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FACE Conference 2023

Opportunities and risks for raw milk products

A Scientific synthesis of the 2023 Conference of the FACEnetwork

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Content

Zusammenfassung

Das Kompetenzzentrum für Rohmilchprodukte, welches im Jahr 2021 gemeinsam von Agroscope und dem Kanton Freiburg in enger Zusammenarbeit mit der schweizerischen Milch- und Käsebranche gegründet wurde, war 2023 Gastgeberin für das 3-tägige Jahresmeeting von FACEnetwork. Der Anlass fand vom 11. – 13. Oktober in Grangeneuve, Kanton Freiburg, statt. Er beinhaltete eine wissenschaftliche Konferenz und ein buntes und reich befrachtetes Rahmenprogramm mit Besichtigungen, praktischen und theoretischen Workshops, Informationsständen sowie dem europäischen Käsebuffet.

Die wissenschaftliche Konferenz beleuchtete verschiedene Aspekte zum Thema «Rohmilch und Rohmilchprodukte». Es konnte gezeigt werden, dass das Wissen und Können vorhanden sind, um sichere und qualitativ hochwertige Rohmilchprodukte herzustellen. Die Herstellung von Rohmilchprodukten aus graslandbasierter Milch ist ein nachhaltiger Weg, um für Menschen nicht essbare Biomasse in hochwertige Lebensmittel umzuwandeln. Diese Umwandlung ist für die weltweite Ernährungssicherheit unerlässlich. Bei der Milchproduktion und -verarbeitung gibt es viele Möglichkeiten, um die Nachhaltigkeit weiter zu verbessern. Es gibt immer mehr Studien, die einen anti-allergenen Effekt von Rohmilch und Rohmilchprodukten belegen. Der Allergieschutz beruht einerseits auf der Versorgung der Immunzellen mit Mikronährstoffen durch native beladene Molkenproteine wie das β-Laktoglobulin über die Lymphe, und andererseits auf nativen bioaktiven Molkenproteinen wie die alkalische Phosphatase und das Laktoferrin. Auch die allermeisten Mikroorganismen können sich positiv auf das Immunsystem auswirken. Hohe und einseitige Anforderungen an die Qualität der Rohmilch haben zu einer unerwünschten Verarmung der mikrobiellen Biodiversität in der Rohmilch und den Rohmilchprodukten geführt. Es braucht neue Wege, um diesen Trend zu stoppen und umzukehren.

Résumé

Le Centre de compétences sur les produits laitiers à base de lait cru, créé conjointement par Agroscope et le canton de Fribourg en étroite collaboration avec la branche laitière et fromagère suisse en 2021, a accueilli en 2023 le congrès annuel de FACEnetwork. Il s'est déroulé du 11 au 13 octobre à Grangeneuve, dans le canton de Fribourg, et comprenait des conférences scientifiques et un programme-cadre riche et varié avec des visites, des ateliers pratiques et théoriques, des stands d'information ainsi qu'un buffet européen du fromage.

Les conférences scientifiques ont mis en lumière différents aspects sur le thème du lait cru et des produits à base de lait cru. Il a pu être démontré que les connaissances et le savoir-faire sont disponibles pour fabriquer des produits au lait cru sûrs et de haute qualité. La fabrication de produits laitiers crus basée sur les herbages est une voie durable pour transformer la biomasse non comestible en aliments de qualité. Cette transformation est essentielle pour la sécurité alimentaire mondiale. Il existe de nombreuses possibilités d'améliorer encore la durabilité dans la production et la transformation du lait. De plus en plus d'études démontrent un effet anti-allergène du lait cru et des produits à base de lait cru. La protection contre les allergies repose d'une part sur l'apport de micronutriments aux cellules immunitaires par des protéines natives du petit-lait au travers du système lymphatique, comme la β-lactoglobuline et, d'autre part, sur des protéines bioactives natives du petit-lait comme la phosphatase alcaline et la lactoferrine. La grande majorité des micro-organismes peuvent également avoir un effet positif sur le système immunitaire. Des exigences élevées et déséquilibrées en matière de qualité du lait cru ont entraîné un appauvrissement indésirable de la biodiversité microbienne dans le lait cru et les produits à base de lait cru. De nouvelles voies sont nécessaires pour stopper et inverser cette tendance.

Summary

The Centre of Excellence for Raw-Milk Products, established jointly in 2021 by Agroscope and the Canton of Fribourg in close partnership with the Swiss dairy and cheese sector, hosted the three-day annual conference of FACEnetwork in 2023. The event, which took place from 11-13 October in Grangeneuve, Canton of Fribourg, included a scientific conference as well as a packed and varied supporting programme with tours, practical and theoretical workshops, information stands and the European Cheese Buffet.

