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Current examples of the effect of milk processing on nutritionally relevant milk components

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The lecture will cover the following topics:
(1) Thermal treatment and novel preservation technologies of milk
(2) Lactose hydrolysis and glucose isomerisation in milk and whey
(3) Enzymatic crosslinking of milk proteins and prececal digestibility

(1) Extended shelf life (ESL) milk has a durability of about 3 weeks under chill chain conditions and fills the gap between high-temperature short-time (HTST)-heated milk, which typically is assigned a shelf life of 10 days and ultra-high temperature (UHT)-heated milk, which can be stored for a few months at room temperature. In a study of the Max Rubner-Institut, different drinking milk samples from 17 German dairies were analysed. HTST-heated products showed lower contents of non-denatured lactoferrin, serum albumin and immunoglobulin in comparison with raw milk, while the average content of the main whey proteins did not differ significantly. The contents of non-denatured whey proteins in ESL milk are highly dependent on the manufacturing technique. In UHT-heated milk, heat sensible proteins like lactoferrin, serum albumin and immunoglobulin were not detectable. The furosine content of HTST-heated and ESL milk types was between 5 and 20 mg/100 g protein, but ten times as high in UHT-heated milk. As long as the milk samples were stored at 4-6°C, no vitamin losses were detectable, and comparable concentrations of vitamins were found in the different types of drinking milk. In addition, novel preservation techniques for drinking milk will be compared in relation to whey protein denaturation. An exemplary manufacturing process for drinking milk with a high content of non-denatured whey proteins will be presented.

(2) During the processing of lactose free milk, transgalactosylation occurs apart from hydrolysis, and leads to the formation of galacto-oligosaccharides (GOS). Up to 5% of the lactose is transformed in GOS, depending on the type of β-galactosidase (β-GAL) used. In further studies, the potential of β-GAL and glucose isomerase (GLI) to enhance the sweetening power out of lactose and to generate GOS and lactulose was studied.
UF-permeates of skim milk, sweet whey, acid whey and lactose solutions were incubated with β-GAL and GLI. Lactose hydrolysis was 96-99%, glucose isomerisation about 50%. On a scale from 0 to 5, the intensity of sweetness increased from 1 to 3. The use of these food ingredients in the manufacture of dairy products and other foodstuffs may lead to significant reduced total sugar contents. Applying the bi-enzymatic system to 400 g/l lactose solutions led to synthesis of about 200 g/l prebiotic GOS. Several products, such as 6-galactobiose, allolactose and 6-galactosyllactose were identified. In addition, up to 30 g/l lactulose was formed. Besides the enhancement of sweetening power, the novel bi-enzymatic process provides a potential health effect by the generation of GOS and lactulose.

(3) Crosslinking of food proteins by transglutaminase improves especially techno-functional properties like water binding, gel forming and heat stability. In order to examine whether crosslinking reduces protein digestibility, the prececal digestibility of caseinate was studied in Goettingen miniature pigs. For *in vivo* investigations four boars with a T-cannula at the ileum were each given a semi-synthetic test meal containing 30 g of native or crosslinked caseinate, which were labelled with the stable isotope ^{15}N. The protein digestibility was determined from ^{15}N recovered in the ileal chyme. The indigestible markers chromic oxide and polyethylene glycol 4000 were added to the test meals in order to compensate for the chyme lost and to determine the flow-rate of the liquid phase of the digesta. Neither the quantity nor the dry matter of the chyme showed significant differences during the 33 hour collection period after feeding the test animals. Furthermore, the kinetics of the digesta-flow were similar. The calculated protein digestibilities were 92.3% for caseinate and 91.9% for crosslinked caseinate, which are not significantly different.

Likewise, the quantities of endogenous nitrogen, i.e. the nitrogen secreted into the gastrointestinal tract during digestion, were not significantly different after the two test meals. The results of this study indicate that crosslinking of caseinate by transglutaminase changes neither the normal physiological process of digestion nor the protein digestibility.