FoCus - Food Chain Plus

SPONSORED BY THE
Federal Ministry of Education and Research

LactoTrans I - Milk Proteins As Nanocarriers

Julia Keppler, MSc., Prof. Dr. Karin Schwarz

Institute of Human Nutrition and Food Science, CAU Kiel

Introduction

Milk proteins naturally bind hydrophobic compounds within the milk.

Combination of **bioactive food constituents** and milk proteins

= creation of **natural and safe nanocarriers** in food.

The possibilities are explained below, using **ß-Lactoglobulin** (ß-LG) as example.

Background

ß-Lactoglobulin...

Is the main protein of the **whey protein** fraction of milk.

It is cheap, available and **food grade.**

- pH-resistant (to pH 2).
- heat stable (to 70 °C).
- reaches the small intestine native and intact [1].

It resembles **human plasma retinol-binding proteins...**

...both have an inner cavity in which fat-soluble compounds can bind and are **protected.**

Experiments

Transporter for fatty acids and fat-soluble vitamins

(presumed binding site in cavity)

Aim

Obtain clear, aqueous beverages enriched with water-insoluble vitamins and omega-3 fatty acids.

The cavity protects against degenerative processes.

Problem

Heat-induced denaturation (Fig. 1) or a pH drop below pH 6 closes the cavity [2].

Solution

Coating of the protein-ligand complex with a polysaccharide such as the dietary fiber pectin [3].

A safe transport of a ß-LG bound agent in the digestive tract up to the large intestine might be possible.

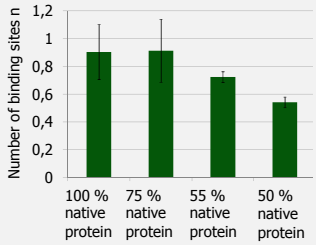
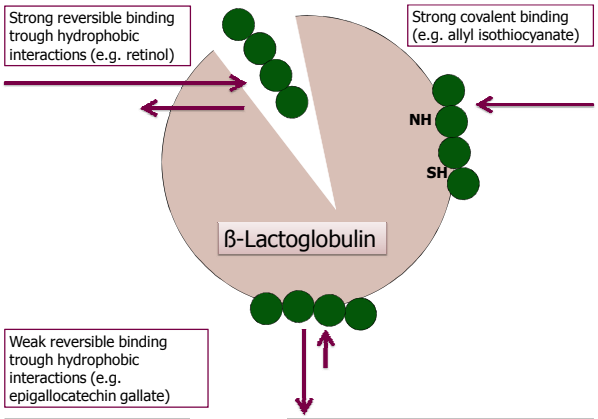


Figure 1: Loss of binding sites (n) for Retinol on ß-Lactoglobulin in dependence of heat denaturation of the protein.



Transporter for polyphenols

(presumed binding sites in hydrophobic pockets)

AIM

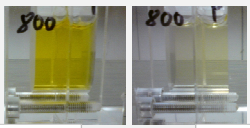
Enrichment of food with polyphenols like epigallocatechin gallate (EGCG) due to their beneficial health effects.

Problem

Polyphenols are often instable, their bioavailability in foods is very low.

Solution

Heat denaturized ß-LG binds EGCG in hydrophobic pockets on the surface of the molecule and protects it from oxidization:



EGCG without protein: oxidation after 24 h

EGCG with protein: no oxidation after 24 h

Transporter with taste-, or odor neutralizing activity

(e.g. binding to functional groups)

Aim

Some sulfur-containing compounds from garlic or brassica-vegetables exert health beneficial effects. Their enrichment in food is desirable.

Problem

The accumulation of those compounds in foods leads to a strong off-taste. Consumers might decline functional foods with those ingredients.

Solution

ß-LG binds allyl isothiocyanate (AITC) from red cabbage covalently to its functional groups (Fig. 2). This masks the odor and taste [4] of AITC.

This is also conceivable for garlic compounds or even bitter peptides.

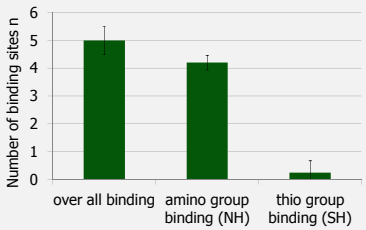


Figure 2: The binding sites (n) of AITC on ß-Lactoglobulin. 5 binding sites over all. Consisting of 4 binding sites at amino groups and 0,2 at thio groups.

Conclusions

ß-LG provides a **variety of ways** to insert ingredients **with added health** benefit into foods...

...it solubizes water-unsoluble compounds and transports them...

...it **protects** the **bound substance** during processing and storage of foods...

...it **masks undesirable odor** or taste...

...a **targeted transport** to the site of absorption in the **digestive tract** is conceivable.

[1] Mahe, S., Messing, B., Thuillier, F., Tome, D. (1991): Digestion of bovine milk proteins in patients with a high jejunostomy. In: The American Journal of Clinical Nutrition 54 (3): 534–538.
[2] Mousavi, S., Bordbar, A., Haertle, T. (2008): Changes in Structure and in Interactions of Heat-Treated Bovine ß-Lactoglobulin. In: Protein & Peptide Letters 18 (8): 818–825.
[3] Zimet, P., Livney, Y. D. (2009): Beta-lactoglobulin and its nanocomplexes with pectin as vehicles for [omega]-3 polyunsaturated fatty acids. In: Food Hydrocolloids 23 (4): 1120–1126.
[4] Pripp, A. H., Vreeker, R., van Duynhoven, J. (2005): Binding of olive oil phenolics to food proteins. In: Journal of the Science of Food and Agriculture 85 (3): 354–362.

FoCus Coordination Center: University of Kiel • Heinrich-Hecht-Platz 10 • D-24118 Kiel • E-mail: info@focus.uni-kiel.de www.focus.uni-kiel.de