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This review provides a broad overview of the role that yoghurt may play in the management of various disease conditions and to consider how yoghurt can contribute to meeting nutrient requirements at the different life stages.

A publication for health professionals

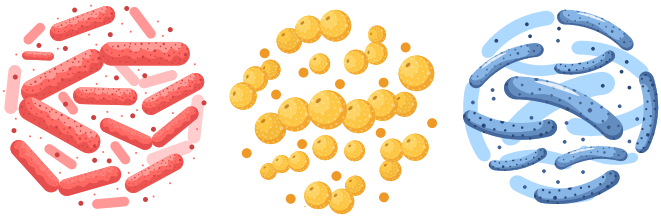
Know your yoghurt
The role of yoghurt in a balanced diet

YOGHURT AS A NUTRIENT-DENSE FOOD

Yoghurt is a fermented dairy product, and a semi-solid, nutrient-dense food with low energy density. The relative energy contribution of plain yoghurt to total daily energy intake is much lower than its relative contribution of protein and calcium. For a standard portion (175 g) of plain yoghurt (1% to 2% fat), the relative content of phosphorus (261 mg), zinc (1.6 mg), riboflavin (0.39 mg), and vitamin B12 (1 mg) exceeds its contribution to energy intake, but contributes to dietary requirements in both men and women.[1]

The nutrient content of yoghurt therefore promotes adherence to dietary guidelines for many nutrients, especially nutrients of concern. This is why yoghurt is often cited as a signature of a healthier diet and lifestyle.[1] In adults, studies suggest that regular yoghurt eaters make healthier food choices, eat less fast food, fried food, fried chips, processed meat, red meat, and pizzas, consume less soft drinks and alcohol, and are also more physically active.[2] This suggests that regular yoghurt consumption may contribute to compensatory changes in food intake: a decreased intake of less healthy foods high in energy from fat and/or sugar.[3] Such findings extend to children where yoghurt consumption has been associated with higher intakes of calcium, vitamin D (when fortified), and protein, with an inverse association between yoghurt intake and total and saturated fat intake.[4]

Added to this, there is much evidence of the beneficial role of yoghurt in the management and treatment of chronic disease conditions such as obesity,[5,6,7] cardiovascular disease,[8,9] hypertension,[10–12] and Type 2 diabetes.[13–16] It also plays a role in gut health.[17,18] This lends support to the recommendation by the South African Department of Health's food-based dietary guideline on dairy to consume yoghurt (as well as milk and maas) daily.[19]



The production of yoghurt

Yoghurt is produced when milk is fermented by two strains of bacteria (also known as live cultures), namely *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.[20,21] During fermentation, the live cultures in yoghurt digest lactose, the natural sugar found in milk, into glucose and galactose. This lowers the lactose content of yoghurt, making yoghurt a viable option for those with lactose intolerance. It also produces lactic acid, giving yoghurt its distinctly thickened texture and slightly acidic flavour. Therefore, the pH is decreased, which causes the casein protein from milk to coagulate, making the calcium and phosphorus more soluble with a higher degree of absorbability. The milk proteins are better digested by enzymes, enhancing the digestibility and bioavailability of yoghurt.[22] The fermentation process also increases shelf life and improves microbiological safety.[17]

As per local and international food standards and guidelines, yoghurt must contain at least 10^7 colony forming units per gram.[20,21] The live cultures in yoghurt must remain active and therefore yoghurt cannot be subjected to heat treatment after fermentation. Yoghurt must also have at least 2.7 g of protein per 100 g, whereas the fat content may vary depending on the type of milk used (see Table1). Additionally, yoghurt may be modified with fruit pulp, sweeteners, and flavour.

Table 1:
Fat classes of yoghurt in South Africa[20]

CLASS OF YOGHURT	MILK FAT CONTENT (PER 100 G)
High-fat / double-cream	More than 4.5 g
Full-fat / full-cream	3.3 – 4.5 g
Medium-fat	1.5 – 3.3 g
Low-Fat	0.5 – 1.5 g
Fat-free / skimmed	Less than 0.5 g

Types of yoghurt

With the variety of yoghurts available on the South African market, it remains a matter of personal preference as to which yoghurt is preferred.

Plain yoghurt vs flavoured/sweetened yoghurt

Plain yoghurt has no added flavouring and/or sugar and is a good choice for those who prefer the tart, unsweetened taste of yoghurt. Plain yoghurt lends itself well to being used as part of recipes, such as soups or curries, or blended with fruit.