The scientific conference shed light on various aspects of the topic 'Raw Milk and Raw-Milk Products'. It succeeded in showing that the knowledge and skills are available to produce safe, high-quality raw-milk products. Producing raw-milk products from grassland-based milk is a sustainable way for humans to transform non-edible biomass into high-quality food. This transformation is essential for global food security. In milk production and processing, there are many ways to further improve sustainability. There are more and more studies attesting to an anti-allergenic effect of raw milk and raw-milk products. The protection against allergy is conferred on the one hand by the supply of the immune cells with micronutrients by native charged whey proteins such as β-lactoglobulin via the lymph, and on the other hand by native bioactive whey proteins such as alkaline phosphatase and lactoferrin. In addition, the vast majority of microorganisms can have a positive effect on the immune system. High and one-sided requirements regarding raw-milk quality have led to an unwelcome impoverishment of microbial biodiversity in raw milk and raw-milk products. New approaches are needed to halt and reverse this trend.

Riassunto

Dall'11 al 13 ottobre 2023 il centro di competenze Prodotti a base di latte crudo, fondato nel 2021 da Agroscope e dal Cantone di Friburgo in stretta collaborazione con la filiera lattiero-casearia, ha ospitato a Grangeneuve (FR) l'incontro annuale di FACEnetwork. Il programma prevedeva una conferenza scientifica e un programma collaterale ricco e articolato con visite guidate, laboratori teorici e pratici, chioschi informativi e un buffet di formaggi europei.

La conferenza scientifica si è concentrata su vari aspetti legati al latte crudo e ai prodotti a base di latte crudo e ha evidenziato che grazie alle conoscenze e competenze disponibili è possibile fabbricare prodotti a base di latte crudo sicuri e di alta qualità. La loro preparazione con latte proveniente da superfici inerbite è una soluzione sostenibile per trasformare la biomassa non commestibile per l'uomo in alimenti di qualità: una conversione essenziale per la sicurezza alimentare globale. Esistono molti modi per migliorare ulteriormente la sostenibilità della produzione e trasformazione del latte e sempre più studi dimostrano che il latte crudo e i prodotti a base di latte crudo esercitano un effetto antiallergico. Questa prevenzione delle allergie si basa sull'apporto di micronutrienti alle cellule immunitarie attraverso le proteine native del siero di latte come la β-lattoglobulina (mediante la linfa) e sulle proteine native bioattive del siero di latte come la fosfatasi alcalina e la lattoferrina. Anche la maggior parte dei microrganismi può avere un effetto positivo sul sistema immunitario. Requisiti di qualità del latte crudo elevati e unilaterali hanno determinato un indebolimento indesiderato della biodiversità microbica di questa materia prima e dei prodotti derivati. Sono ora necessari nuovi approcci per fermare e invertire questa tendenza.

1 Introduction

It began in 2006 as an exchange of practical information among German and French farmhouse cheesemakers and has gradually evolved into a significant European network. Artisan producers of cheese and dairy products now work together on areas of common concern such as hygiene regulations, preserving traditional knowledge, sharing experiences, difficulties for small-scale dairies and the need for a flexible and scientific approach to the development and application of regulations.

The FACEnetwork was founded in 2013 with the aim of championing the interests of farmhouse and artisan cheese and dairy producers at national and European level. FACE stands for '**F**armhouse and **A**rtisan **C**heese & Dairy Producers **E**uropean Network'. Today, the FACEnetwork represents cheesemakers from 15 European countries, along with 15 supporting members ranging from technical centres, research institutes and associations to laboratories and health authorities.

Switzerland joined the network in 2020 through Fromarte (the umbrella association for Swiss cheesemakers) and supporting members Grangeneuve and Agroscope. In 2021, Agroscope and the Canton of Fribourg together founded the Centre of Excellence for Raw Milk Products in close partnership with the Swiss dairy and cheese sector. Through their joint research, they aim to create new synergies, increase the added value of raw milk products and ensure that there are no increased risks associated with their consumption. The Centre of Excellence hosted the three-day annual congress of the FACEnetwork in 2023. The event, which took place from 11-13 October in Grangeneuve, included a scientific conference as well as a packed and varied programme with tours, practical and theoretical workshops, information stands and a grand buffet of European cheeses. The scientific conference shed light on four different aspects of 'Raw Milk and Raw Milk Products':

- Safety and quality
- Sustainability
- Health effects
- Microbial biodiversity

The annual congress jointly organised by Fromarte, Grangeneuve and Agroscope adopted the motto 'Roh-Cru-Raw' to reflect the subject matter and the main languages of the event: German, French and English (Figures 1.1 and 1.2).

Figure 1.1: Agroscope created an eye-catching logo for the conference

Figure 1.2: The event attracted 240 participants from 17 different countries

The annual congress is well documented on the Internet: https://meeting2023.face-network.eu/.

The website https://www.rohcruraw.ch/ will continue to deliver different activities on the subject of raw milk products to a wider audience.

The scientific conference was organised and presented by the Scientific Programme Committee, comprising the three authors of this Agroscope Science paper (Figure 1.3). One of the many highlights was the opening address given by Daniela Weber (Figure 1.4).

