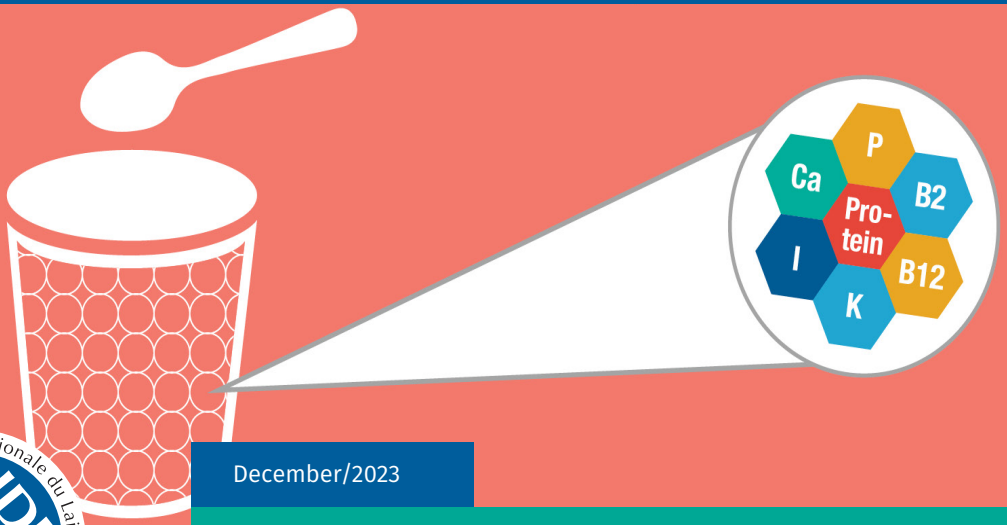

December/2023

Dairy matrix: The case of yoghurt

Scientific excellence
Industry applicability
Strategic networking
Global influence

Highlights

- The yoghurt matrix describes the unique structure of yoghurt, its components, and how they interact, and how this impacts potential health effects upon consumption.
- Yoghurt consumption has consistently been linked with a lower risk of type 2 diabetes.
- The yoghurt matrix benefits gut health. Yoghurt, containing lactose, defies expectations as lactose-intolerant individuals often experience no discomfort after consumption.
- Fermented dairy foods, like yoghurt, can enhance the absorption of nutrients.

Factsheet series summary

Nowadays, nutrition research focuses on the holistic impact of whole foods on health. This entails the recognition that a food's impact is shaped by the interaction of its components and structure, going beyond the sum of its individual nutrients (i.e., food matrix effect). This factsheet series delves into the emerging body of research on the dairy matrix, reshaping current nutritional and health perspectives. Dairy foods have different matrices that result in distinct matrix effects.

What is the yoghurt matrix?

The yoghurt matrix describes the unique structure of yoghurt, its nutrient and non-nutrient components, and how they interact (International Dairy Federation, 2023). In yoghurt, proteins create a gel-like network, interspersed with fats, minerals, bacteria, and fermentation products like peptides. Different processes and ingredients in yoghurt-making result in different types of yoghurt (e.g., set, stirred, drinking yoghurt) with different matrices (Farag et al., 2022). Yoghurt is formed by lactic acid fermentation. In order to meet the Codex Alimentarius standard, yoghurt must contain two strains of live bacteria, *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus*, at a content of at least 10 million total viable bacteria per gram in the final product (Codex Alimentarius, 2011). The yoghurt matrix affects its nutrient digestibility and bioavailability, which in turn, impacts physiological responses and health.

Yoghurt matrix health effects

Yoghurt matrix health effects refer to those that cannot be explained by the components in yoghurt themselves and presuppose some (unexpected) interaction between individual components or with the yoghurt structure itself that ultimately results in unanticipated health effects.

Cardiometabolic health

The latest scientific evidence from systematic reviews and meta-analyses of prospective cohort studies shows neutral or beneficial associations between yoghurt and cardiovascular (CV) and metabolic health outcomes (see Table 1) (Chen et al., 2021; Feng et al., 2022; Jakobsen et al., 2021; Soedamah-Muthu & De Goede, 2018). Additional meta-analyses of prospective studies show that yoghurt intake is associated with a lower risk of all-cause and CVD mortality (Gao et al., 2020; Tutunchi et al., 2023). The analysis of the Netherlands Cohort Study by Goldbohm et al. (2011) found an inverse association between consumption of fermented full-fat milk (mainly full-fat yoghurt) and all-cause mortality, whereas low-fat milk fermented products showed no such association. Yoghurt intake has consistently been shown to be linked with a reduced risk of type 2 diabetes (T2D). This effect has been shown regardless of the fat content emphasizing that this health effect goes beyond the predicted effect of fat alone. Prospective cohort studies showed that full-fat yoghurt products were associated with a lower rate of T2D (Ericson et al., 2015; Ibsen et al., 2017). Alvarez-Bueno et al. (2019) reported that, in all the studies included in their systematic review, yoghurt consumption was associated with a lower risk of T2D. In linear dose–response studies, three out of four studies showed a significant and inverse association with T2D risk; however, the dose reported varied across studies (50–200 g/d or 0.5–2 servings/d) with a suggested nonlinear association that indicated that consumption of 80–125 g/d was related to an approximately 14% lower T2D risk. A follow-up study (more than 20 years) of three large prospective cohort studies showed that increasing yoghurt consumption by >0.5 serving/d was associated with an 11% lower T2D risk (Drouin-Chartier et al., 2019).

