Introduction. P. Kindstedt*, University of Vermont, Burlington, VT.

This symposium is the second event to be hosted by the ADSA Dairy Foods Division International Partnership Program (IPP). The IPP arose out of a 2015 strategic initiative of the ADSA board of directors to strengthen the ADSA community for our international members. The Program seeks to accomplish this by partnering with outstanding international dairy research organizations to provide them with a venue to showcase a concentration of their work at our North American Annual Meetings. An equally important objective is to give our North American dairy scientists direct access to these overseas colleagues to facilitate personal connections, collaborations, the sharing of ideas, and a genuine sense of community and collegiality across international lines. The first international organization to collaborate with ADSA under the IPP has been the Teagasc-Moorepark Food Research Center in Ireland. In 2017, the IPP sponsored the Teagasc-Moorepark/University College Cork Cheese Symposium, which was held at the ADSA Annual Meeting and funded jointly by ADSA, Teagasc-Moorepark and University College Cork. Building on the success of the 2017 Cheese Symposium, ADSA and Teagasc-Moorepark are now strengthening their partnership by again jointly funding a day long Symposium which moves beyond cheese science into areas of animal diet and feeding regimen and how they affect dairy product quality, and nutrition and health aspects of dairy foods, areas that are of intense interest to dairy scientists worldwide. As this partnership continues to grow, new opportunities to cooperate, such as through IPP support of short-term PhD student international exchange visits, are beginning to be explored. Beyond this, the resounding success of this first partner experience has provided the IPP with a solid foundation to seek a second outstanding international research organization to join Teagasc-Moorepark to become a founding member of the IPP. Toward that end, efforts are underway to recruit a new partner with the goal of co-sponsoring an IPP Symposium event at the 2020 ADSA Annual Meeting.

Key Words: dairy, research, partnership


The “Profiling Milk From Grass study” carried out in Teagasc Moorepark, investigated the effects of pasture versus indoor TMR feeding systems on a variety of milk production, composition and quality attributes on a range of dairy products. The experiment had 3 treatments. Group 1 was housed indoors and fed a TMR diet of grass silage, maize silage and concentrates. Group 2 was exclusively fed grass on perennial ryegrass (Lolium perenne L.) only pasture (GRS), while Group 3 was also maintained outdoors perennial ryegrass/white clover (Trifolium repens L.) pasture (CLV). Feeding system was demonstrated to have a significant effect on the composition and quality of milk and subsequent products. Milk from pasture-based systems had greater fat and protein contents, and improved protein quality compared with milk from TMR. Feeding system was demonstrated to have a significant effect on the vitamin profile of milks. Pasture feeding had a beneficial impact on the fatty acid profile of milk and dairy products with increased concentrations of beneficial nutrients such as n-3 (omega-3) fatty acids, conjugated linoleic acid, vaccenic acid and reduced levels of palmitic acid, n-6 fatty acids and thrombogenicity index score than TMR. Alterations to the fatty acid content resulted in significant rheological differences of butter and Cheddar cheeses including textural properties and color. Pasture derived products were shown to have significantly greater contents of β-carotene, imparting a yellow color on products characteristic of Irish dairy products. Sensory analysis revealed a preference for dairy products derived from the pasture-based systems compared with the TMR-based system. The application of 1H-NMR to raw milks identified significant diet induced alterations to the milk metabolome and identified a variety of potential biomarkers of pasture derived milks. Furthermore, fatty acid profiling and 1H-NMR metabolomics coupled with multivariate analysis demonstrated being capable of distinguishing both rumen-fluid and milk derived from cows on different feeding systems, specifically between indoor TMR and pasture-based diets used in this study.

Factors influencing the flavor of bovine milk and cheese from grass-based versus TMR-based milk production systems. K. Kilcawley*, Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork, Ireland.

The impact of diet on the sensory properties of bovine milk and dairy products is complex due to the wide range of on farm and production factors that are potentially involved. It is well established that pasture affects the color of milk and dairy products due to β-carotene content, and that nutritional and potentially textural properties are altered due to dietary factors influencing fat synthesis. Very little research has been undertaken on aromatic volatile compounds derived from diet that may affect sensory perception. It is obvious that any potential effect depends upon their concentration and odor activity. We have found evidence of direct transfer (digestion/absorption or inhalation), and indirect transfer (rumen metabolism) of volatiles and via secondary mechanisms (lipid oxidation, Maillard reactions, de novo synthesis) for volatile incorporation into bovine milk. We found 3 volatile compounds present at higher levels in milk derived from pasture; toluene, dimethyl sulfone and p-cresol, that may be potential biomarkers for pasture feeding based on concentration. In our studies only p-cresol affected flavor, which has a ‘barnyard’ or ‘cowy’ attribute and is derived from the rumen metabolism of β-carotene and aromatic acids which are higher in pasture diets, but also from the rumen metabolism of isoflavones present in clover. We are also aware that US consumers have a lower threshold for this ‘barnyard’ ‘cowy’ attribute than Irish and Chinese consumers.


