Yogurt Consumption as a Signature of a Healthy Diet and Lifestyle

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Abstract

Yogurt is considered to be a nutrient-dense food that significantly contributes to the intake of several nutrients, including calcium and protein. As described in this paper, yogurt consumers have a higher nutrient intake than do nonconsumers. Yogurt consumers are also characterized by healthier dietary habits than nonconsumers, which partly explains their reduced incidence of overweight and obesity. Recent studies also suggest that yogurt consumers exhibit healthier nonnutritional behaviors, such as reduced smoking and greater participation in physical activity, than do nonconsumers. Furthermore, when greenhouse gas emissions are used as an additional criterion to categorize foods, yogurt appears to be an eco-friendly food. Compared with that of other foods, the carbon footprint of yogurt production is low to moderate and may be included as part of a healthy and sustainable diet. Based on these factors, yogurt consumption may be the signature of a healthy diet and lifestyle. J Nutr 2017;147(Suppl):1476S–80S.

Keywords: yogurt, nutrients, healthy eating, lifestyle factors, appetite control, greenhouse gas emissions

Introduction

Popular consensus suggests that “we are what we eat.” Beyond this basic notion, population studies provide evidence that the consumption of specific foods, such as dairy products, may influence nutrient intake and overall diet beyond what would be attributable to their nutrient content (1–4). As discussed in this review, this appears to be the case for consumers of yogurt, who are characterized by a better global dietary profile (2, 5, 6). Furthermore, recent findings have raised the possibility that the profile of nonnutritional behaviors may also be better in yogurt consumers than in nonconsumers (7).

Yogurt is a semisolid fermented milk product that is the result of culturing a mixture of milk and cream products with the lactic acid–producing bacteria Lactobacillus bulgaricus and Streptococcus thermophiles (8). Most of the industrialized production of yogurt uses cow milk of various fat content, and some may also add various other ingredients, including skim milk; nonfat dry milk; whey protein; lactose; sweeteners such as glucose, sucrose, aspartame, and sucralose; fruits; and artificial coloring and flavoring. Because of yogurt’s specific manufacturing procedures and fermentation, it contains higher amounts of several micronutrients, including riboflavin, vitamins B-6 and B-12, calcium, potassium, zinc, and magnesium than do other dairy products, such as milk. The consumption of yogurt varies greatly worldwide, with some of its highest consumers in parts of Europe, North America, Middle East, and Russia (9); however, trends are changing as various countries in the world become more integrated through travel and migration. Furthermore, because yogurt is a marker of a healthy diet in various regions of the world, its consumption has been shown to be more common in healthier, leaner, more highly educated individuals from higher socioeconomic levels and more widespread in women (10).
This paper summarizes a lecture presented at Experimental Biology 2016, the aim of which was to provide possible explanations for the reasons yogurt consumption may be considered to be a signature of a healthy diet and lifestyle.

**Contribution of Yogurt to Nutrient Intake**

Yogurt is a nutrient-dense food with low energy density. As recently described by Panahi and Tremblay (11), the relative caloric contribution of plain yogurt to daily energy intake is much lower than its relative contribution of protein and calcium. Moreover, for a standard portion (175 g) of plain yogurt (1–2% milk fat), the relative content of phosphorus (261 mg), zinc (1.6 mg), riboflavin (0.39 mg), and vitamin B-12 (1 μg) largely exceeds its contribution to energy intake, but greatly contributes to dietary requirements in both men and women. In the absence of dairy consumption, it would be difficult for individuals to meet some nutrient requirements. Thus, the nutrient content of yogurt promotes adherence to dietary guidelines for many nutrients, particularly nutrients of concern.

Population studies make it possible to verify whether the contribution of yogurt to the intake of some nutrients remains detectable when daily food intake is analyzed. In the NHANES (2005–2008), Keast et al. (12) found that yogurt and dairy consumption were associated with a higher intake of calcium, protein, and vitamin D. The investigators also observed an inverse association between yogurt consumption and total and saturated fat intake, suggesting that yogurt consumption may contribute to compensatory changes in food intake (i.e., lower overall energy intake), as will be discussed further in this paper. Concordant results were obtained by Wang et al. (2), who used the Framingham Heart Study Offspring (1998–2001) and Third Generation (2002–2005) cohorts to study the yogurt-nutrient intake relation. It was observed that yogurt consumers were less likely to have an inadequate intake of riboflavin, calcium, magnesium, zinc, and vitamin B-12. Yogurt consumers also reported a higher potassium intake than did nonconsumers. In children participating in the UK Diet and Nutrition Survey of Infants and Young Children and the National Diet (2011) and Nutrition Survey (2008/2009−2010/2011) (13), yogurt provided a useful contribution to the intake of calcium, phosphorus, iodine, riboflavin, and vitamin B-12. These cohort data support the idea that the high content of these nutrients in yogurt contribute to greater daily nutrient intake in the populations studied. Thus, in a context in which many individuals, including children, consume excess energy, particularly fats and sugars, and an insufficient amount of micronutrients, yogurt is a relevant replacement for high-fat and high-sugar foods, especially when consumed with fruits and vegetables (14).