Each 100 g of plain yoghurt will typically contain 4 g of lactose, the naturally occurring sugar in milk and dairy, indicated on the food label as 'total sugar'. In South Africa, the law requires of food manufacturers to indicate the total amount of sugar on the product label, both added and naturally occurring (intrinsic sugar). Therefore, consumers may incorrectly interpret that plain yoghurt contains added sugar.

Some yoghurts may have added flavour, sugar, and/or fruit pulp for a sweeter flavour. The added sugar in sweetened yoghurt may range from 6% to 25% on the mass of the final product. An interesting study conducted in France[23] observed how yoghurt consumers add sweetener (sugar, jam, and honey) to plain yoghurt. On average, plain-yoghurt consumers added more sugar to yoghurt (13.6 g) compared to sugar already contained in pre-sweetened yoghurts (10.2 g). Also, participants underestimated the amount of sugar added to yoghurt by half. The study draws attention to consumer behaviour of consuming pre-sweetened yoghurt, which will result in a lower sugar intake than when adding sweetener to plain yoghurt.

Full-cream vs reduced fat yoghurt

In South Africa, yoghurt consumers are spoiled for choice with a range of yoghurts, from double-cream (more than 4.5 g fat per 100 g) to fat-free (less than 0.5 g fat per 100 g).[20] It is a common misconception that double-cream/full-cream dairy is high in energy. When compared to other high-fat foods (e.g. boerewors 32% fat, hamburger 30% fat, and chocolate bar 20% to 30% fat), double-cream yoghurt (4.5%) and full-cream yoghurt (3.3% to 4.5% fat) are much lower in fat.

Greek-style yoghurt

Strained yoghurt is a yoghurt that has been strained to remove most of the whey component. This results in a thicker, creamier yoghurt with a higher protein content.

Whereas Greek yoghurt (which is traditionally strained) is praised internationally, Greek yoghurt, as per the regulations,[20] needs to originate from Greece and hence is not found in retail stores in South Africa. This is because few yoghurt manufacturers in the country have the manufacturing technology to make true Greek yoghurt. For this reason, South Africans will find 'Greek-style' yoghurts in the marketplace, but double-cream yoghurt can easily be used as a substitute for 'Greek-style' yoghurt.

Yoghurt vs a dairy snack

According to manufacturing guidelines in South Africa[20], yoghurt needs to have at least 2.7 g of protein per 100 g to be called yoghurt. A dairy snack has a protein content of 1.5 g per 100 g.
The lower protein content of a dairy snack may therefore impact on the cost of the product.

Lactose-free yoghurt

Lactose-free yoghurt is manufactured when lactase enzymes are added to yoghurt. However, yoghurt is naturally lower in lactose than milk due to live cultures in yoghurt-producing lactase, the enzyme which converts lactose in milk to glucose and galactose. For this reason, the European Food Safety Agency (EFSA)[24] has issued a scientific opinion that there is a relationship between yoghurt consumption and improved lactose digestion. Those with lactose intolerance can therefore tolerate up to 12 g of lactose per day without developing symptoms.[17] A 200 g serving will contain approximately 8 g lactose.

Children's yoghurt

A secondary analysis was done of data from the UK Diet and Nutrition Survey of Infants and Young Children (2011) and the National Diet and Nutrition Survey (2008/2009–2010/2011). Children (under three years) were found to have the highest intake of yoghurt compared to adolescents and adults.[25] Whereas any yoghurt can be included as part of a child's diet, there are yoghurts available specifically for children.

According to a European review[26] on total and added sugar intake and dietary sources, sweet products (such as cakes, sweets, and chocolates) and sugar-sweetened beverages account for 50% of total sugar and 66% of added sugar in children's diets. In contrast, yoghurt accounts for 4% to 8.5% of added sugar in the diets of European children.[26]

The health benefits of yoghurt

Obesity

Several systematic reviews have investigated the associations between yoghurt consumption and weight.[5-7] Published in the International Journal of Obesity, a systematic review concluded that, in epidemiological studies, yoghurt consumption was associated with lower body mass index (BMI), body weight/weight gain, smaller waist circumference, and lower body fat.[5]