In response to growing consumer interest in pasture fed dairy products, research was conducted on the characteristics of Continental type-cheese derived from milks produced from cows fed indoors on total mixed ration (TMR), or pasture fed cows on grass only (GRA) or grass mixed with clover (CLO). A preliminary study showed that the curd moisture loss rate constant (k/min) was similar for curds from protein-standardised TMR, CLO and GRA milks, showing minimal feed-induced variations
in syneresis. Maasdam cheeses manufactured from standardized milks derived from the feeding systems showed that pasture-derived cheeses had significantly lower L* (whiteness) and higher b* values (yellowness) compared to TMR-derived cheeses. Acetate levels were significantly lower in CLO and butyrate levels significantly higher in TMR compared to the other cheeses. Grass-fed cheese had significantly higher scores for smooth texture, ivory color and shiny appearance compared to TMR. The influence of feed type was minimal on cheese yield, composition and on indices of glycolysis, lipolysis and proteolysis during ripening. The untargeted metabolic profiles of the ripened Maasdam cheese samples were profiled using high-resolution nuclear magnetic resonance (1H NMR), high-resolution magic angle spinning NMR (1H HRMAS NMR) and headspace (HS) gas chromatography mass spectrometry (GC-MS). On comparing the 1H NMR metabolic profiles, TMR-derived cheese had higher levels of citrate compared to GRA-derived cheese. The major differences between outdoor or indoor feeding system on cheese metabolites were detected in the lipid phase, as indicated by 1H HRMAS NMR. The toulene content of cheese was significantly higher in GRA or CLO compared with TMR cheeses and dimethyl sulfide was identified only in CLO-derived cheese samples as detected using HS GC-MS. Overall, this study shows that once milk is standardized, cheese manufacture, composition and yield properties are not influenced by herd diet while certain sensory characteristics and a small number of compounds and lipid derived metabolites differ.


Milk is an ideal nutritional base for lifestyle beverages, providing both functionality and basic nutrition. It is a complete food source, containing all the major macro- and micro-nutrients, i.e., protein, fat, carbohydrate, minerals and vitamins needed to formulate nutritional, therapeutic and medical and/or sports beverages. Researchers at Teagasc have studied the effect of the interaction between composition and processing parameters on in-process and finished product functionality, and identified the key constraints to beverage manufacture. Studies have demonstrated that feed type (e.g., grass fed), stage of lactation and milk quality influence the formulation dynamics of dairy-based beverages. Selection of protein ingredients, and knowledge of their thermal history, is key to optimising functionality in the final reconstituted formulation. For example, increasing the α-lactalbumin to β-lactoglobulin ratio of a first stage infant formulation (i.e., 1.3% protein (60:40 casein:whey) 7.4% lactose and 3.4% fat) resulted in a significant (P < 0.05) reduction in powder particle PSD D(4,3) size and viscosity of the reconstituted formulation. In addition, increasing α-lactalbumin content reduced the rate of thermal gelation on addition of calcium and magnesium. Other strategic priorities at Teagasc include adoption of technology to create a “digital dairy” platform of research within the food program. This area includes food biomechanics, digital mapping and virtual / augmented reality applications for visualization of internal powder structure. When coupled with formulation strategies, the continued integration of digital technology is seen as a significant development for the dairy-based nutritional beverage sector.


Oligosaccharides are the third most abundant component in human milk. It is widely accepted that they play several important protective, physiological, and biological roles including selective growth stimulation for beneficial gut microbiota, inhibition of pathogen adhesion and immune-modulation. However, until recently, very few commercial products on the market capitalized on these functions. This is mainly because the quantities of human milk oligosaccharides required for clinical trials have been unavailable. Recently, clinical studies have tested the potential beneficial effects of feeding infants formula containing 2'-fucosylactose, the most abundant HMO in human milk. These studies have opened this field for further well-designed studies which are required to fully understand the role of HMO. However, one of the most striking features of human milk is its diversity of oligosaccharides with over 150 identified to date. It may be that a mixture of oligosaccharides is even more beneficial to the infant than a single structure. For this reason, the milk of domestic animals has become a focal point in recent years as an alternative source of complex oligosaccharides with associated biological activity. Bovine milk is an ideal candidate, given its wide availability and its use in so many regularly consumed dairy products. The carbohydrate fraction of bovine milk is divided into lactose, free oligosaccharides and bound glycans or glycoconjugates. This presentation will focus specifically on free oligosaccharides and glycosylated bovine milk proteins and the biological roles associated with such structures. A major area of interest is the effect of milk glycans on host-microbial interactions in the gut. For instance, glycosylated components in milk are known to alter intestinal glycosylation, which in turn contributes to early immune development and maturation of the newborn intestinal tract. Strategies to increase the colonisation of infant-associated bifidobacteria have been extensively investigated in recent years with promising results.