**Potential Impact of Yogurt on Overall Diet**

Yogurt may also influence the diet by promoting changes in the consumption of other foods and improving overall diet quality. In the NHANES, Zhu et al. (6) evaluated the potential relation between yogurt consumption and diet quality in American children and found that frequent consumers of yogurt (≥1 time/wk) had significantly better diet quality, as assessed by the Healthy Eating Index 2005, than did infrequent consumers (<1 time/wk). They also consumed more fruits, whole grains, and milk, which reflected better compliance with dietary guidelines. In addition, the children who consumed yogurt were found to have lower fasting insulin concentrations than were nonconsumers. In a similar study examining American men and women (n = 6526) from the Framingham Heart Study Offspring (1998–2001) and Third Generation (2002–2005) cohorts, yogurt consumption (≥0 servings/wk; 1 serving = 250 g) was associated with a higher Dietary Guidelines Adherence Index score (i.e., better diet quality) and improved metabolic profiles (2). After adjustment for various demographic and lifestyle factors and the Dietary Guidelines Adherence Index, consumers were also found to have a higher intake of dietary fiber and several micronutrients. In concordance, secondary analysis of data from the Diet and Nutrition Survey of Infants and Young Children (2011) and the National Diet and Nutrition Survey (2008/2009–2010/2011) examining the contribution of yogurt to nutrient intake (13) found that French adults who were greater consumers of fresh dairy products, including yogurt, also reported a greater intake of fruits, fish, legumes, nuts, and water; ate fewer pre-prepared meals; and had lower alcohol consumption than did those who consumed fewer fresh dairy products. In addition, frequent consumers had a better diet quality score and exhibited greater adherence to recommended guidelines for 11 micronutrients (thiamin, riboflavin, pantothenic acid, vitamin B-6, folate, vitamin A, vitamin C, calcium, iodine, selenium, and copper). Overall, the available literature suggests that yogurt consumption is positively associated with diet quality. This interpretation is in agreement with the recommendation for children to rely on foods such as whole milk, yogurt, fruits, and vegetables for snacks in order to increase consumption of valuable nutrients without adding excess sugar and energy (14).

The possibility that the consumption of a specific food can be a global signature of a healthy lifestyle may be related to what the food symbolizes to the consumer and its specific properties. Recently, Cormier et al. (5) investigated dietary patterns in relation to the consumption of specific foods, focusing on the Western dietary pattern, which was in contrast to the Prudent dietary pattern. As expected, foods such as French fries and fried foods, processed meats and red meats, refined grains, beer, regular soft drinks, and mayonnaise were positively associated with the Western pattern. In contrast, vegetables, fruits, nuts, legumes, fish, and other seafood, as well as yogurt, were more associated with the Prudent dietary pattern. In the same cohort, yogurt consumers presented a favorable cardiometabolic profile, specifically lower plasma TG and insulin concentrations (5). These observations are in agreement with the study by Mozaffarian et al. (4), which found that food groups related to a Western dietary pattern (red meat, processed red meat, rice, or sugar-sweetened beverages) favored body-weight gain over time, whereas the opposite trend was observed for foods, including yogurt, associated with the Prudent diet.