Figure 1.3: The Scientific Programme Committee

From left to right: Hans-Peter Bachmann, Marie-Therese Fröhlich-Wyder and Walter Bisig

Figure 1.4: Daniela Weber, master cheesemaker from Düdingen, gave an impressive opening address

2 Safety and quality

2.1 Presentation by Catherine Donnelly on the war against artisan cheeses

Catherine Donnelly (Figure 2.1), Emeritus Professor of the University of Vermont (USA), world-renowned expert on the behaviour of *Listeria monocytogenes* in food and co-director of the Vermont Institute for Artisan Cheese from 2004 – 2016, spoke about her latest book in her presentation (Figure 2.2).

The thoroughly well-researched and documented book gives revealing insights into US government overreach and the struggle to save traditional raw milk cheesemaking. Over the past 25 years, the US Food and Drug Administration (FDA) "*has waged a punishing war against artisan cheeses, both domestic and imported"* (Quotation C. Donnelly).

The FDA has attempted to ban the use of raw milk in cheesemaking and instead require pasteurisation. It has also tried to ban the use of wooden boards for cheese ripening. Many traditional varieties of cheeses made from both raw and pasteurised milk are aged on wooden boards in order to regulate the moisture content and surface microflora and allow the flavour and character of the cheese to develop.

Figure 2.1: Franziska Roth-Walter, Hans-Peter Bachmann and Catherine Donnelly

(from left to right; during a visit to the Cheese Grotto in Gstaad; see Chapter 4.1)

The FDA has also put in place stringent standards for *Escherichia coli* which many artisan cheeses, regardless of whether they are made from raw or pasteurised milk, simply cannot meet.

According to Catherine Donnelly, these interventions are thought to be part of the FDA's repeated efforts to help US industrial cheese giants fight a trade war with Europe over the protection of cheese names (e.g., Gruyère, Emmental and Parmesan). Furthermore, the imposition of these standards is seen as a mean of suppressing the emergence of artisan cheeses produced in the US itself.

Fortunately, various members of the US Congress came to the aid of artisan cheesemakers because science was on their side, and the FDA was unable to scientifically defend its position on wooden boards, *E. coli* criteria, and the use of unpasteurised milk in cheesemaking. Congressional oversight was essential to get the FDA to step back from proposed regulations that would have made it extremely difficult, if not impossible, for artisan cheeses from the US and Europe to gain a foothold on the market.

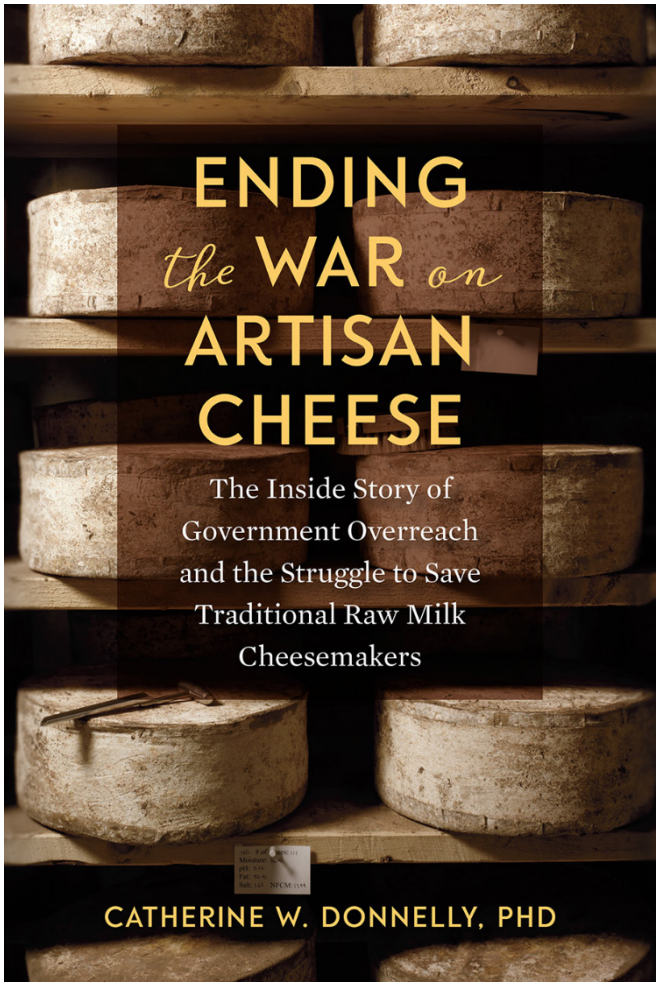

Figure 2.2: Front cover of the book 'Ending the War on Artisan Cheese' by Catherine Donnelly

(ISBN: 9781603587853)

The FDA was given far-reaching additional regulatory powers under the 2011 Food Safety Modernization Act (FSMA) which enabled it to adopt a preventive approach to the problems of food safety and establish food safety standards. The debate around raw milk cheese offers an in-depth insight into the workings of the FDA. Perhaps trade and special interests rather than science and public health lay at the heart of the FDA's regulations aimed at artisan cheesemakers.