Supporting these findings, new research has shown that yoghurt intake could decrease the risk of obesity by 44% with increasing yoghurt intake up to 165 g per day.[7] In another review of ten cohort studies, weight and waist change may be reduced in an overall dietary pattern that includes frequent consumption of yoghurt, more so when yoghurt is consumed as part of a healthy diet with fruit.[6]

As yoghurt is a complex food with many dietary and nutrient components,[22] the exact mechanism of action of how yoghurt plays a role in weight management/obesity risk has yet to be confirmed. Available evidence suggests that the high calcium and protein content of yoghurt may influence appetite regulation and consequently energy intake.[3,27] In particular, the protein content and composition of yoghurt may contribute to appetite control. Whey protein and casein are high-quality dairy proteins that contribute to metabolic regulation of hormones (e.g. insulin, cholecystokinin, glucagon-like peptide 1, peptide tyrosine, and glucose insulinotropic peptide), as well as the suppression of ghrelin and delay of gastric emptying.[1] This may suppress food intake and increase satiety. Further to this, lactic acid bacteria may positively affect the gut microbiota to influence appetite,[1] and evidence has shown that a dysbiosis of the gut microbiota may contribute to the development of obesity.[27]

It is also plausible that yoghurt consumption is linked to healthier non-nutrition-related behaviours, which, in turn, are linked to positive weight-related outcomes.[1,28] For example, regular consumers are 30% less likely to smoke and 40% more likely to be physically active compared to non-yoghurt consumers.[2]

Lastly, there is evidence to support that the inflammation linked to obesity may lead to a host of chronic diseases, including cardiovascular disease and diabetes. Clinical trials have shown that daily yoghurt consumption for more than eight weeks has a beneficial effect on C-reactive protein (CRP), an inflammatory marker, in those who are overweight.[29]

Type 2 diabetes

Studies have shown that yoghurt intake is linked to lower risk of Type 2 diabetes.[13-16] A review of observational studies showed a 14% lower risk of Type 2 diabetes with yoghurt consumption of 80 to 125 g per day (compared to no yoghurt consumption). The intake of fermented dairy like yoghurt may be inversely associated with variables in glucose metabolism.[16] In addition, yoghurt consumption may be effective in reducing the risk of gestational diabetes in pregnant women.[30] It has also been predicted that increasing yoghurt consumption in adults by 100 g per day could result in 388 000 fewer cases of Type 2 diabetes, saving £2.3 billion.[31]

The various components of the complex food matrix of yoghurt may impact metabolic control in diabetic patients.[14,15,16,22] These include high-quality protein, bioactive peptides, calcium, B-complex vitamins, fatty acids, and low glycaemic index. Each of these components may interact synergistically to influence metabolic pathways linked to insulin resistance and diabetes.[16] Also, the impact of yoghurt on intestinal microbiota may contribute to the prevention and management of diabetes, though the exact mechanism of action has yet to be clarified.[15]

Though dairy may contribute to saturated fat intake in the diet, studies do not suggest an association with saturated fatty acids in dairy and diabetes risk.[16] The intake of nutrient-dense, low energy foods like yoghurt may subsequently reduce the intake of foods high in fat, simple sugars, and energy. The reduction of energy intake may also be connected to the protein content of yoghurt contributing to satiety.[15] Given the effect of regular yoghurt consumption on satiation and regulation of energy intake, there is a reduction of body fat levels strongly linked to insulin resistance and the risk of Type 2 diabetes.

Hypertension

In a long-term cohort study, researchers found yoghurt consumption to be associated with a 16% lower risk of hypertension. This was supported by data from the Framingham Heart Study, which found a 6% lower risk of hypertension with each additional serving of yoghurt consumed.[11] It is suggested that the unique bioactive compounds formed during fermentation as well as the live cultures and conjugated linoleic acid in full-cream yoghurt may be responsible for the beneficial associations between yoghurt and cardiometabolic health.[22,32] In particular, bioactive peptides are linked to hypertension risk. Yoghurt contains bioactive peptides that are released from milk protein during fermentation. Bioactive peptides inhibit the release of angiotensin-converting enzyme (ACE),

which converts angiotensin I to angiotensin II, a potent vasoconstrictor. The inhibition of ACE will cause a vasodilator response, lowering blood pressure.[12]

Cardiovascular disease

Research (2017) suggests that yoghurt intake is associated with a lower risk of cardiovascular disease. In a large systematic review and meta-analysis (n = 291 236), yoghurt consumption of 200 g per day was significantly associated with lower risk of cardiovascular disease.[8]