Furthermore, studies have shown beneficial associations between yoghurt intake and hypertension as well as body weight management. A 30-year follow-up study of three large cohorts showed that participants consuming 5 servings/week of yoghurt in comparison to < 1 serving/month presented 19% lower risk of developing hypertension (Buendia et al., 2018). A recent cross-sectional study reported that, in U.S. adults, eating yoghurt was associated with lower body weight and body mass index, as well as a 23% lower risk of being overweight or obese (Cifelli et al., 2020). Similarly, a recent meta-analysis showed that the risk of overweight or obesity decreased by 13% per 50-g/d increment of yoghurt intake (Feng et al., 2022). Furthermore, the consumption of yoghurt made from whole milk was associated with changes in waist circumference and higher probability of reversion of abdominal obesity (Santiago et al., 2016).

The favourable impact of yoghurt on T2D and obesity/overweight might be driven by several potential mechanisms. Enhanced bioavailability of calcium by fermentation might reduce lipogenesis and increase lipolysis by the suppression of the formation of 1,25dihydroxyvitamin D (Perna, 2019), and can promote the formation of calcium soaps in the intestine, resulting in increased fat excretion and reduced fat absorption (Lorenzen & Astrup, 2011). Additionally, yoghurt's fermentation process catalysed by lactic acid bacteria yields bioactive peptides like isoleucine–proline–proline and valine–proline–proline, known to inhibit angiotensin-converting enzyme and thus promote antihypertensive effects (Rubak et al., 2020). Nutrients in yoghurts such as calcium and magnesium might help the regulation of blood pressure (Kim et al., 2012). Research findings also showed that bioactive peptides, branched-chain amino acids, and different compositions of ß-casein improved blood glucose homeostasis and postprandial insulin response (Mann et al., 2017).

Taking together the body of evidence consistently shows that yoghurt consumption is associated with lower risk of T2D, hypertension and obesity.

Table 1. Yoghurt consumption and cardiometabolic health outcomes in dose-response meta-analyses of cohort studies.

Study	Stroke	Type 2 Diabetes	Coronary heart disease	Hypertension	Overweight or obesity
Feng et al. (2022)		Beneficial		Neutral	Beneficial
Chen et al. (2021)	Neutral		Neutral	Neutral	
Jakobsen et al. (2021)	Neutral		Neutral		
Soedamah-Muthu and De Goede (2018)	Neutral	Beneficial	Neutral		

Beneficial refers to a statistically significant reduced risk. Neutral refers to no statistically significant effect – neither beneficial nor harmful. Grey cells indicate the parameter was not assessed.

Gut health

Conventional yoghurt cultures have limited viability in the gut and a limited ability to influence the composition of the gut microbiota. Adults consuming yoghurt with S. thermophilus and L. bulgaricus had less than 103 CFU/g of these cultures in their feces (del Campo et al., 2005). Although yoghurt cultures have apparently low viability throughout the lower parts of the gastrointestinal tract, more information is needed about their small intestine viability. Current scientific literature indicates that conventional yoghurt, even without added probiotics, can still have favourable effects on gut health. Fermented milks including yoghurt are associated with favourable outcomes in gastrointestinal health including functional outcomes like lower incidence of bloating, diarrhoea and constipation (Savaiano & Hutkins, 2020).

Yoghurt itself can efficiently improve lactose digestion by providing active microbial β-galactosidase (He et al., 2008). Bacterial lactase, inherent to yoghurts, survives passage through the gastrointestinal tract which is seen as a unique characteristic of the yoghurt matrix (e.g., buffering capacity) (Savaiano, 2014). The yoghurt matrix acts as a transport vehicle delivering the enzyme lactase (e.g., from lactic acid bacteria) to digest lactose, mainly in terminal ileum and in the proximal colon, and sufficiently to prevent symptoms in lactose-intolerant people. This understanding led the European Food Safety Authority (EFSA) to approve the generic claim that yoghurt cultures promote better lactose digestion (EFSA Panel on Dietetic Products & Allergies, 2010). We also speculate that the residual lactose, when entering the colon, acts as a prebiotic fibre (Torres-Gonzalez & Rice Bradley, 2023).

Fermented dairy foods, like yoghurt, might enhance nutrient absorption (Rizzoli & Biver, 2018). This could be due to many different effects that move from the one on gut microflora to the supply of calciotropic and growth hormones and to their effect on intestinal inflammation, which can consequently promote bone growth and health (Tu et al., 2021). Moreover, fermentation of milk creates an acidic environment that facilitates mineral absorption (Shkembi & Huppertz, 2021).

Recent systematic reviews and meta-analyses have shown that consumption of yoghurt is associated with a lower risk of hip fracture (Bian et al., 2018; Hidayat et al., 2020). However, Hidayat et al. (2020) highlighted that this could be a confounder effect: "the stronger inverse association observed between yoghurt consumption and hip fracture risk could be due to the fact that yoghurt consumption is often associated with healthy lifestyles and dietary patterns that may contribute to improved bone health".

In relation to musculoskeletal health, differences in food matrices affect the digestion of proteins differently, which in turn affects postprandial aminoacidemia and subsequent muscle synthesis responses. Yoghurt led in older adults to a higher increase in postprandial aminoacidemia compared to milk and cheese (Horstman et al., 2021).

Conclusions

Consistently, epidemiologic studies suggest that yoghurt consumption is linked to reduced risk of cardiometabolic diseases, particularly T2D. Randomised controlled trials and mechanistic studies are warranted to unravel the causal mechanisms. The distinct effects reported about different dairy products beyond their nutrient composition suggest that the yoghurt matrix may play an important role in potentiating the health benefits of its nutrients. Yoghurt is a nutrient-rich fermented dairy product that plays a crucial role in a healthy diet and lifestyle, deserving promotion in food-based dietary guidelines.

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