Coagulation and digestion characteristics of milk protein mixtures

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RATIONALE
Malnourished older adults need high levels of essential amino acids (EAA), including leucine, to stimulate muscle protein synthesis, but their intake is limited. Oral nutritional supplements can support the protein intake of malnourished people by providing fast-digestible, high-quality proteins. Using only whey proteins, however, is challenging for developing heat-stable oral nutritional supplements with a very high (10%) protein concentration and well-acceptable thickness. Therefore we aimed to evaluate mixtures of milk proteins on coagulation and digestion.

Methods
Coagulation characteristics of milk proteins and mixtures in different ratios were studied in an in vitro stomach digestion model. Mixtures of micellar casein, whey protein, and whey hydrolysate, in concentrations ranging from 100%, 90%, 80%, 67%, and 50% micellar casein, were dissolved in a simulated milk ultrafiltrate solution and incubated at 37°C. A pepsin solution was added, mixed well, and incubated for 15 minutes. After the incubation the samples were filtered on a gauze and the protein content in the filtrate and retentate was determined with Kjeldahl analysis.

Results
Whey protein and protein mixtures that consisted of 50% and 67% micellar casein showed no coagulation in the in vitro stomach screening model. However, protein mixtures containing 80%, 90%, and 100% micellar casein showed substantial coagulation in vitro. The protein mixture (R) that consisted of two-thirds of micellar casein combined with whey protein and whey hydrolysate was selected for comparison with casein and whey protein in a randomized, controlled, cross-over trial.

CONCLUSIONS
The milk protein mixture consisting of two-thirds of micellar casein combined with whey protein and whey hydrolysate showed less coagulation than mixtures consisting ≥80% casein in an in vitro stomach digestion model. Consumption of 20 g of this protein mixture (RESANA™) by older volunteers resulted in fast and high rise in post-prandial serum essential amino acid levels, followed by a sustained delivery. This finding in the human digestion trial may be partially explained by the limited gastric coagulation as shown in vitro. The essential amino acid digestion profile, including leucine, might help malnourished older adults to preserve their muscle mass.

HUMAN DIGESTION AND ABSORPTION TRIAL

The mixture with micellar casein:whey protein and hydrolysate in 67%:33% ratio (RESANA™, R) was selected for comparison with casein and whey protein in a randomized, controlled, cross-over trial (ClinicalTrials.gov Identifier: NCT03547262). Twelve healthy older adults (mean age 71.3 ± 4.6 years, 50% male, BMI 24.7 ± 4.3) consumed 20 g of either casein (C), whey (W), or selected protein mixture (R) on separate occasions. Blood samples were taken 10 min before and at 15-min intervals until 2 h followed by 30-min intervals until 5 h after protein intake. Post-prandial serum profiles of total amino acids (TAA), essential amino acid (EAA) and leucine profiles were evaluated and statistically analyzed using mixed models, pairwise compared, and expressed as means ± SEM.

Results
The healthy older adults tolerated and accepted the study products containing 20 g of either W, C, or R protein well and the blood samples were analyzed according to protocol:

- Consumption of C, W and R proteins resulted in different serum amino acid profiles of TAA, EAA and leucine (R vs C p<0.001, W vs C p<0.001, W vs R p<0.001) in the healthy older participants.
- Maximum concentration of TAA and EAA were significantly higher for W and R vs C (total AA W vs C p=0.037 and R vs C p=0.001), EAA, p<0.001 for both).
- Maximum leucine concentration was significantly higher for W vs. R vs C (4.08 ± 1.3 vs 2.04 ± 1.2 µmol/L), R vs C p<0.001, W vs C p<0.001, W vs R p<0.001), which was only partly explained by differences in leucine content. Also the areas under the curve (AUC) for leucine were different for W, R, and C (R vs C p<0.001, W vs C p<0.001, W vs R p>0.001).
- The time point associated with maximal leucine concentrations (Tmax) after consumption of R was similar to Tmax after consumption of W.

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