Evidence suggests that yoghurt might interfere with cholesterol synthesis. In a systematic review of seven randomised control trials, the consumption of yoghurt significantly reduced total cholesterol concentration, the ratio of total cholesterol to high-density lipoprotein (HDL) cholesterol, and plasma glucose.[9] The positive effects of yoghurt on lipid profiles may be linked to the calcium in yoghurt. Calcium interferes with fat absorption in the intestine, forming calcium soaps with fatty acids and binding of bile acids. This accelerates faecal fat loss. Bioactive peptides have also been shown to lower cholesterol levels.[9] In addition, yoghurt may influence weight reduction, with obesity a known risk factor for developing cardiovascular disease.[8]

Gut health

There is a growing body of evidence to support the role of the gut microbiome in health. The microorganisms present in fermented foods like yoghurt are known to survive transit through the gastrointestinal tract.[17] Frequent yoghurt consumption has been shown to increase the microbial diversity in the gut.[18] The human gut is primarily dominated by bifidobacteria and *Lactobacillus* bacteria (both found in yoghurt), *streptococci,* and clostridia. Hence, yoghurt may have positive effects on the gut microbiota[6] linked to changes in the equilibrium and metabolic activity of gut microbiota.[33]

Obesity is often accompanied by chronic, low-grade inflammation related to high levels of adipose tissue. In the gut, obesity-associated dysregulation of microbiota and impaired gut barrier function may increase inflammation levels further. Yoghurt consumption may improve gut health and reduce chronic inflammation by enhancing innate and adaptive immune responses, intestinal barrier function, lipid profiles, and regulating the appetite.[25]

The nutritional value of yoghurt through the life stages

Maternal health and early life

Published in 2020, a systematic review on maternal health and pregnancy outcomes concluded that the consumption of yoghurt may decrease rates of preterm births. This was linked to improvements in metabolic, inflammatory, and infectious outcomes of pregnancy.[34]

Such benefits have been shown to extend beyond pregnancy and are present through early life, too. Recommendations are that infants from six months be offered a varied diet, including foods with different flavours and textures.[35] To delay the introduction of allergenic foods is unnecessary, according to consistent scientific evidence.[35] Therefore, during this time, it is recommended that allergenic foods (i.e. yoghurt made from cow's milk) be introduced soon after complementary feeding is commenced.

In a large study on 1 041 infants, the introduction of yoghurt in the first year of life was independently associated with a reduced risk for developing atopic dermatitis.[36] In a cohort study of 1 166 infants, consumption of yoghurt in infancy was also associated with a lower likelihood of developing atopic dermatitis and food sensitivity at five years old.[37] Researchers in Japan also reported that daily yoghurt consumption in infants may reduce skin hypersensitivity and reduce the risk of atopic dermatitis in infancy.[38]

With an appropriate texture for complementary feeding, it is therefore feasible to recommend that yoghurt be included as a first food.[39]

Toddlers and children

In South Africa, the Provincial Dietary Intake Study[40] (a follow-up of the National Food Consumption Study) aimed to determine the energy and macronutrient intakes of children aged one to ten years. Results found that yoghurt contributes 7.3% of total added sugar in the diets of children. This is similar to international studies where yoghurt accounts for 4% to 8.5% of added sugar in the diets of European children.[26] However, granulated sugar (39.6%), candy (18.5%), and cold drinks (8.3%) account for more of the added sugar in the diets of South African children.[40]

Research confirms that yoghurt makes a valuable contribution to the nutrient intakes of young children. Data from the National Health and Nutrition Examination Survey (NHANES)[4] in America concluded that children (8 to 18 years) who eat yoghurt regularly (once a week) may have

healthier diets. Research suggests that children who eat yoghurt consume 10% more milk, 23% more fruit, and 30% more wholegrains. Similar findings[41] have been reported in other studies. Compared to non-yoghurt consumers, children who consumed yoghurt had significantly higher intakes of:

- carbohydrate (2.3%);
- dietary fibre (4.5%);
- total sugar (9.3%);
- protein (4.9%);
- calcium (21.4%);
- magnesium (10,0%);
- potassium (11.1%);
- vitamin B12 (7.1%); and
- vitamin D (7.6%) (when fortified);

and lower intakes of:

- total fat (-5.2%); and
- sodium (-5.7%).

Yoghurt consumers in this study also had significantly higher intakes of total dairy (21.9%), fruit (26.7%), and wholegrains (25.4%).

