FUTURE FOODS: WHERE DOES MILK FIT?

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Introduction

The future for food is about healthy choices for well-being of body and mind, all in the perspective of moderation. The four 'mega-drivers' that dictate where future foods will succeed are convenience, health, mood enhancement and self-indulgence. Consumers' increased awareness of food as being so much more than just nutrition is evident in the success of functional foods including speciality milk ingredients and products. This paper outlines just where science has been taking milk, and where it is headed to in the future.

The pathway to food innovation

Consumer awareness

Today's consumers are more aware of their diet. Essentially, eating choice has shifted from eating to live in prehistoric times (and granted there is a big gap in the timeline here) to living to eat in the mid-twentieth century when, post-World War II, food was relatively abundant, to the current shift back to eating to live. Modern consumers are more knowledgeable about health and well-being, and the impact food choice can have on every-day life. Many consumers are also willing to pay for products that promise beneficial effects. There is a catch, however. Consumers want to find the right balance between lifestyle, health and diet. Although the fad diets will always be with us, consumers would prefer that healthy eating progress from avoidance of nutritionally bad foods, to finding the right balance between healthy and less healthy food choices – in other words, everything in moderation.

A **functional food or beverage** can be defined as providing health benefits or desirable physiological effects beyond basic nutrition. In a survey of food choice, 43% of US shoppers said that they purchased foods that did more than just provide nutrition, i.e. they were looking for functional foods. Furthermore, of these same shoppers, 56% said they would like to know more about the benefits of food they ate. So what is really driving consumer choice?

Mega Drivers

A range of health issues appear to drive consumers' food choices, and these choices are often influenced by the appearance of fad-diets and trends. Consumer trend data found that 55% of the population want to make an effort to eat healthily, while 50% regularly eat snacks, and an amazing 33% of consumers either skip meals or graze all day as part of their normal meal patterns. To fit with these trends, consumers are asking for **better-for-you snacks, low-carb and low-cal** options, foods

with **low-fat** and **low-transfat,** together with foods that control blood sugar levels. To top it off, the food has to still taste good. These consumer desires can be captured by four mega-drivers that are pushing food innovation:

1. Convenience – easy to prepare, on-the-go, travel-friendly
2. Health – food with substance, energy-dense, no "empty-calorie"[1] foods
3. Mood enhancement – high stress lives need a tonic
4. Self indulgence – tasty and pleasurable, bringing enjoyment back into eating.

This is all great news for the dairy industry because milk and milk products are already recognised as being calming, comforting, energizing, indulging and satisfying.

Dairy industry involvement

Dairy foods are one of the biggest contributors to the growing functional foods market. In the UK, 87% of the functional foods market is captured by cereals, spreads, yoghurts and yoghurt-drinks[iii]. To maintain a sizeable proportion of this market, and to benefit from current food-choice trends and consumer beliefs, dairy companies will need to be innovative about their product development, and it may even mean thinking beyond just milk. Dairy ingredients already have taste, functionality, nutritive value and versatility on their side. Milk and milk products will be able to provide a base for new foods and beverages. And, as the result of significant advances in scientific understanding of milk science, the exploitation of specific components in milk that can contribute to health and well-being will help to support innovation in the dairy industry.

Where does milk fit in future foods?

The need to survive in an environment of potentially limited food supply provided the mammalian dam with an evolutionary drive to protect her own health during lactation while still providing the neonate with exactly what was required for optimal growth and development. In addition, the milk needed to provide a source of protection from the environment into which the neonate was born, i.e. immune protection. As such, it is hard to find a more perfect functional food than milk.

Milk contains over 200 individual components, packaged in a seemingly uniform white fluid, all of which are designed to provide nutrition and other biological functions such as immune protection to the neonate. Man has manipulated the productive capacity of the cow to provide a nutrient-dense food containing nutritionally superior protein, a source of readily available carbohydrate in the form of lactose, energy-rich milk fat, and significant amounts of other important nutrients such as calcium, phosphorus, magnesium, numerous vitamins and other trace minerals.

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[1] **Empty-calorie** means a food/beverage that usually delivers significant amounts of energy without adding many other nutrients, e.g. a can of soft-drink, being full of sugar (often more than a tablespoon full), water and flavourings can be defined as delivering empty calories.

The composition of milk changes throughout lactation, most notably in the first few days as the secretion transitions from colostrum to a more consistent composition. Although the levels of some components such as the protein remain fairly constant throughout the lactation period, there are other components in milk such as the milk fat content and composition that are readily manipulated by management practices including diet. One example of milk composition is given in Figure 1. The values provided are reasonably standard, but do not account for differences in composition related to cow breed, feeding regimens or the point of lactation, all of which will impact on the relative proportions of each nutrient.

