Formulation of submicron ternary complex encapsulates for delivery of curcumin

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Objective: The main objective of this study is to develop submicron ternary complexes as delivery vehicle for curcumin using biopolymer in order to improve the physicochemical stability, solubility, bioaccessibility and intestinal permeability of the curcumin.
Methods: The submicron ternary complexes were successfully formulated with 2-hydroxypropyl ?-cyclodextrin (2-H?CD), pectin (Pec) and whey protein (WP) using modified spray drying process. Surface morphology, particle size, and poly dispersity index of submicron single (cur/2-H?CD), binary (cur/2-H?CD/Pec & cur/2-H?CD/WP) and ternary (cur/2-H?CD/Pec/WP) complexes were studied using scanning electron microscope (SEM) and Dynamic Light Scattering (DLS). Functional attributes and physical state of the submicron complexes were analysed using Fourier Transform Infra-Red Spectroscopy (FTIR) and Differential Scanning Calorimetry (DSC). Encapsulation efficiency and dissolution behavior for all the encapsulates were studied. Bioaccessibility of the curcumin from complex encapsulates was studied using in-vitro gastrointestinal digestion. Intestinal permeability of curcumin from complex encapsulates was evaluated using ex-vivo everted gut sac technique and engineered small intestinal system.
Results: The complex encapsulates cur/2-H?CD, cur/2-H?CD/Pec, cur/2-H?CD/WP, and cur/2-H?CD/Pec/WP had particle sizes of 424.5, 505.7, 531.6, and 769.5 nm, respectively and exhibited spherical shape with homogeneous size distribution. The encapsulation efficiency of cur/2-H?CD, cur/2-H?CD/Pec, cur/2-H?CD/WP, and cur/2-H?CD/Pec/WP was found as 69.22, 75.55, 77.20 and 86.47%, respectively. FTIR analysis showed that the ternary complexation was mainly formed by hydrogen bonding. DSC results revealed that curcumin exhibited amorphous state in complex formulation. Moreover, curcumin ternary complexes exhibited better dissolution behaviour and enhanced stability under in-vitro gastrointestinal digestion. Additionally, the ex-vivo intestinal permeability study by dynamic small intestinal system revealed that permeation of curcumin from ternary complex encapsulates had 1.7-fold higher than the unencapsulated curcumin.
Conclusions: Physicochemical stability of curcumin can be pronouncedly enhanced with ternary complex system developed by low temperature modified spray drying process and also stabilized with proteins and polysaccharides.