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Minimal processing using mild heat treatment may positively affect milk protein digestion

A systematic review by Lieshout *et al* 2019 was recently published in the journal *Critical Reviews in Food Science and Nutrition*. The review focused on the effect of dairy protein modifications—caused by industrial heating—on its digestion and the overall physiological relevance of these modifications. The authors note that dairy processing significantly affects protein quality and can be a tool to steer gastrointestinal protein digestion. Dairy, especially milk, is a natural source of high quality protein. The high nutritional quality is attributed to the high level of essential amino acids and it's high bioavailability. Industrial dairy processing can change the structure of milk proteins in several ways, depending on the conditions under which it is processed.

Characteristics of the review

The review by Lieshout *et al* 2019 is a systematic review on the effect of protein modifications on protein digestion in dairy. Via Scopus, 5,363 studies were retrieved and a total of 103 studies were included in the review. The studies were included when:

- Differently heat processed dairy proteins were compared.
- Major bovine dairy proteins were included.
- Digestion was involved that is (partly) representative for gastrointestinal digestion in humans, either *in vivo* or *in vitro*.
- Outcome measures related to protein digestion and absorption were used, including nitrogen balance calculations, protein hydrolysis, SDS-PAGE, LC/MS-MS data, or possible physiological consequences.

Review findings and discussions

During heat processing of milk and dairy products, glycation occurs. Glycation, also known as Maillard reaction, refers to a non-enzymatic reaction between sugars and proteins. According to the review, both animal and *in vitro* studies show that glycation decreases protein digestibility and amino acid availability, especially lysine. A possible explanation for the decrease in protein digestion is that glycation causes chemical modification of lysine residues, which prevents cleavage by digestive enzymes (proteases). While glycation mainly occurs during drying of milk (production of milk powder), protein denaturation mainly occurs during heat processing of milk and dairy products in the liquid phase (pasteurization, sterilization). Unlike glycation, denaturation does not appear to affect overall protein digestibility or bioavailability. Nonetheless, protein denaturation can affect digestive kinetics mainly through an altered stomach behaviour. This is a possible explanation for the physiological consequences of heat-induced milk protein denaturation.

Other heat-induced chemical modifications can occur during heating of milk. Examples are oxidation, cyclization and racemization of amino acids. These modifications may also affect milk protein quality and digestibility, but are less studied. More research is needed to better understand their physiological effects.

Physiological effects for a change in digestibility or digestion kinetics mainly point towards amino acid bioavailability and immunological consequences. Processing-induced milk protein modification may alter their allergic potential through different processes with relevance for both sensitization and subsequent allergic response. Currently, the fate of modified amino acids after digestion is unclear and more data is necessary.

The review findings are in line with the European Food and Safety Authority (EFSA)'s recommendation that milk processing in infant formulae should be kept as low as technologically possible owing to their potential effects on protein digestibility, protein metabolism, as well as immunological responses *(EFSA Journal* 2014;12(7):3760).

Summary

The main protein modifications that occur during heat processing of milk are denaturation and aggregation of the protein and chemical modifications of its amino acids. According to Lieshout *et al* 2019, many studies show that heat processing-induced protein modifications negatively impact protein digestion and overall protein quality.

There is a need for more human studies to identify overall physiological relevance of digestive differences as a result of processing-induced protein modifications. In particular, the metabolic fate and longer-term impact of modified amino acids is, to a large extent, still unclear.

References

1. Glenn A. A. van Lieshout, Tim T. Lambers, Marjolijn C. E. Bragt and Kasper A. Hettinga. How processing may affect milk protein digestion and overall physiological outcomes: A systematic review. Critical Reviews in Food Science and Nutrition 2019. DOI: 10.1080/10408398.2019.1646703.
2. EFSA Journal 2014;12(7):3760

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