin (0.2 % (w/v)) at 75 °C for 20 minutes. After heat treatment, 35 mM (w/v) of ferric chloride was added. Nanohydrogels were characterized in terms of size distribution, polydispersity index (PDI) and morphology. Release experiments were conducted at different pH (2.0 or 7.0) at 37 ^{o}C (simulation of human digestive system conditions). Mathematical models were used to discuss the transport mechanism. Results showed that nanohydrogels with size of 110.0±0.4 nm and PDI of 0.218±0.005 were produced, and were stable during 76 weeks. Data from release experiments at pH 2 were successfully described by linear superimposition model which accounts for both Fick and Case II (polymer relaxation phenomenon) transport; in contrast, transport mechanism at pH 7 cannot be described by either Fick or Case II transport.
These results suggest that lactoferrin nanohydrogel system can be used in the food industry as a carrier to facilitate the release of essential nutrients, such as iron, in the human body. Additionally, the approach presented in this work allows interpretation of the phenomena involved in mass transport at the nano-scale.

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