438 Relationships between structures of dairy-based matrices and digestibility within the gastrointestinal tract. A. Brodkorb*, Teagasc Food Research Centre Moorepark, Fermoy, Co. Cork, Ireland.

Milk proteins are the main structural components of dairy and dairy-containing foods. Their molecular structure and aggregation behavior can be tuned by targeted, “smart” processing. Whey proteins, previously considered a low-value by-product from cheese production, exhibit a globular molecular structure, and are prone to unfolding and self-aggregation or association with caseins or casein micelles. This can be either detrimental or advantageous for food processing. In this talk, several examples are given on how to understand, control and modify the structure of milk proteins, thereby adding value. Rapid pilot scale, pre-heat treatments of whey proteins can improve the standard processability and/or efficiency of the enzymatic hydrolysis of protein products. This will benefit down-stream production of nutritional products such as infant formula, sports nutrition, and nutrition for the elderly. Changes in processing conditions can also affect the gastro-intestinal transit of dairy proteins and accelerate or delay the bioaccessibility of nutrients,
as demonstrated by static (Brodkorb et al., Nature Protocols 2019) or semi-dynamic in vitro digestion methods (Mulet-Cabero et al., Food Hydrocolloids, 2018). In particular, heat treatment and homogenization can have a profound effect on the mechanism and kinetics of in vitro and in vivo gastro-intestinal digestion of dairy proteins, due to gastric restructuring. Dairy proteins can also act as carriers for labile, bioactive components of food to protect or encapsulate them during food production, storage or the harsh environment of the gastrointestinal tract (in vivo and in vitro, Doherty et al., International Dairy Journal 2012).

439  Metagenomic and metabolomic analysis of the impact of exercise or whey protein supplementation on the gut microbiome. W. Barton*, Teagasc Food Research Centre Moorepark, Fermoy, Co. Cork, Ireland.

The intestinal microbiome has become intensely investigated as its role in health has become increasingly evident. An important factor of understanding the gut microbiome lies in unravelling the means by which it may be modulated. Although parameters such as diet, medication use, and living environment are well established as modifiers of the microbiome, recent evidence suggests a role of physical activity (i.e., exercise) as one such factor. In conjunction with novel insights on dietary contributions, the session will present evidence for physical activity and whey protein supplementation as influencing agents of the structure and function of the human gut microbiome.

440  Dairy matrix effects: Response to consumption of dairy fat differs when eaten within the cheese matrix. E. Gibney*, University College Dublin, Belfield, Dublin, Ireland.

Evidence suggests the association between intake of saturated fat and risk of heart disease is dependent on the food sources of the dietary fat, with much work focused on the impact of saturated fat from dairy and in particular cheese on markers of metabolic health and risk of CVD. Several published randomized controlled trials (RCT) have demonstrated a beneficial effect of cheese consumption on markers of metabolic health and CVD risk. Research conducted within UCD has both supported and added to the existing evidence. A 6-wk randomized parallel intervention involving 164 volunteers who received ~40 g of dairy fat/d, in 1 of 4 treatments: (A) 120 g full-fat Irish cheddar cheese (n = 46); (B) 120 g reduced-fat Irish cheddar cheese + butter (21 g) (n = 45); (C) butter (49 g), calcium caseinate powder (30 g), and Ca supplement (CaCO3) (500 mg) (n = 42); or (D) 120 g full-fat Irish cheddar cheese, for 6 weeks following completion of a 6-wk “run-in” period, where this excluded all dietary cheese before commencing the intervention, was undertaken–delayed intervention group. This study found a stepwise-matrix effect was observed between the groups for total cholesterol (TC) (P = 0.033) and LDL cholesterol (LDL-C) (P = 0.026), with significantly lower post intervention TC (mean ± SD) (5.23 ± 0.88 mmol/L) and LDL-C (2.97 ± 0.67 mmol/L) when all of the fat was contained within the cheese matrix (Group A), compared with Group C, when it was not (TC: 5.57 ± 0.86 mmol/L; LDL-C: 3.43 ± 0.78 mmol/L). These findings suggest that dairy fat, when eaten in the form of cheese, appears to differently affect blood lipids compared with the same constituents eaten in different matrices, with significantly lower total cholesterol observed when all nutrients are consumed within a cheese matrix. There is a need to further understand this research in the context of both public health and industry needs, and to elucidate the components of the cheese matrix causing these effects.