In an American study, yoghurt intake in children was associated with higher intakes of calcium, vitamin D, protein, and potassium, and lower intakes of total fat and saturated fat.[4] Data from the UK also concluded that yoghurt made a substantial contribution to intakes of vitamin B12, riboflavin, calcium, iodine, and phosphorus in children under three years.[25]

In 2015, using data from the (NHANES) children (4 to 10 years) who were regular yoghurt consumers (i.e. more than 60 g/day) had a higher overall diet quality, nutrient intakes and adequacy, and lower pulse pressure. Children aged 11 to 18 years were found to have lower HbA1c concentrations, were shorter, and had a smaller hip circumference. Children who ate more yoghurt also had lower levels of body fat, smaller waist circumferences, and better weight.[4]

Added to this, in an analysis of data from the NHANES, there was a relationship between yoghurt consumption and metabolic profiles in American children aged 2 to 18. In this study, frequent yoghurt consumers had better diet quality and a healthier insulin profile.[42]

Adolescence

Adolescents may fail to meet minimum recommendations for dairy intake, with dairy consumption decreasing through childhood and into early adolescence.[43] Data suggests that only a third of adolescents consume yoghurt, and the least amount of yoghurt (21 g per day compared to 44 g per day in 4- to 18-month-old infants and 47 g per day in 18- to 36-month-old infants).[25]

Yet research suggests that the addition of yoghurt to the adolescent diet may help meet recommended intakes for calcium and iodine, nutrients of concern in the teenage diet.[25] The addition of 125 g of low-fat fruit yoghurt may increase both calcium and zinc intake in the adolescent diet to above 100% of reference nutrient intake (RNI), and increase intakes of magnesium and potassium.[25]

In adolescence, long-term avoidance of dairy has been associated with smaller stature and lower bone mineral mass. Calcium and protein, two components of yoghurt, can induce bone growth and bone mass accumulation.[44] Furthermore, researchers found that dairy was the food group best associated with adolescents with low risk of cardiovascular disease.[45] In the Healthy Lifestyle in Europe by the Nutrition in Adolescence (HELENA) study of adolescents, higher consumption of yoghurt and milk was associated with lower body fat and higher cardiorespiratory fitness.[45]

Collectively, this data suggests that yoghurt is an important food to help increase nutritional adequacy in the diets of adolescents.

The elderly

It has been suggested that yoghurt can play a role in improving the nutritional status and health of older adults.[46] Interestingly, the average yoghurt consumption is twice as high in women compared to men in older adults (aged 65 years and older).[25]

Bone health is a common concern in the elderly. A systematic review and meta-analysis reported that yoghurt consumption was associated with a lower risk of hip fracture.[47] Fermented dairy such as yoghurt contains calcium, phosphorus, and protein, which together promote bone health through an increase in bone mineralisation, decrease in bone resorption, and the increase of bone formation. In addition, the bacteria in yoghurt may modify intestinal calcium absorption and/or bone metabolism.[44]

Beyond bone health, yoghurt may play a role in other conditions related to aging. In an elderly population at high cardiovascular risk (n = 4 545), full-cream yoghurt consumption was associated with a decrease in waist circumference and 43% higher probability for reversion of abdominal obesity. Interestingly, this association was, however, not found for low-fat yoghurt.[48]Sarcopenia refers to the loss of skeletal muscle mass and function and is a common age-related concern which overlaps with frailty.[49] milk has been linked to positive effects on frailty. Higher consumption of

yoghurt. In Spanish adults over 60 years of age, the consumption of yoghurt and low-fat (more than seven servings per week) was associated with a lower risk of frailty (specifically slow walking speed and weight loss) compared to lower consumption of yoghurt (less than one serving per week).[50]

