Yogurt, living cultures, and gut health1-3

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ABSTRACT

Bacteria used to ferment milk to obtain yogurt belong to thermophilic, bile-sensitive species of lactic acid bacteria, which are not ideally suited for survival into the human gut. However, assessing the viability of these bacteria through the digestive tract may be relevant to evaluate their potential to deliver some beneficial effects for the well-being of the consumer. The well-known reduction in the symptoms caused by lactose malabsorption is not the only benefit provided by yogurt starter cultures; some additional effects will be reviewed here, with special attention paid to data that may suggest a strain-dependent effect, features that are not present with lactose hydrolysis. Am J Clin Nutr 2014;99(suppl):1248S–50S.

Traditionally, yogurt is considered to be a fermented dairy food carrying viable bacteria with health-promoting effects. Lactobacillus delbrueckii subspecies bulgaricus and Streptococcus thermophilus have generally been used as starters for milk fermentation in yogurt production [for a recent review, see Mohammadi et al (1)]. The concentration of these organisms in the human or animal gastrointestinal tract has been poorly examined (2) in comparison with the full range of studies devoted to assessing yogurt starter cultures in the human gut. Moreover, the viability of probiotic bacteria intentionally added to food is rarely been assessed at high amounts in the intestine (2). Moreover, the viability of probiotic bacteria in the upper part of the gastrointestinal tract has led to few studies being conducted in fecal samples of individuals consuming yogurt. Results of the assessment of viability in stools of L. bulgaricus and S. thermophilus ingested by humans in yogurt are summarized in Table 1.

García-Albiach et al (9) reported essentially negative results and concluded that they were “consistently unable to detect viable yogurt lactic acid bacteria in fecal samples after repeated yogurt consumption by healthy volunteers.” They also noticed a difference between results obtained at the DNA level when fresh or pasteurized yogurt was consumed: “L. bulgaricus and/or S. thermophilus DNA remains were detected by hybridization assays in only 10% of volunteers who had ingested fresh yogurt.” This study could suggest that yogurt cultures are unable to survive intestinal transit and that heat treatment impairs the potential of dead cells to remain intact during the transit. However, 2 additional studies (10, 11), in which the authors used less yogurt per day but with a higher concentration of viable bacteria, reported a different scenario: both trials detected L. bulgaricus cells in fecal samples, whereas viable cocci were recovered only in the trial by Mater et al (10). These results may be explained by the following: 1) the higher amount of ingested cells, 2) differences in the recovery/detection methods, or 3) differences in the used strains.

Puzzled by the third hypothesis, I searched the existing literature to verify if there are some indications for strain specificity of certain beneficial actions possibly exerted by different strains of yogurt cultures. Data produced by our laboratory have shown a marked difference in the chromosomal arrangements, as determined by pulsed field gel electrophoresis analysis (12), of...
several strains taxonomically identified as *S. thermophilus*. This observation may also indicate a potential difference in the phenotypic behavior. Two major outcomes resulted from this search: one related to the action toward the immune system exerted by an *L. bulgaricus* strain, and second, of the ability of some yogurt cultures to enrich the vitamin content of yogurt, both of which appear to be strain-dependent.

The action on the immune system is not really a new item in the area of yogurt research, but the novelty of the series of studies published by a Japanese group (13) is that they have shown both in vitro and in vivo the immune modulation exerted by a specific strain of *L. bulgaricus*, and also identified the bacterial component responsible for this action. The *L. bulgaricus* strain OLL1073R-1 was shown to produce a capsular polysaccharide, which has a marked effect on the immune system in mice (14, 15). This specific strain was initially studied for its extracellular polysaccharide, but this action was not present in yogurt fermented with a different strain of *L. bulgaricus* (15). One clinical trial in humans showed that this strain was able to reduce the incidence of the common cold in elderly people when administered daily in yogurt (Table 2) (16).

An additional example of a beneficial action exerted by yogurt cultures, which is not related to lactose digestion, is the improvement of the vitamin B profile in adults (17, 18), with special attention paid to young healthy women (17). A group of nutritionists based in Vienna, Austria, conducted a study in which volunteers consumed 100 g probiotic yogurt daily for 2 wk and 200 g/d for another 2 wk. Plasma and urine concentrations of thiamine, riboflavin, and pyridoxine were determined. The main outcome was that plasma concentrations of thiamine increased in both groups (*P < 0.01*).

The same group published in 2001 (18) a similar article in which the thiamine, riboflavin, and vitamin B-6 status of healthy adults who consumed yogurt was not influenced by bacterial flora of the examined yogurt; therefore, it seems highly possible that vitamin production could be strain related, and future genomic studies will be relevant (19) to select the most actively producing vitamin cultures. It is possible to conclude therefore that a new research line is open for scientists: to assess and exploit the strain-specific beneficial properties of traditional yogurt starter cultures.

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### TABLE 1

Assessment of the survival rate of yogurt cultures in the human gut<br>

<table>
<thead>
<tr>
<th>Authors, year (ref)</th>
<th>Human subjects</th>
<th>Yogurt intake</th>
<th>Daily dose of <em>Streptococcus</em></th>
<th>Survival of <em>Streptococcus</em></th>
<th>Daily dose of <em>Lactobacillus</em></th>
<th>Survival of <em>Lactobacillus</em></th>
<th>Analytic technique used</th>
</tr>
</thead>
<tbody>
<tr>
<td>García-Albiach et al, 2008 (9)</td>
<td>63 ± 16</td>
<td>g/d</td>
<td>375</td>
<td>2 × 10^8 CFU/g feces</td>
<td>1.3 × 10^7 CFU/g feces</td>
<td>&lt;10^3</td>
<td>MRS/M17 plate counts + species-specific primers + hybridization (positive 10%) difference between heated and viable cells</td>
</tr>
<tr>
<td>Mater et al, 2005 (10)</td>
<td>13</td>
<td>125</td>
<td>8 × 10^10 CFU/g feces</td>
<td>6.3 × 10^5 CFU/g feces</td>
<td>8 × 10^10 CFU/g feces</td>
<td>7.2 × 10^4 CFU/g</td>
<td>MRS-agar plates containing 1000 mg streptomycin/mL and 100 mg rifampicin/mL for selective recovery of <em>Streptococcus thermophilus</em></td>
</tr>
<tr>
<td>Elli et al, 2006 (11)</td>
<td>20</td>
<td>250</td>
<td>5 × 10^9</td>
<td>None</td>
<td>6 × 10^5</td>
<td>Log of min 3 to max 5.5 subjects</td>
<td>Specific selective media + species-specific primers + strain-specific RAPD</td>
</tr>
</tbody>
</table>

*max, maximum; min, minimum; MRS, de Man, Rogosa and Sharpe; RAPD, rapid amplification of polymorphic DNA; ref, reference.*
REFERENCES