**Yogurt Reformulation and Appetite Control**

Research has suggested that yogurt consumption is associated with weight loss over time (4). In the updated version of an analysis by Mozaffarian (3), the yogurt category, including artificially sweetened, flavored, and sweetened yogurts, was inversely associated with long-term weight gain in 3 cohorts of American men and women over 4 y. The yogurt food matrix is versatile, enabling reformulations that expand its functionality (Table 1). In a randomized crossover study by Lluch et al. (13), consumption of low-fat yogurt enriched with
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<td>Randomized cross-over clinical study</td>
<td>32 men and women</td>
<td>200-kcal preloads (semisolid yogurt containing pieces of peach, same yogurt in a drinkable homogenized</td>
<td>Hunger, thirst, satiety, desire to eat, and food intake</td>
<td>Consumption of the 2 yogurts (semisolid and liquid) led to lower hunger and higher fullness ratings than did the fruit drink or dairy fruit drink. Energy intake at lunch was the same across all 4 conditions (mean ± SD: 806 ± 43 kcal).</td>
<td>The 2 yogurts were more satiating than the 2 beverages; however, lower ratings of hunger and higher fullness after yogurt consumption did not reduce food intake at the next meal.</td>
<td>Lluch et al. (15)</td>
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<td>(age: 18–35 y)</td>
<td>form, a peach-flavored dairy beverage, and a peach juice beverage) were consumed on 4 separate occasions. Visual Analogue Scales were used to measure appetite at 20-min intervals after treatment. A tray lunch was presented 90 min after the preload.</td>
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<td>Randomized cross-over clinical study</td>
<td>15 women (mean age: 26 ± 2 y)</td>
<td>160-kcal afternoon yogurt snacks containing LP, MP, or HP (5, 14, 24 g protein, respectively) or NS for 3 d. On day 4, the volunteers came to the facility to consume a standardized lunch. The respective snack pattern was completed 3 h after lunch. Perceived sensations were measured every 30 min until dinner was voluntarily requested. Dinner was then consumed ad libitum.</td>
<td>Perceived appetite sensations and food intake</td>
<td>Snacking, regardless of protein content, led to reduced hunger and increased fullness, sustained ≥120 min after snack vs. NS (all, ( P &lt; 0.05 )). Hunger was lower and fullness was higher throughout after snack after HP vs. LP (( P &lt; 0.05 )). The HP snack led to the latest request time vs. LP (( P &lt; 0.001 )) and MP (( P &lt; 0.05 )). Although the energy content consumed at dinner was lower after the yogurt snacks vs. NS, the 160-kcal snacks were not fully compensated for at this meal.</td>
<td>An afternoon snack of Greek yogurt containing 24 g protein led to reduced hunger, increased fullness, and delayed subsequent eating vs. lower-protein snacks in healthy women.</td>
<td>Douglas et al. (16)</td>
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<td>Randomized double-blind crossover study</td>
<td>20 healthy men (mean age: 32.4 ± 9.1 y)</td>
<td>Over 5 sessions, participants randomly consumed 5 isocaloric and isoproteic yogurt snacks (120-g servings, ~230 kJ, ~4.5 g protein) differing by their C:W or dietary fiber content: 1) control C:W = 2.8:1; 2) high-whey C:W = 1.5:1, and fiber-enriched formulations with the use of control; 3) 2.4 g inulin; 4) +IN-bG; and 5) 0.5 g b-glucan.</td>
<td>Appetite sensations with the use of 150-mm visual analogue scales, plasma variables (glucose, insulin, ghrelin) measured at 30-min intervals after yogurt consumption for 2 h, and ad libitum food intake measured at 2 h</td>
<td>No differences were observed in appetite sensations. Ad libitum energy intake was lower after HW than after control yogurts. Significantly lower AUC for ghrelin was found after the +IN-bG and HW yogurts (( P = 0.04 )).</td>
<td>Although appetite sensations were not affected by the yogurts’ protein compositions, reduced energy intake was observed after the ad libitum lunch for the HW yogurt, attributed to its lower C:W. Fiber enrichment did not affect the outcome measures.</td>
<td>Doyon et al. (17)</td>
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1 C:W, casein-to-whey protein ratio; HP, high protein; HW, high whey; LP, low protein; MP, medium protein; NS, no snack; +IN-bG, 1.9 g inulin and 0.5 g b-glucan.
proteins (8 g/serving) and fiber (2.6–2.9 g/serving) as a midmorning snack demonstrated reductions in hunger sensations and subsequent energy intake of 274 kJ in healthy women. More recently, a study assessing the effects of a Greek yogurt snack containing 24 g protein on appetite sensations found that high-protein yogurt reduced hunger, increased fullness, and delayed subsequent eating, as reflected by an increase in the time to request a subsequent meal after consuming the snack (16). Our research also demonstrated that the yogurt matrix could be modified to facilitate appetite control. In our recent study that examined the impact of a yogurt snack on ad libitum energy intake at lunchtime, we modified a reference yogurt to increase the relative content of whey protein, which is known to be more rapidly digested and more bioavailable than casein (17). Two yogurts with identical volume and energy and protein contents were formulated, but differed in their casein to whey protein ratios. The main hypothesis was that an increase in the relative content of the rapidly bioavailable whey protein would improve satiety-related signaling and decrease subsequent energy intake. Ad libitum energy intake at lunchtime was significantly reduced after consumption of the high-whey yogurt snack at 1000 compared with that after consumption of a control yogurt (1216 ± 370 kcal compared with 1410 ± 411 kcal, respectively), and this effect was obtained without differences in appetite sensations, suggesting a beneficial effect on the satiety quotient. Interestingly, the assessment of taste was comparable for the 2 yogurts, an observation that provides an encouraging message to the food industry that modifications can be made without compromising palatability.