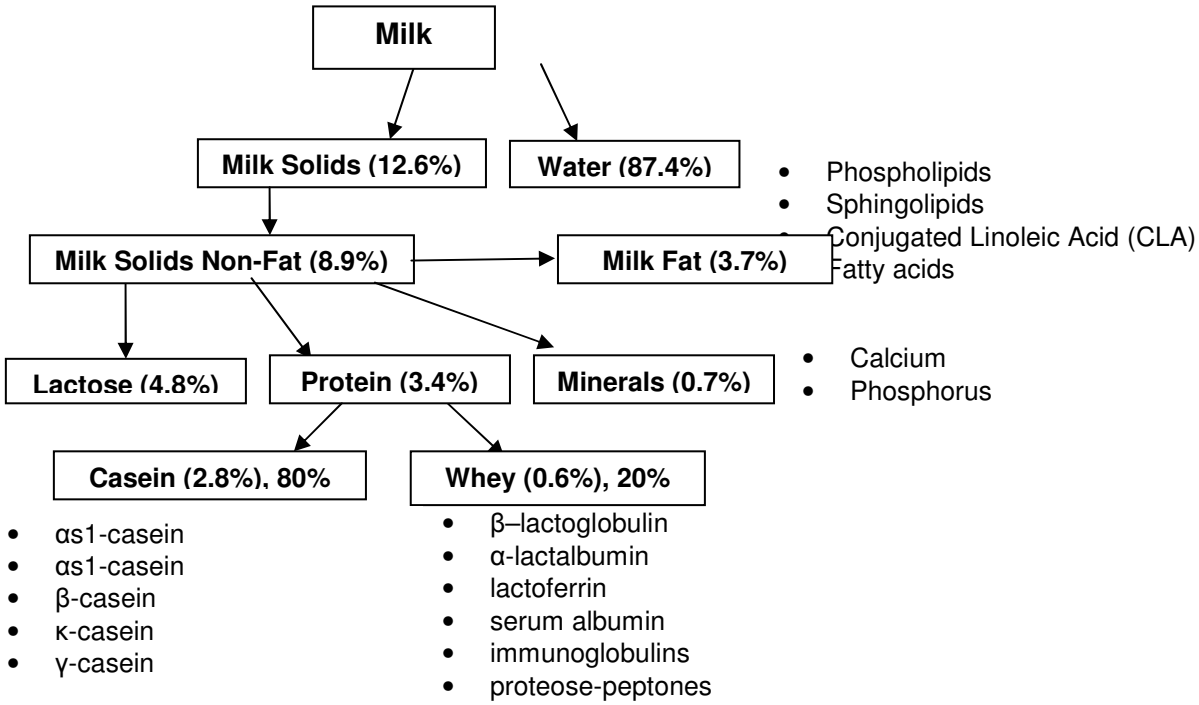

Figure 1: Major components of milk, and the specific constituents of each component (compiled from Jensen, G. *Handbook of Milk Composition*. New York: Academic Press, 1995, and Chandan, R. 1997)

Milk Composition

Protein

The protein in milk provides all the essential elements (amino acids) needed to form protein in our body, in amounts that exceed our requirements for these amino acids. This is what defines dietary protein quality, and is the key reason why milk is considered to be one of the highest quality proteins in our diet. Protein in milk contains two different fractions – casein proteins, and whey proteins. Each fraction has a different function with the caseins targeted mainly at delivering amino acids for nutrition, and the whey proteins having other roles such as protection against infections, enhancing development of the gut, and providing direct immune protection to the neonate.

Carbohydrate

Lactose is the predominant carbohydrate in milk, providing the major source of energy in milk. Smaller amounts of glucose can also be found in milk, together with relatively indigestible compounds called oligosaccharides that act more like a source of fibre, than a source of energy, in the gut. Recently, Arla Food Ingredients, a food company in Europe, patented a process of extracting a

minor milk sugar called Tagatose in commercially viable amounts from processed dairy products (in particular, heated whey). This is an exciting advance in dairy technology because tagatose can be used as a sugar-replacement instead of the more controversial artificial sweeteners currently available. Being only 8% less sweet than sugar, yet with minimal calorific value (it usually passes through the digestive system undigested) the potential application of tagatose as a natural, low-cal sugar replacer is very exciting for the dairy industry.

