



Next Generation Dairy Processing Science and Technology: Functional and Rational in Dairy Industry

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Abstract

The dairy industry, as part of the broader agricultural sector, is classified as a basic industry to the Korea economy. Basic industries provide income to a region by producing an output, purchasing production inputs, services and labor. An integrated, multidisciplinary approach for the next generation of dairy products with added health benefits represent the direct economic contribution. The commercialization of “nutritional” functional foods can only be successful if the consumer is confident in the scientific validity of the claims. Modern biotechnologies such as genomics, genetic expression and biomarkers of health performance suggested to whole dairy products, such as fluid milk, butter, cheese, ice cream and frozen dessert products (German, 1999). The following definition makes the point that dairy products can provide a nutritional value beyond the basic nutritional requirements: 1) The dairy industry has the opportunity to improve the health and well-being of its customers and/or to reduce their risk of disease through dairy products with added activities. 2) Functional dairy products are those that can be demonstrated to benefit target functions in the body in a way that improves the state of health and/or reduces the risk of disease. They are food products that are consumed as part of a normal diet rather than pills or supplements. 3) Dairy products based on functionality will need to link the scientific basis of such functionality to the communication of its benefit to the general public. 4) Both the efficacy and the safety of the food components with health benefits will require evidence based on the measurement of scientific biomarkers relevant to their biological responses and health end points. 5) Sound evidence from human studies based on intermediate health end points using accepted biomarkers will provide the basis for promotional messages divided into two categories-enhanced function and reduced risk of disease. 6) Success in solving key scientific and technological challenges will only be achieved by interdisciplinary research programs to exploit the scientific concepts in functional dairy science.

Keywords: functional dairy products, food vehicle, probiotics, paraprobiotics

What are Functional Dairy Products?

Functional foods have been broadly defined as ‘foods similar in appearance to conventional foods that are consumed a part of a normal diet and have demonstrated physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions. Dairy foods are central to this sector: they are good delivery system for functional foods (yogurts, milk drinks, spreads) and are also rich in compounds which can be extracted and used as functional ingredients in other food types (Sawalha, 2014).

With regard to improvement of gut health and lipid metabolism, successes in cholesterol reduction were followed by new innovations including: probiotics, which are live bacteria that not only protect the gut from undesirable microbial species but also encourage the effective modulation of the host immune system; fibers, which modify intestinal digestion and absorption rates, and influence rheology and motility; prebiotic of oligosaccharides (e.g. bifidogenic carbohydrates) which via fermentation, both encourage a beneficial microflora and provide products that enhance intestinal-cell differentiation and health; and growth factors that promote the optimal development of intestinal and immune systems.

Organoleptic functionalities (texture and flavor) are more easily

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Table 1. Functional foods benefit area and frequently used food matrices

Benefit area	Frequently used food matrices
Brain health	-Beverages -Cereals, bars
Beauty inside	-Beverages -Smoothies, dairy drinks
Gut health	-Dairy products
Heart health	-Dairy products -Spread
Joined/sports	-Beverages -Bars
Weight	-Dairy products

detected by the consumer while scientific evidence will make confident to consumers if the extra dimension of health benefits over foods are applied.

The last factor is that consumers are generally looking for convenience. Therefore beverages on-the-go shots as well as bars may have a higher chance of market success than other functional food products (Table 1).

Success Story of Probiotics for Promoting Health

Probiotics are live bacteria that not only protect the gut from undesirable microbial species but also encourage the effective modulation of the host immune system, due to improvement of gut health and lipid metabolism, successes in cholesterol reduction as well. Gut protection as a functionality is not defined by single molecules but by living bacteria and their metabolic products (Cencic, 2010). The next stage in the development of probiotic functional foods requires a very new approach. The

benefits of ingesting living bacteria can only result when multiple properties are simultaneously expressed by a single strain or appropriate mixtures of strains. Probiotic bacteria must simultaneously survive in the food in high numbers, survive gastric pH, survive intestinal bile acids, adhere to or interact with the intestinal surface, colonize the intestinal environment, displace pathogenic bacterial competitors and prevent immune sensitization by the host. Many microorganisms could be considered as potential probiotics but only a few able to satisfy the necessary criteria. The functional criteria of probiotics should be established based on both *in vitro* and *in vivo* assays, and the results should be also reflected in controlled human studies. Through clinical, animal, and cellular experiments, researchers have shown that probiotic preparations consisting of dead cells and their metabolites can also be biological response modifiers (Taverniti and Guglielmetti, 2011). This paradox of probiotics has been concisely reviewed by Adams (2010) and Taverniti *et al.* (2011), who reported probiotics as ‘paraprobiotics’ or ‘ghost probiotics’. The impact of probiotics can be attributed to their molecular components, and their effects can be mediated by either live or dead cells. Nevertheless, scientific evidence implies that inactivated microbes and their metabolites positively affect human and animal health (Kataria *et al.*, 2009; Adams, 2010; Hor *et al.*, 2014). Hence, products designed with heat-killed strain *Lactobacillus acidophilus* LB from human origin *Lactéol* strain (Coconnier *et al.*, 1997) have been imported and marketed since early 1998 (*Lactéol Fort* from PUMC Pharmaceutical Co., Ltd and *Fermenti Lattici Tindalizzati* from Frau, AF United S.p.a).

An overview of the most significant criteria to define a probiotic microorganism is presented in Table 2.

Presently, the most attractive potential use of probiotics is in

Table 2. Criteria used to define a probiotic microorganism

Safety criteria	Be of human origin Non-pathogenic in nature Generally recognized as safe (GRAS)
Functional criteria	Be resistant to destruction by gastric acid and bile salts Adhere to intestinal epithelial tissue Be able to colonize the gastrointestinal tract, even in short term Modulate immune responses Produce antimicrobial substances Influence human metabolic activities (i.e. cholesterol assimilation, lactase activity, vitamin production)
Technological criteria	Be resistant to destruction by technical processing Be subjected to scale-up processes

the fight against abnormal intestine microorganisms. This covers a wide range of conditions, such as virulent enteropathogens, with its wide virulence variability, rotavirus, diarrhea associated with the use of antibiotics and small-bowel bacterial overgrowth (a frequent condition of the elderly or of patients administered with drugs that suppress gastric acid secretion). The last two conditions are most often not associated with an enteropathogen but with a globally disturbed ecology that can alter digestive and absorptive intestinal functions or promote inflammatory gut-barrier damage.

Concluding Remarks

Probiotic potential is very exciting, for the next generation of scientific advances to add further physiological and protective properties to the already-existing spectrum of benefits assembled by screening available bacteria. The rate of these advances will depend on the sciences of bacterial and human physiology, and genetics, and the extent to which the scientist community and the health authorities are open to a new way of promoting health and preventing disease, using milk as a food vehicle.

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