As evidenced by the investigative book *Ending the War on Artisan Cheese*, authorities must be held accountable if they introduce standards for which there is no scientific justification. In Catherine Donnelly's view, there is a pressing need for specific standards for artisan cheeses that are grounded in science and thus support food safety as well as promoting the preservation of traditional products and precious rural working landscapes in the US and across the globe. *"Our food culture and the freedom to choose what we eat are at stake".*

2.2 Presentation by Hans-Peter Bachmann on the safety and quality of raw milk cheeses

'Safety and quality of raw milk cheeses: Two sides of the same medal is the title of the lecture given by Hans-Peter Bachmann (Figure 2.1), scientific project manager at Agroscope. The title refers to the scientific hypothesis which was tested with *Staphylococcus aureus*. This bacterium was selected because it is the most widespread pathogen in cheese made from raw milk. Due to its significance, it is also one of the process hygiene criteria stipulated in legal requirements in the EU and Switzerland. Yet *S. aureus* is not only a problem for food safety, but for animal welfare and cheese quality as well. What's more, it leads to high avoidable costs. The contagious genotypes cause the biggest problems, with genotype B (GTB) being the most common by far in Switzerland and surrounding countries.

For this reason, Agroscope, in collaboration with research partners, has developed a highly specific routine method for detecting GTB, and a practical sanitation plan for infected cow herds. Strict compliance with a defined milking sequence and twice daily cleaning of the entire milking system in accordance with the manufacturer's instructions have proved to be the most effective measures. The sanitation plan was applied with great success, first on individual farms and then with all 165 herds in the Canton of Ticino. At the start of sanitation in 2017, 37% of herds tested positive. By 2018 this figure had fallen to 8% and since 2019, no GTB-induced mastitis has been detected in Ticino.

The enormous success of these sanitation measures was achieved within 20 months, with a very high cure rate of 93%. No enterotoxins have been found in cheese from Ticino since 2018. As a result, the cheesemakers today are

much more confident of being able to produce top quality cheese. The satisfaction rate too is high: 97% of participants would carry out the sanitation measures again.

The next goal must now be to get cow herds free of *S.aureus* GTB throughout Switzerland, and ideally the neighbouring countries as well. This would be good for our cows, our raw milk cheese, our health and our purse. Thus, the scientific hypothesis in the title is correct. The talk concluded with four take-home messages:

1. Raw milk cheese must claim quality leadership for itself; there is so much to be gained in terms of food safety.
2. It is possible to keep livestock free of *Staphylococcus aureus* GTB. Everyone benefits if we work consistently towards this goal.
3. To produce high quality, safe raw milk cheeses, a holistic production system is needed that must be continuously maintained and adapted to the increasing requirements.
4. Raw milk cheese is often sold below its value today because retailers and consumers have little understanding of the complexities of its production system and the benefits of higher microbial biodiversity and richer flavours.

Hans Graber, retired head of mastitis research at Agroscope, co-authored this talk (Figure 2.3). His pioneering work on developing the new detection method for *S. aureus* GTB and the sanitation plan based on it has received high international recognition. He was supported by the Federal Food Safety and Veterinary Office (FSVO), the Vetsuisse Faculty at the University of Bern, the Canton of Ticino and many Agroscope colleagues.

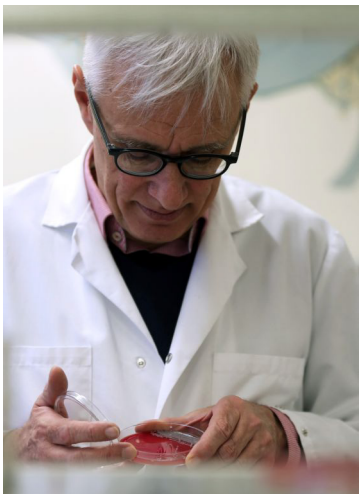

Figure 2.3: Hans Graber

2.3 Poster presentations

The ‘Safety and Quality’ session featured twelve poster presentations – more than any other session, highlighting the shear breadth and importance of the topic. Two posters shed light on the role of biogenic amines. Darnay and Austheim’s poster – awarded ‘first runner-up’ – used a literature review to compare different varieties of cheese made from raw and pasteurised cow’s, ewe’s and goat’s milk as well as cheeses with different ripening periods in order to illustrate the role of factors which can have an important influence on the formation of biogenic amines.

Dreier *et al*. in their study of Vacherin Fribourgeois AOP, a cheese from the region hosting the conference, showed that season has a significant influence on the formation of tyramine, the amine detected the most often in this cheese variety: the highest concentrations were found in cheese produced from raw milk in summer (Figure 2.4), presumably due to the proliferation of raw milk microbiota at higher temperatures.