Fat

The fat in milk contributes to the appearance, texture, flavour and general acceptance of dairy products. Milk fat provides an energy source, as well as key essential elements called fatty acids several of which have a biological role in the body (such as conjugated linoleic acid). Milk fat can also act as a carrier for fat-soluble vitamins such as vitamins A, D and E. It is the ability of milk fat to carry vitamin A and carotenoids that gives milk fat its universally recognisable yellow colouring.

Minerals

Many different types of minerals are found in the milk solids fraction of whole milk. The quantity of each mineral in the milk defines whether that mineral is classified as a macronutrient (e.g. calcium, phosphorus, magnesium), a micronutrient (e.g. iron, zinc, selenium) or a trace element (e.g. aluminium, cobalt). By far the most important mineral in milk is calcium, and dairy products are well accepted by nutritionists and the general public alike as being the best source of dietary calcium, both in terms of amounts available and potential for absorption from the gut.

Table 1: Beneficial effects on common health problems associated with consumption of milk and its components

Health Issue	Evidence in support milk
Bone health	• Calcium content is high relative to protein in milk • Milk contains other bone-supporting nutrients such as phosphorus, magnesium, zinc and vitamins A, D and K
Cancer	• The whey proteins lactoferrin and CLA appear to limit cancer growth in cells • In animal studies, whey proteins have been shown to provide protection against intestinal, mammary and colon cancers
Microbial infection	• Several proteins in milk have been shown to have antimicrobial activity and may neutralise toxins and viruses
Cardiovascular disease – heart attack and stroke	• Some whey protein fragments (peptides) have antihypertensive properties, inhibit clotting, and in some cases reduce cholesterol levels
Exercise recovery	• Whey proteins, that are easily digested, also contain the highest level of the important components (branched chain amino acids) needed for muscle repair • Other proteins in milk appear to enhance an athlete's immune response, e.g. immunoglobulins
Dental caries	• Studies show that milk does not enhance the formation of dental caries, and in fact cheese is protective • Casein fragments can enhance re-mineralization of the enamel on teeth, and calcium phosphopeptide is now used in a commercially available toothpaste
Mood, memory and sleep patterns	• Compared to all other dietary proteins, milk contains the highest levels of a chemical tryptophan which is involved in brain function, and increasing our intake of tryptophan can influence mood and sleep

Health Issue (Contd)	Evidence in support milk
Weight management	• Dairy products have been shown to have a beneficial effect on weight management in children • Three servings a day of milk or milk products can help achieve and maintain a healthy weight in adults mostly through an increased calcium intake • Now that it is recognised that dietary calcium plays a key role in the metabolism of fat in the body, recent findings suggest that dairy food sources of calcium had significantly greater effects than calcium alone • Whey proteins may help augment the effects of milk calcium on weight management
Type 2 diabètes mellitus and Syndrome X	• Consuming dairy products may lower the incidence of insulin resistance syndrome, which in turn reduces the risk of type 2 diabetes onset
Gastrointestinal function	• Friendly bacteria, also known as probiotics are almost exclusively found in dairy products such as yoghurt • Consumption of probiotics can alleviate gut problems such as lactose intolerance, diarrhoea, infections and stomach ulcers. Also, consumption of probiotics in dairy products may reduce the risk of colon cancer

Biological activity of milk components

When included in our diet (2-3 servings of dairy per day) milk and milk products can provide a significant proportion of the nutrients known to be essential for health and well-being. Also of interest to the dairy industry is the potential for milk and milk products to provide health benefits beyond basic nutrition. Some key health issues have been identified in Table 1, together with the positive role milk can have in the prevention, management or treatment of certain health concerns. Rather than going into the wealth of detail available to support the role of milk in our health and well-being, this paper serves to highlight the different areas where the value of milk is being enhanced through technology and science. From the information given in Table 1, there are four key areas which deserve further attention.

Bone health

The risk of osteoporosis is reduced if the foundations for a healthy skeleton are formed at critical times during childhood and adolescence. Bone mass in advancing adult years is mostly

influenced by peak bone mass, with about 90% of our peak bone mass being established by 20 years of age. In addition, the risk of developing osteoporosis can also be alleviated by ongoing consumption of high-calcium products such as milk throughout life. Milk and milk products are recognised as the preferred source of dietary calcium to support optimum bone health because not only are they calcium-rich, but milk products also contain unique protein fragments that enhance bone development early in life, and bone structure in later life.