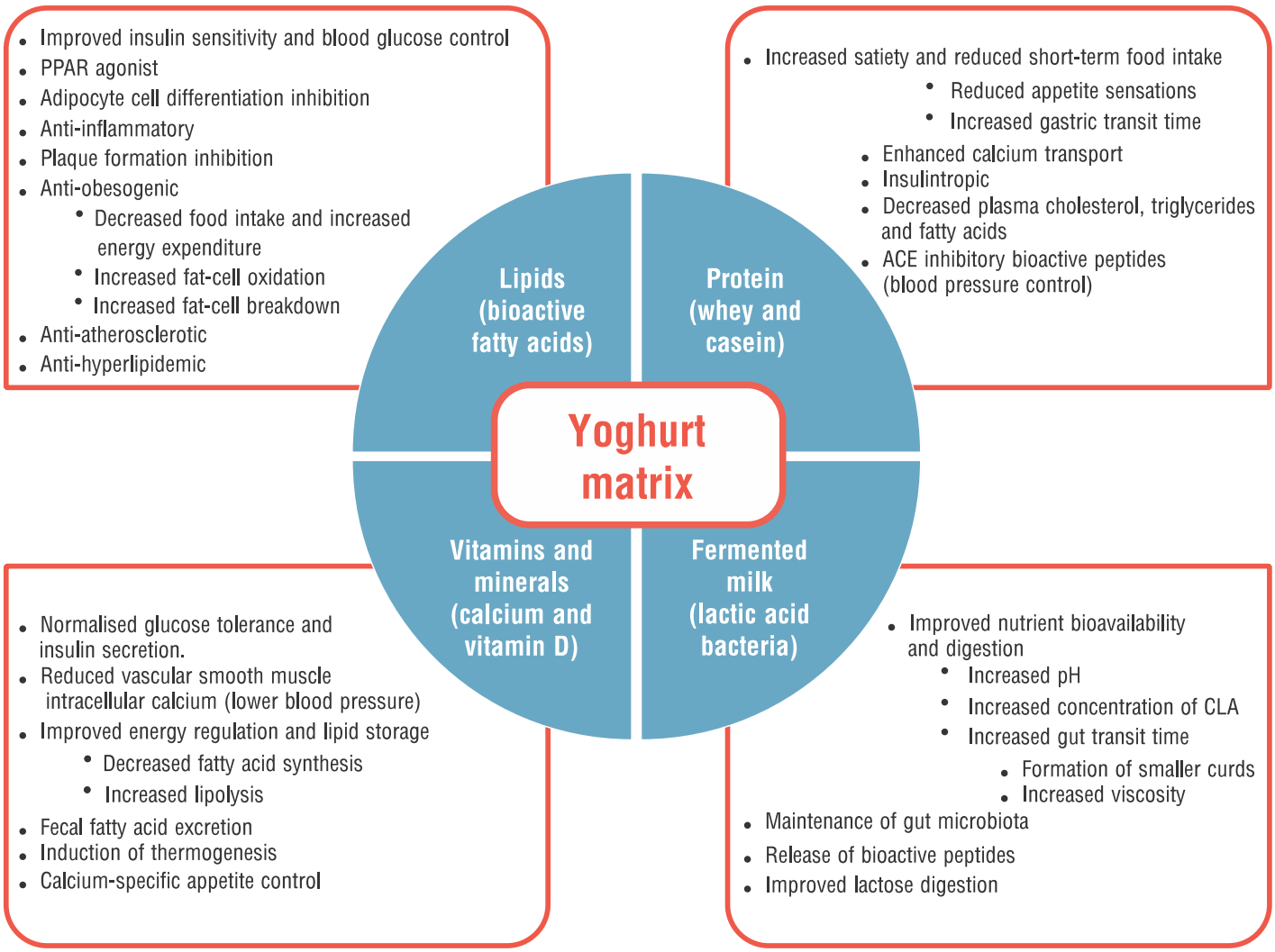


Figure1:
The Yoghurt Matrix[22]

Conclusion

Available scientific evidence supports the role of yoghurt to help meet key shortfall nutrients in the diets of children and adults. The totality of available evidence shows that yoghurt plays a significant role in the diet to help manage weight and safeguard against various chronic diseases such as cardiovascular disease, hypertension, and diabetes. Yoghurt may also help meet nutrient recommendations, with agreement that dairy intake in totality may be a surrogate marker of diets higher in nutritional quality.

The yoghurt matrix (Figure 1) is the sum of the nutrients, bioactive compounds, and live culture that gives yoghurt its health benefits. The yoghurt matrix proposes that yoghurt is more than the sum of its individual nutrients: the combination of nutritive components can act independently of the individual nutrient components.

Yoghurt is a nutrient-dense, well-liked food. The above discussed health benefits of yoghurt in the treatment and management of various chronic diseases/conditions suggest that yoghurt may play a beneficial role in a healthy and balanced diet. This lends support to the recommendation by the South African Department of Health's food-based dietary guideline to consume yoghurt (as well as milk and maas) daily.

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