# *E. coli* as a probiotic

Bob Rastall & Glenn Gibson

One rapidly developing area in the food microbial sciences is the use of dietary intervention to modulate the gut flora, with the consequent aim of improving health. Although probiotics have been used in human and animal nutrition for centuries, many new food products have recently become available, including fermented milks, lyophilized preparations and drinks. The most popular delivery system for human use is yoghurt, whereby additional cultures to the traditional starter strains (*Lactobacillus delbrueckii* subsp. *bulgaricus*, *Streptococcus thermophilus*) are used in the fermentation process and/or added to the product afterwards. Both bacteria and yeasts are used for their probiotic effects. The literature indicates over 50 reported human trials with a so-called 'positive' result. These have largely centred around gastrointestinal disorders, such as protection from travellers diarrhoea and alleviation of symptoms of irritable bowel syndrome. However, some systemic effects are also said to occur through the metabolic end products of probiotic growth in the gut (e.g. acetic acid is transported to muscle tissues where it can act as a source of ATP) and probiotics have been used to treat conditions such as atopic eczema and vaginosis. The annual European market for probiotics is said to be in excess of several billion euros, with new product developments occurring rapidly.

The Greek translation of probiotic is 'for life', and it is formally defined as a '*live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance*'. This has since been modified by a European working party on gastrointestinal function foods to a '*live microbial food ingredient that is beneficial to health*'. This implies that health outcomes should be defined and proven, which is not the case for all of the purported benefits of probiotics. Most research has been directed towards the use of intestinal isolates of bacteria as probiotics. Over the years, many species of micro-organisms have been used. They consist not only of lactic acid bacteria (lactobacilli, streptococci, enterococci, lactococci, bifidobacteria) but also *Bacillus* spp., yeasts such as *Saccharomyces* spp. and fungi such as *Aspergillus* spp.

Most probiotic bacteria are Gram-positive strains. This is largely because of their ability to persist within the gut ecosystem and produce organic acids such as lactate and acetate. One difficulty with many probiotics, however, is stability within the product. For example, the bifidobacteria are strictly anaerobic, leading to processing difficulties. Attention has therefore turned to less fastidious micro-organisms and recent reports have cited the use of *E. coli* as a probiotic.

Most of the work on probiotic *E. coli* centres around one particular strain, known as Nissle 1917. It was isolated in World War I from a soldier who survived a particularly severe outbreak of diarrhoea. Nissle proposed the use of *E. coli* as early as 1916 and showed in the 1930s that administration of this strain improved symptoms in patients with non-infectious bowel disorders. Subsequent work with Nissle 1917 has shown that administration to infants results in colonization of the gastrointestinal tract and a serum antibody response. Further, such colonized infants showed reduced colonization by bacterial pathogens and potentially pathogenic species. It has also been found that postnatal colonization with Nissle 1917 results in a significantly reduced incidence of allergies by the age of 10.

The use of this *E. coli* strain to treat Crohn's disease and ulcerative colitis has generated attention. In well controlled, doubly blind trials, Nissle 1917 was found to be as effective as the drug mesalazine in maintaining remission periods in patients with ulcerative colitis. In addition, it was found to inhibit adhesion of pathogenic *E. coli* strains isolated from patients with Crohn's disease to intestinal epithelial cells. As such, the use of *E. coli* as a probiotic for inflammatory bowel diseases has renewed interest in the use of microbial intervention for these conditions (established therapies include broad spectrum antibiotics like metranidazole and anti-inflammatory agents such as sulphasalazine – often, neither are especially effective).

The data on Nissle 1917 suggests that it may have some use as a probiotic, although much more data from human trials are required before firm conclusions can be safely drawn. Further research to clarify how it works is also necessary.

Use of a Gram-negative species as a probiotic is rare, but is likely to stimulate interest in other species. One aspect to consider is that within the normal gastrointestinal microflora, *E. coli* is normally present only in relatively trivial numbers, when compared to bacteroides, bifidobacteria, eubacteria, clostridia, lactobacilli, etc. In the context of colonization of the neonatal gastrointestinal tract, the 'Gold Standard' is generally held to be human milk. The result of breast feeding is a gastrointestinal microflora very much dominated by Gram-positive micro-organisms (usually bifidobacteria), more so than in formula feeding. In this light, the strategy of colonization of infants with *E. coli* should be pursued with caution.

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The use of probiotic microbes to improve health is becoming well established. Most of the bacteria in commercial preparations are Gram-positive, but as Bob Rastall and Glenn Gibson describe, *E. coli* may also prove to be a useful probiotic.

ABOVE:
A premature tube-fed baby.
PHOTO J. WESTWELL, SGM

## Further reading

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