Cardiovascular health

Adequate dietary intakes of calcium, potassium and magnesium, all three of which are found abundantly in milk, will have a beneficial effect on blood pressure and help reduce the risk of hypertension, and consequently cardiovascular disease[1]. In addition, a special component of milk fat, conjugated linoleic acid (CLA) – which is found in enhanced levels in the milk from New Zealand dairy cows because of pasture-based feeding systems – has been shown to reduce cardiovascular disease in animal models.

Immune health

Environmental factors, stress and even inadequate nutrition can all compromise a person's immune system. Many foods are reported to provide immune protection, or an immune "boost" via bioactive components in the food ingredients. Several components in milk including immunoglobulins, lactoferrin and lysozyme are known to affect the immune system. However, it is the delivery of probiotics (beneficial bacteria) via cultured products such as yoghurt and cultured drinks that has the greatest potential to deliver immune protection or immune system enhancement.

Weight management

Obesity is predicted to become the single most prevalent public health problem globally in the next few years. One figure suggests that if obesity trends continue at their current levels, 39% of the population of the USA will be obese by 2008. It is evident from research findings that changes to dietary patterns such as increasing calcium intake, and in particular dairy calcium intake, may provide a very workable option for weight management. The challenge for the dairy industry will be to convince those who traditionally turn away from dairy products because of a preconceived idea that milk is fattening that in fact, dairy products may well be their salvation.

Future foods

Future foods are likely to be quick to prepare for eating, highly transportable, and packed full of both nutrients and biologically active components that will enhance our health and well-being. The dairy industry's main hope is that the health benefits of milk and milk products, together with milk's versatility, taste and technology-based functionality will support the on-going development of innovative products that meet consumers' needs as defined by the four mega-drivers of convenience,

health, mood enhancement and self-indulgence. It is likely that milk ingredients will be included in not only traditionally recognised healthy products such as yoghurts, cheeses, liquid and powdered milks, but will also be combined with other food groups to produce a whole new range of multi-formulated future foods. One example of this is the recent release by the Coco-Cola company of "Swerve" – a milk-based, carbonated soft drink. An indication of the potential inclusion of dairy ingredients in the future beverages market is provided in Table 2, and if the predictions are correct, then the dairy industry will have captured a significant share of this beverage market.

Table 2: Potential use of dairy ingredients in Beverages of the Future*

Beverage Segment	**2008 Projected volume^**	**Potential % using dairy ingredients**
Fruit beverages	4,524	4-5%
Isotonics	1,295	5-10%
Meal replacers	177	30-60%
Milk drinks	95	100%
Yoghurt drinks/smooties	40	80-100%
Ready-to-drink tea	569	5%
Enhanced water	243	5-10%
Carbonated soft drinks	123	100%
Sports nutrition	13	100%
Energy drinks	127	5-10%
TOTAL SEGMENT	7,207	7-10%

* (source: http//www.dairycheckoff.com/news/release-041305.asp) ; ^ million US gallons

Conclusions

Milk and milk products do indeed have great potential both as a source of high quality nutrition to meet people's requirements for essential nutrients, and as the basis for functional foods that will deliver tangible health benefits recognised and appreciated by the consumer. The challenge for the dairy industry in the next few decades will be to continue funding research in this area, and to remain abreast of both consumers' needs/desires, and global trends in health that will continue to expand (e.g. osteoporosis and obesity) or emerge in the future.

References

Research unlocks opportunities for dairy products with health positioning, http//www.tetrapak.com.

Tools for Innovation:Nutrition-packed beverages attract On-the-go Baby Boomers, http//www.dairyfoods.com/CDA/ArticleInformation/features/BNP_Features_Item/0,6775,111261,00.html.

The Future is bright with consumer-led innovation, http//www.dairyfoods.com/CDA/ArticleInformation/features/BNP_Features_Item/0,6775,130892,00.html.

Jensen, R.G. Handbook of Milk Composition. San Diego, Academic Press, 1995.

Chandan, R. (1997). Dairy-Based Ingredients. St. Paul, Minnesota: Eagan Press.

Heaney, R.P., Abrams, S., Dawson-Hughes, B. *et al* (2004). Osteoporosis International 11:985.

McLeod, R.S., LeBlanc, A.M., Langille, M.A., *et al* (2004). American Journal of Clinical Nutrition 79:1169S.

Ohr, L.M. (2005). Food Technology 59 (1): 65-68.

McBean, L. (2004). National Dairy Council. Dairy Council Digest 75 (3): 13, www.nationaldairycouncil.org.nz

Zemel, M.B. (2003). Journal of Nutrition 133: 252S-256S.