Although yogurt contains numerous components, its protein content and composition has been suggested to contribute to appetite control by suppressing food intake and increasing satiety through several mechanisms (18–20). Dairy proteins (whey protein and casein) have physiologic properties that contribute to the suppression of food intake and may partly explain the relation found in some studies between higher dairy consumption and lower body weight (21). Both whey protein and casein are high-quality proteins that contribute to metabolic regulation through the stimulation of many hormones controlling food intake, including insulin, cholecystokinin, glucagon-like peptide 1, peptide tyrosine tyrosine, and glucolysinotopic peptide; the suppression of ghrelin (22, 23); and slower gastric emptying (24). The role of individual yogurt components, particularly protein, on metabolic regulatory mechanisms has received much attention; however, yogurt is a complex food that contains numerous components, including micronutrients such as calcium and lactic acid bacteria that may affect gut microbiota and influence appetite control. Thus, the precise mechanisms regulating satiety, food intake, and long-term body weight have not yet been clearly elucidated.

Relation between Yogurt Consumption and Lifestyle Behaviors

Recent studies have also documented that yogurt consumption is associated with healthier nonnutritional factors and behaviors. Yogurt consumption has been shown to be more common in healthier, leaner, more highly educated individuals from higher socioeconomic levels, and more widespread in women (25). In a Brazilian cohort, Possa et al. (7) reported that yogurt consumers had a higher family income and were less likely to be smokers than were nonconsumers. Similarly, a study by D’Addezio et al. (26) found that adult yogurt consumers were 30% less likely to smoke and 40% more likely to practice physical activity than were nonconsumers. Also, in the Preventión con Dieta Mediterránea study (27), there was a low percentage of smokers observed among participants at the top tertile of yogurt consumption compared with in the reference tertile, although in general this behavior may not be specifically associated with yogurt consumption per se after adjustment for relevant covariates. In addition, smokers have been shown to have lower Healthy Eating Index scores, as evident from their lower consumption of fruits, vegetables, and dairy products and diets higher in sugar and fat than those of nonsmokers.

Yogurt: An Ecofriendly Food?

With consumers being more mindful about their food choices and concerns about the environment (e.g., climate change), focus on factors that have the potential to influence the carbon footprint [the sum of greenhouse gas emissions (GHGEs) related to food production, processing, transporting, and retailing] has increased (28, 29). Drewnowski et al. (30) recently documented the amount of GHGEs for numerous food groups per 100 g and per 100 kcal and found that the more nutrient-dense animal products, including meat and dairy food groups, were characterized by higher GHGE values per 100 g, whereas values were lower when GHGEs were expressed per 100 kcal. However, yogurt was categorized as an ecofriendly food whether its GHGE value was expressed on a per-kilocalorie or per-gram basis (~200–300 g CO2 per 100 kcal or 100 g). Grains and sweets had the lowest GHGEs, whether they were expressed per 100 g or 100 kcal; however, fruits and vegetables had a low GHGE per 100 g, but not when expressed per kilocalorie (30). Although sugar and sweets may have little effect on the environment, they cannot be considered to be part of a sustainable diet, according to the definition of sustainable diets provided by the FAO, which references the health and well-being of the population as a component of sustainability (31). The introduction of a GHGE-based criterion does not seem to lessen the contribution yogurt makes to the diet, because its carbon footprint is low to moderate compared with many other foods. This new criterion indicates that yogurt production is compatible with adequate sustainable development.

The Gaps

The majority of population studies support the benefits of yogurt consumption on diet quality and have shown positive effects on metabolic health, although a few have shown no associations (32, 33). Several studies have not considered the wide variety of yogurt products or their composition (i.e., their protein, fat, and sugar contents), have used diverse study populations, and have used different methods of intake measurement that make it difficult to assess consumption and may misclassify consumers, particularly if there was no consumption over the period for which dietary data were collected. Furthermore, controlling for various factors, including physical activity, lifestyle habits such as smoking and alcohol consumption, and amount of yogurt intake, is required. Future longitudinal and intervention studies are needed to address some of these limitations. It is important to better control for differences in diet and lifestyle.

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Conclusion
Yogurt is a healthy, low-energy dense, high-nutrient dense food that may be viewed as a signature of a healthy lifestyle. Its contribution to the intake of nutrients such as calcium and protein is substantial and favorably influences the total daily intake of these nutrients. Yogurt consumers are characterized by healthier dietary habits that align with dietary guidelines. The profile of nonnutritional behaviors among yogurt consumers in part may also explain their reduced likelihood for overweight and metabolic diseases. Finally, a classification of foods based on their carbon footprint ranks yogurt among those with GHGE values that may be compatible with long-term sustainable development.

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References