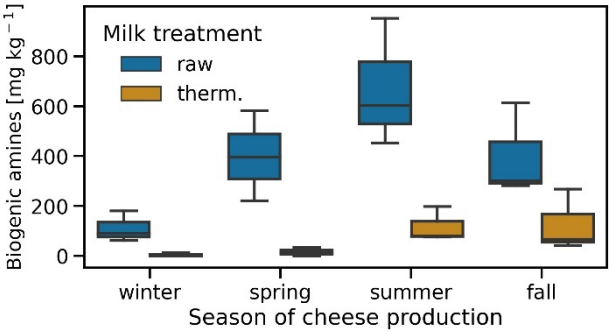

Figure 2.4: Biogenic amine in Vacherin Fribourgeois AOP (n = 24) from raw and thermised milk

The microbiological safety of yoghurt made from raw milk was the subject of a Bachelor thesis by Berger *et al.* They demonstrated that an acidic yoghurt can be safely produced from raw milk (Figure 2.5); but cautioned that it was important to monitor levels of Shiga toxin-producing *E. coli* (STEC) in raw milk.

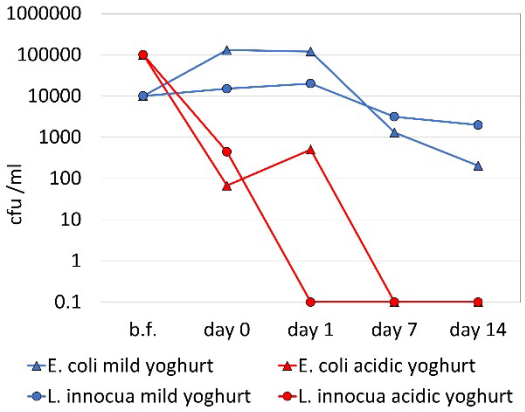

Figure 2.5: Bacterial count of Escherichia coli *and* Listeria innocua *in mild and acidic yoghurt*

Bacteriocin-producing lactic acid bacteria can contribute to the safety and quality of cheese. Morandi *et al.* studied four *Lactococcus lactis* strains and one *Lactococcus cremoris* strain which naturally contain one or more genes involved in the formation of bacteriocins under conditions similar to those used in cheesemaking. Only the *Lc. lactis* strain, which contains several genes, was able to produce enough bacteriocins to inhibit the growth of *Clostridium tyrobutyricum* under these conditions.

Analytical and sensory features can be used to describe and characterise the quality of cheese. Using controlled machine learning algorithms, Fröhlich-Wyder *et al.* were able to classify ten different varieties of Swiss raw milk cheese and define their typical composition based on their content of volatile carboxylic acids. This promising approach has received little attention so far in research of traditional cheeses. Guggenbühl *et al.* carried out a sensory test with 245 consumers who were asked to judge young and mature Vacherin Fribourgeois AOP made from raw and thermised milk. The majority of respondents expressed a clear preference for young cheese. In another study using the same cheese variety, Dreier *et al.* showed that the milk treatment also has a major influence on the texture (core characteristics): cheeses made from thermised milk were firmer than those made from raw milk; and even firmer in winter. Microbial diversity is another aspect that can shape the character of a cheese – especially artisan raw milk cheese, which is predestined to have high diversity. However, the bacterial diversity of Bernese Alpine Cheese (Berner Alpkäse AOP) is surprisingly low compared with the findings for raw milk, as demonstrated by Schmidt *et al.* in their poster. It would appear that the majority of raw milk microbiota are unable to survive the high scalding temperatures. Despite this, sensory diversity remains high.

In their poster about Tomme de Savoie PGI, Ducrey *et al.* describe how more stringent raw milk hygiene standards in recent years have contributed to a significant reduction in microbial diversity. For this reason, there is high demand for cultures containing isolates from raw milk. But before you can grow the 'right' cultures, you have to know what the cheese variety in question consists of. The research group used sensory, biochemical and chemical analysis to describe the cheese variety Tomme de Savoie PGI and to identify some of the responsible metabolic pathways. They counted 42,769 metabolic compounds – a clear illustration of the complexity of the raw milk cheese system.

The technological steps in cheesemaking still play a key role in the safety and quality of cheese. As part of the European Innovation Partnership (EIP) project *Hessischer Hofkäse* (Hessian Farmhouse Cheese), Schwaiger listed the technical parameters for fresh, soft, semi-hard and hard cheese in a clearly arranged table. The table serves as a guide and can be adapted as required. This poster addresses the important topic of knowledge transfer. The challenge is to feed relevant research findings into guidance and practice. The cheese database http://www.kaesefehlerdatenbank.de/ is a good example of how this can be done. In their poster, Lauber Fürst *et al.* presented an EU project which aims to transfer knowledge within a broad consortium. Ultimately, however, it is not just about existing knowledge or new insights in cheesemaking, but innovation as well.

And the theme of innovation aptly rounds off the presentation of posters in the 'Safety and Quality' session: in their poster Stoffers *et al.* demonstrated a new take on smear ripening using a removable fabric wrapping (Figure 2.6).

Figure 2.6: Removing the biodegradable wrapping from a Raclette cheese (Photo Agroscope)

3 Sustainability

3.1 Presentation by Urs Niggli on the role of sustainable grassland management

Urs Niggli (Figure 3.1) gave a talk on the role of sustainable grassland management for food security and the conservation of natural resources. He is one of the world's foremost agricultural scientists and was long-standing Director of the Research Institute of Organic Agriculture (FiBL) until March 2020. Among his many activities, he is currently President of the Institute of Agroecology (agroecology.science).

