Dairy Foods Symposium: Dietary Influence on Milk Synthesis of Health-Promoting Components in Bovine and Human Milk

343 Hot topics in human milk composition. M. K. McGuire*[1], K. Hunt[2], J. Williams[2], and M. A. McGuire[2], *[1]Washington State University, Pullman [2]University of Idaho, Moscow.*

Human milk continues to be the "gold standard" in terms of optimal infant nutrition during the first 4 to 6 mo of life, although its composition is variable and incompletely understood. The purpose of this talk will be to highlight 3 areas of intense current research concerning human milk composition, as well as reviewing what is known about the effects of maternal diet and putative infant health outcomes. The first topic is the potential for human milk to be classified as a "symbiotic" food containing both pre- and probiotic constituents. Indeed, one of the most abundant components of human milk is a large and diverse group of complex carbohydrates (human milk oligosaccharides; HMO), which appear to be largely indigestible by the infant's intestinal enzymes but which may modulate healthy development of the infant's gastrointestinal (GI) microbes. Human milk oligosaccharides are also thought to impart health benefits via modulation of the immune system and direct interactions with pathogenic GI microbes. Some data also suggest that HMO might mediate microbial metabolism. Noteworthy, however, is the fact that the oligosaccharides currently added to some proprietary infant formulas are structurally quite different from those common in human milk; this likely has important functional health outcomes (or lack, thereof) for the recipient infant. Recent studies have also shown that human milk, even when produced by healthy women without signs or symptoms of mastitis, contains a rich and diverse community of bacteria. This finding, along with evidence that the human milk microbiome can be influenced by maternal probiotic consumption, suggests that consumption human milk might be particularly critical for establishing a healthy complement of GI microbiota during early life and that this effect may be modulated, at least in part, by maternal diet. Finally, research continues to support a strong and consistent effect of maternal diet on relative milk n-3 and n-6 fatty acid contents, although results of controlled clinical trials are mixed in terms of relating this variation to short- and long-term effects on infant health and wellbeing.

Key Words: human milk, oligosaccharides, microbiome

344 Increasing n-3 fatty acids in milk through pre- and post-harvest approaches: Challenges and opportunities. A. L. Lock*[1] and D. E. Bauman[2], *[1]Michigan State University, East Lansing, [2]Cornell University, Ithaca, NY.*

Milk fat is a complex mixture of saturated and unsaturated fatty acids (FA) and varies according to breed, season, stage of lactation, and nutrition of dairy cattle. The amount of omega-3 FA in milk, in particular 20:5 n-3 (EPA) and 22:6 n-3 (DHA), are of interest as they are beneficial in the maintenance of human health and prevention of chronic diseases. Enhancing their content in milk requires an understanding of the interrelationship between dietary supply of FA, rumen fermentation, and mammary gland synthesis. Milk fat content of n-3 FA is generally low (<0.5% total FA), and this is mainly 18:3 n-3 (ALA). EPA and DHA are typically present in very low amounts (<0.1% total FA). Efforts to increase n-3 FA have often involved feeding diets that have a high content of ALA (e.g., flaxseed, pasture). While this approach increases milk fat content of ALA, it has little effect on levels of EPA or DHA because of limited Δ^6-desaturase activity in the mammary gland of the cow. Humans also have limited Δ6-desaturase activity, hence there is increasing interest in the use of fish oils, fish byproducts, and marine algae in dairy cattle diets as sources of EPA and DHA, as well as plant sources of stearidonic acid (18:4 n-3), an n-3 FA that bypasses the Δ^6-desaturase reaction. Transfer of dietary EPA and DHA to milk fat, however, is very low (<4%); this is related to their biohydrogenation in the rumen and because they are not transported in plasma lipid fractions that serve as major mammary sources of FA uptake. Despite this, modest changes have been achievable, and in some markets specialty milk and dairy products are currently available that have been enriched with EPA and DHA. Claims of large percentage increases in n-3 FA in dairy products should, however, be considered with caution due to their initial very low levels. Opportunities for greater enrichment of n-3 FA will likely rely on post-harvest fortification of milk, if deemed desirable. Finally, it is import to recognize that all dairy products are an excellent source of nutrients for the human population regardless of n-3 FA content.

Key Words: human health, milk fat, n-3 fatty acid

345 Influence of dietary pro- and prebiotics on the bovine rumen microbiome and milk synthesis. K. Griswold*[1], K. Harvatine[2], and T. R. Callaway[3], *[1]Kemin Industries Inc., Des Moines, IA, [2]The Pennsylvania State University, University Park, [3]USDA-ARS, College Station, TX.*

There is tremendous interest in changing milk composition to improve potential health benefits to both newborn calves and humans. Synthesis of milk within the dairy cow is dependent on the supply of nutrients (e.g., AA, lactose, fatty acids, minerals) at any given point in time. The nutrient supply is heavily influenced by the rumen microbiome as up to 85% of animal's diet is altered or entirely converted by their metabolism. Therefore, altering the rumen microbiome through the use of probiotics, prebiotics, or both (synbiotics) represents a potential opportunity to alter milk synthesis and influence milk composition. Probiotics are, by definition, viable microorganisms or end products of their fermentation that when consumed in adequate amounts confer a health or performance benefit on the host. Prebiotics are host-indigestible ingredients that can be fermented by the gastrointestinal microbiota that result in specific changes in the composition and/or activity of the microbiota, thus conferring benefit(s) upon host health. The effect of pro- and prebiotics on milk synthesis by the dairy cow is complicated by the enormously intricate relationship between ruminal, liver and mammary gland metabolism. Therefore, our objective is to outline the short and long-term opportunities for manipulating milk synthesis with pro- and prebiotics and describe the challenges that must be overcome to both create repeatable, realistic changes in milk composition and develop market opportunities that will convince dairy producers to utilize pro- and prebiotics to this effect.

Key Words: probiotic, prebiotic, milk synthesis

346 Functional components in milk: Effects on processed dairy product quality and human health. S. Duncan*, *Virginia Tech, Blacksburg.*

Subtle changes in milk composition can have a significant effect on milk and dairy product quality and shelf life. As research progresses to better

understand the implications of maternal (bovine, human) nutrition on milk composition and role in infant nutrition, the implications on milk and dairy product quality and human health also must be considered. Changes in fatty acid composition and antioxidant capacity associated with an increase in n-3 fatty acids and polyphenolic compounds, respectively, can contribute to reducing the risk of some chronic diseases. These modifications can change physical properties and oxidative susceptibility of milk, influence milk flavor and texture characteristics, alter ingredient functionality in dairy-based and food products, and affect consumer perception of quality and health value. Polyphenolic components are recognized for antioxidant and antimicrobial functionality, which are valuable functions for protecting milk from oxidation and bacterial spoilage, yet are also commonly recognized for a bitter taste. Dietary sources may increase the concentration of photosensitive molecules, such as chlorophyll, in milk increasing the risk of light-induced oxidation. Modifications in rumen fermentations that increase unsaturated as well as short chain fatty acids, may lead to increased susceptibility to autoxidation and rancidity. Processing and packaging considerations for specialty products are needed to protect the healthful components as well as flavor of milk throughout shelf life.

Key Words: antioxidants, n-3, packaging