Stabilization of vitamin B1 by encapsulation with polysaccharides

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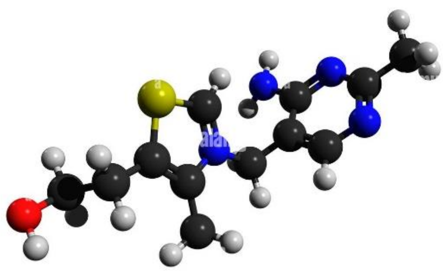
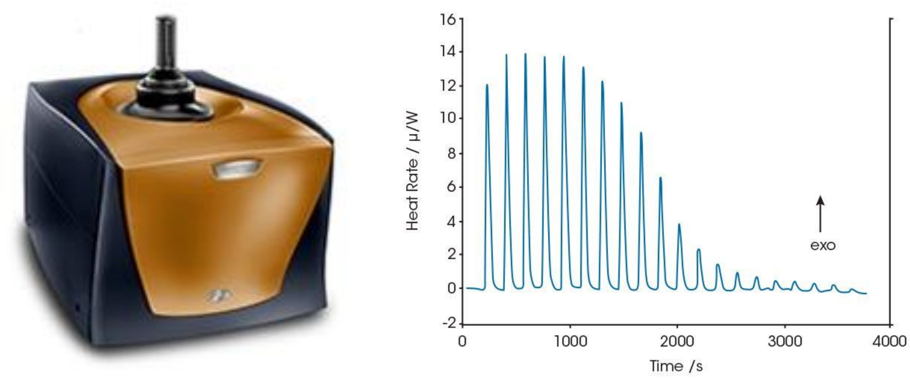


Thiamine (vitamin B1) is an essential micronutrient in the human diet, found both naturally and as a fortification ingredient in many foods (such as cereals) and supplements. However, it is susceptible to degradation due to heat, light, alkaline pH, and sulfites, among effects from other food matrix components, and its degradation has both nutritional and sensory implications as in foods.[1] In its diphosphate form, it serves as a cofactor to enzymes involved in carbohydrate metabolism, breakdown of branched chain amino acids, fatty acid oxidation, and generation of molecules necessary for the formation of nucleotides, amino acids, and protection against reactive oxygen species. As adults have the capacity to store only 30-50 mg of this essential water-soluble vitamin, deficiencies subsequent to reduced intake can occur within 2-3 weeks. Thiamine deficiencies may also occur, if intake of thiamine containing foods is restricted, if foods containing chemical constituents or enzymes which break down or complex with thiamine are concurrently consumed, or if thiamine has been degraded during food processing or storage. The association of thiamine deficiency with malnutrition was previously well known (in the worst case resulting in *beriberi* disease), but today is often misdiagnosed or overlooked in pediatric populations, geriatric populations, and developing nations.[2-4]

Polysaccharides such as alginate, xanthan gum, guar gum, or chitosan are common thickeners in the food industry, and have also been used as pharmaceutical excipients. They range in molecular weight, charge, and solubility, imparting tailorable properties on drug formulations. They can increase the viscosity of a formulation through absorption of water and gelation, even at low concentrations. Xanthan gum and guar gum are potentially beneficial for thermally labile therapeutics as they do not require heat for their hydration. Recent research in food science has shown polysaccharides also can create a chemical microenvironment to stabilize fragile molecules and thus enhance the shelf-life of the product.[5,6] For example natural red food color based on beets can be stabilized by combination with alginate or xanthan gum, thus making it an attractive alternative to the ubiquitous synthetic *Red 40* food color[6,7] which has been implicated with causing attention deficits in children.[8]

Another appealing feature of encapsulation on the molecular level is that drugs and supplements with a bitter or unpleasant taste can be made more palatable, which is particularly important for medications for pediatric populations. Essential for both applications is the molecular interaction of the drug molecule with the polysaccharide. The quantification of this binding affinity is the goal of the proposed work. We will use isothermal titration calorimetry (ITC),[9] in order to quantify binding stoichiometry, dissociation constant as well as binding enthalpy and entropy. ITC has become a common technique in pharmaceutical industry and research to characterize the interaction of drugs and supplements with biomacromolecules. For shelf-life studies we will compare the thiamine concentration in solutions of common thiamine salts (thiamine chloride and thiamine mononitrate) with that of polysaccharide-stabilized thiamine at elevated temperature. For this purpose thiamine will be converted to thiochrome and thiochrome fluorescence will be evaluated with a 96-well microplate reader. [10]



Nano ITC table-top instrument (TA Instruments) and calorimetric spectrum in case of exothermal complexation.

References and suggested reading (*)

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