52% of the global utilised agricultural area, amounting to 4.8 billion hectares, is used to produce feed for livestock (ruminants and monogastrics). 26% is permanent grassland which cannot be converted to arable land. 14% is grass leys grown in crop rotations which perform a threefold function: providing fodder for ruminants, improving soil fertility and fixing nitrogen.

Permanent grassland stores 63.5 million tonnes of CO_2, which corresponds to 20% of the world's soil organic carbon (Figure 3.2). Sustainable management (recycling of manure, adjustments to stocking densities, avoidance of overgrazing) can provide an estimated additional carbon storage potential of 0.3 t CO_2/ha/year.

Grassland is also a hotspot for below- and above-ground biodiversity. Sustainable grazing by cattle is one of the most effective means of further improving it. In contrast, ruminants emit 2.8 Gt CO_2 equivalents per year (CH_4 converted to CO_2 equivalents) through enteric fermentation, amounting to 5% of total anthropogenic greenhouse gas emissions (2019: 51.7 Gt CO_2 equivalents). According to Urs Niggli, plant-based proteins require only half as much land as milk and 20 times less land than meat. Total water consumption also favours plant-based proteins. Since ruminants are reared only on rain-fed grassland, 'blue water' consumption (from irrigation) is important; in this case ruminants produce more efficiently than legumes.

It is estimated that one billion people live directly from livestock farming, many of them smallholders.

Figure 3.1: Urs Niggli in the home of Austrian pioneer of organic farming Gerhard Zoubek in Glinzendorf

(Photo: Mafalda Rakos)

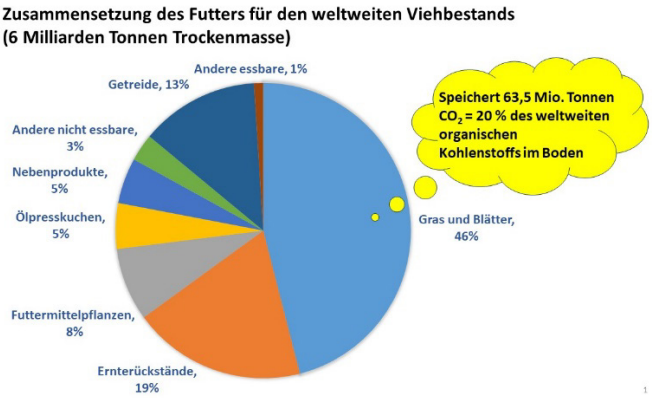

Figure 3.2: Composition of the global livestock diet

(from A. Mottet A, C. de Haan, A. Falcucci, G. Tempio, C. Opio, P. Gerber (2017) Livestock: On our plates or eating at our table? A new analysis of the feed/food debate. Global Food Sec. 14, 1–8.)

Animal-derived foods supply a significant proportion of nutrients and micronutrients in the human diet – and in high quality, density and bioavailability. The conversion of huge swathes of permanent grassland to proteins, energy and micronutrients available to humans makes a significant contribution to food security. Therefore, ruminants are part of a sustainable food system, while the role of monogastrics should be reduced and reserved mainly for the utilisation of food loss and agricultural byproducts.

Urs Niggli concluded his talk with six powerful conclusions:

1. The challenge of feeding 9 to 10 billion people is huge.
2. Sufficiency (sustainable consumption), veganism and organic farming can contribute to solving the problem, but they are unrealistic for agriculture as a whole or overestimated.
3. Grassland – although inefficient to convert – is an irreplaceable natural source of protein, micronutrients and energy.
4. Ruminants can convert biomass that humans cannot eat; therefore, dairy products are essential for food security.
5. Sustainable grassland is an important carbon store and a hotspot for biodiversity.
6. Meat consumption – mainly from monogastric animals – should be significantly reduced.

3.2 Presentation by Elisabeth Eugster on the sustainability of artisanal cheese dairies

Sustainability is becoming increasingly relevant for food marketing and is a hot topic on the international competitive arena. Consumers worldwide have high expectations of food production and processing when it comes to the environment, animal welfare and fair working conditions. Elisabeth Eugster (Figure 3.3), Head of Food Science & Management at the School of Agricultural, Forest and Food Sciences HAFL in her talk presented a 'Guide for sustainability in artisanal cheese dairies in Switzerland'.

Numerous sustainability programmes already exist in the dairy sector, both at international and national level. However, these programmes tend to focus mainly on the sustainability aspects of milk production and less so on milk processing. If one looks at the value chain for cheese, it is certainly true that milk production has the greatest environmental impact. However, various aspects are relevant to sustainability at the level of artisan milk processing as well. A sustainability guide for cheese dairies has been developed in close cooperation with Fromarte, the umbrella association for Swiss cheesemakers, which identifies relevant indicators for measuring sustainability in the cheese value chain and proposes possible measures. Sustainability is measured on the basis of the SAFA guidelines (SAFA = Sustainability Assessment of Food and Agriculture systems) drawn up by the United Nations Food and Agriculture Organisation (FAO) in 2014 (Figure 3.4).

Figure 3.3: The two speakers Elisabeth Eugster and Betty van Esch at the European Cheese Buffet (from left to right, see Chapter 4.2)

Sixteen relevant sustainability criteria along the four sustainability dimensions (1) environment, (2) economy, (3) social and (4) governance were identified and concrete, pragmatic targets defined for each of them. The indicators ensure that artisan cheesemakers can measure and continuously improve their environmental integrity, economic resilience, social well-being in their respective settings and good governance. The presentation focussed on the development of the guide, its implementation and its impact on the cheese sector. Feedback from cheesemakers confirms that the guide is very useful for self-evaluation and raising awareness of the different aspects of sustainability. Unfortunately, however, the guide is still relatively unknown in the industry and consequently

rarely used. Despite this, it will continue to be used on a voluntary basis in the future. Better communication of the benefits such as self-assessment, benchmarking, awareness-raising and continuous improvement should help attract more users and increase the overall credibility of artisan milk processing in terms of sustainability.

Jan Lemola and Matthias Meier, experts in assessing the sustainability of food systems at HAFL, co-authored this presentation.

Figure 3.4: The four sustainability dimensions of the SAFA guidelines
(SAFA = Sustainability Assessment of Food and Agriculture systems)

3.3 Poster presentations

Bettera *et al.* (Figure 5.3) in partnership with the University of Parma and Agroscope have developed a practical tool for selectively enriching beneficial raw milk microbiota in an adjunct culture for cheesemaking. Raw milk cheese has a richer, more intense flavour. Stricter hygiene standards in milk production, including systematic teat disinfection, have led to a decline in the diversity of the raw milk microbiota. The artisan raw milk+whey culture was able to enrich lactic acid bacteria from the raw milk microbiota. The combination of heating, acidity and salt-induced osmotic stress also inhibited some undesirable groups of raw milk microorganisms. However, the raw milk+whey culture they developed was found to have less of an impact on cheese quality than the use of raw milk. Further research is needed.

Fröhlich-Wyder *et al.* presented the first Swiss cheese made from the milk of a single breed of cow, the traditional dual-purpose original Simmental (Figure 3.5), which is already an economically worthwhile option. The new smear-ripened hard cheese is made from the best raw milk using a Liebefeld cheese culture and was developed by Agroscope in collaboration with regional cheese dairies and specialised affineurs. Propionic acid bacteria are added to this flavoursome smear-ripened cheese in addition to lactic acid cultures. However, propionic acid fermentation is intentionally kept low to prevent the formation of eyes and to produce a flavour less sweet and tangy than Emmental AOP.

Figure 3.5: The Simmental is a proven dual-purpose breed

Buchin *et al*. studied the effect of weather conditions on the quality of organic milk and cheese. They found high seasonal variations in the composition and technological properties of the milk. The coagulation time was longer in summer. The effects of milk quality on cheese quality were greater with Raclette cheese than with French Gruyère.

Bel *et al*. and their partners developed a methodology and a software package for collecting traditional cheesemaking knowledge, especially relating to artisan cheeses with geographical indications (GIs), and presenting this knowledge in such a way as to make it sustainable and accessible to future cheesemakers. By 2023, the tool was being used by 15 GI organisations, six training centres and one technological institute. New content will be added as it is continuously improved. Furthermore, the database and software can be individually adapted and added to, facilitating its use by different sectors. The software is commercially available for an annual subscription.

Goats have enjoyed a recent surge in popularity among farmers thanks to a greater awareness of local production, the efforts of breeders and better marketing of goat's milk products. Cremonesi *et al*. presented their work on preserving the biodiversity of goat breeds such as the local Verzasca and Bionda dell'Adamello. A semen bank has been created using semen from selected healthy goats. The researchers also characterised the milk and cheese from these breeds by analysing the milk composition, microbiota and volatilome of the milk and cheese, the technological properties of the milk and the sensory characteristics of the cheese. They also studied the effects of grazing and terroir. The aim is to make goat-keeping more productive in the long-term.

Figure 3.6: Fabien Crausaz delighted the audience with his rendition of 'Ranz des Vaches'

'Ranz des vaches' (call to the cows) is a traditional herdsman's song that can be traced back to the 16th century. It was originally used in many rural areas to call cattle in for milking, back to the cowshed or back from the alpine pastures.

4 Health effects

4.1 Presentation by Franziska Roth-Walter on nutrient transport by whey proteins

The transport of micronutrients to immune cells by whey proteins is an important pathway for health and immune resilience, as evidenced by Franziska Roth-Walter (Figure 2.1), senior lecturer at the University of Veterinary Medicine Vienna.

In the past decade it has emerged that subclinical or acute inflammations can be triggered by micronutrient deficiencies. This affects patient groups with atopic diseases such as inflammatory skin conditions, rhinitis (chronic or acute inflammation of the nasal mucous membrane) and asthma, as well as cancer patients, people with obesity, auto-immune diseases and others. Micronutrient deficiency leads to further chronic inflammations, thereby aggravating the primary diseases and reducing the chances of recovery. Iron and vitamin A deficiency are common causes of increased disease susceptibility (morbidity) and increased total mortality. Inflammatory processes disrupt nutrient uptake in the digestive tract, preventing many micronutrients from being absorbed via the intestinal mucosa and blood vessels. The lymphatic system provides the body with an alternative means of nutrient uptake (Figure 4.1).

Various epidemiological studies of children have shown that raw milk consumption reduces the risk of hay fever by around 50% and asthma by 42%. A mounting body of evidence in recent years suggests that whey proteins play an important part in the anti-allergenic effect of raw milk. Whey proteins also play a major role in the transport of micronutrients:

- α-lactalbumin transports calcium, zinc, magnesium and vitamins
- β-lactoglobulin is a vehicle for iron, selenium, lipids, flavonoids, amino acids, polyphenols and vitamins
- bovine serum albumin transports zinc, lipids, flavonoids, amino acids, proteins, hormones and vitamins
- lactoferrin carries iron, lipids and flavonoids.

In the last decade, micronutrient deficiencies have been linked to increased inflammations and allergies. The findings on micronutrient transport to immune cells by whey proteins via the lymphatic system are the missing link for health and immune resilience. However, whey proteins must be present in their native form to act as a carrier for micronutrients via the lymph system. Heating milk denatures whey proteins, causing them to lose their transportation ability.

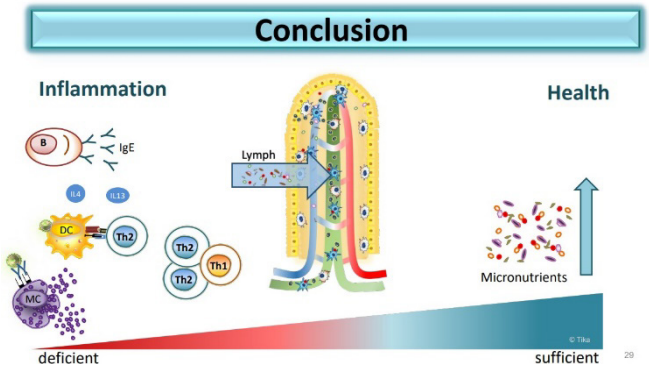

Figure 4.1: Uptake of micronutrients via the lymphatic system

A one-month treatment with oral iron-fortified native whey protein reduced allergy indicators and improved lung function in children with asthma. Iron-fortified holo-β-lactoglobulin supplies immune cells with the key trace element and so prevents allergies. In contrast, unloaded apo-β-lactoglobulin is a known allergen. It is therefore important to load the whey proteins with ligands such as iron, zinc, flavonoids or polyphenols. These are abundantly present in grass.

The research group headed by Franziska Roth-Walter was the first to demonstrate that under chronic inflammatory conditions the mucous membrane blockage of allergy sufferers can be circumvented if micronutrients are absorbed via the lymphatic system with the aid of whey proteins. Native whey proteins such as β-lactoglobulin can act as carriers of micronutrients such as antioxidants, iron or vitamin A and selectively feed immune cells. *In vitro*, *in vivo* and clinical studies have shown that this promotes immunological tolerance and resilience. Supplementation with micronutrient-loaded native whey proteins thus represents a new dietetic and causal approach to redressing functional nutrient deficiencies in allergy sufferers and so improving their allergy status. It is also possible to improve the micronutrient supply and thus the health status in the case of other diseases associated with chronic inflammation such as cancer or auto-immune diseases.

4.2 Presentation by Betty van Esch on the protective effects of raw milk and raw milk kefir

The importance of raw milk and raw milk kefir in preventing and treating allergies was the focus of the talk by Betty van Esch (Figure 3.3), Senior Scientist at the division of Pharmacology at Utrecht University in the Netherlands.

A series of epidemiological studies conducted over the last ten years have shown that consumption of raw cow's milk in the first year of life is an important factor in protecting against asthma, allergies and hay fever in later life. The mechanism behind the protective effect of raw milk is not fully understood. Heating alters several properties of raw milk, which can lead to conformational changes to the protein structures and thus changes to the allergenic potential of cow's milk proteins, especially whey proteins. Furthermore, bioactive enzymes are heat-sensitive and thus rendered ineffective by heating. The aim of the studies conducted by Betty van Esch's research group is to provide causal proof of the allergy-protective effect and to understand the function of the milk components involved.

The allergy-protective effect of raw milk was measured in a food allergy model using mice sensitised to ovalbumin (egg white protein). This protective effect is also observed with skimmed raw milk, but not with pasteurised milk (78°C/15 s). The researchers studied the effect of alkaline phosphatase as it is one of the most heat-sensitive bioactive raw milk components. The addition of alkaline phosphatase to pasteurised milk, 10x the concentration of raw milk, re-confers the allergy-protective effect. The addition of native lactoferrin to heated commercial milk also protected the mice from the allergic response to ovalbumin (Figure 4.2). Milk fat globules, on the other hand, do not appear to be involved in the allergy-protective effects of raw milk, as indicated by the comparison between skimmed and full-fat milk.

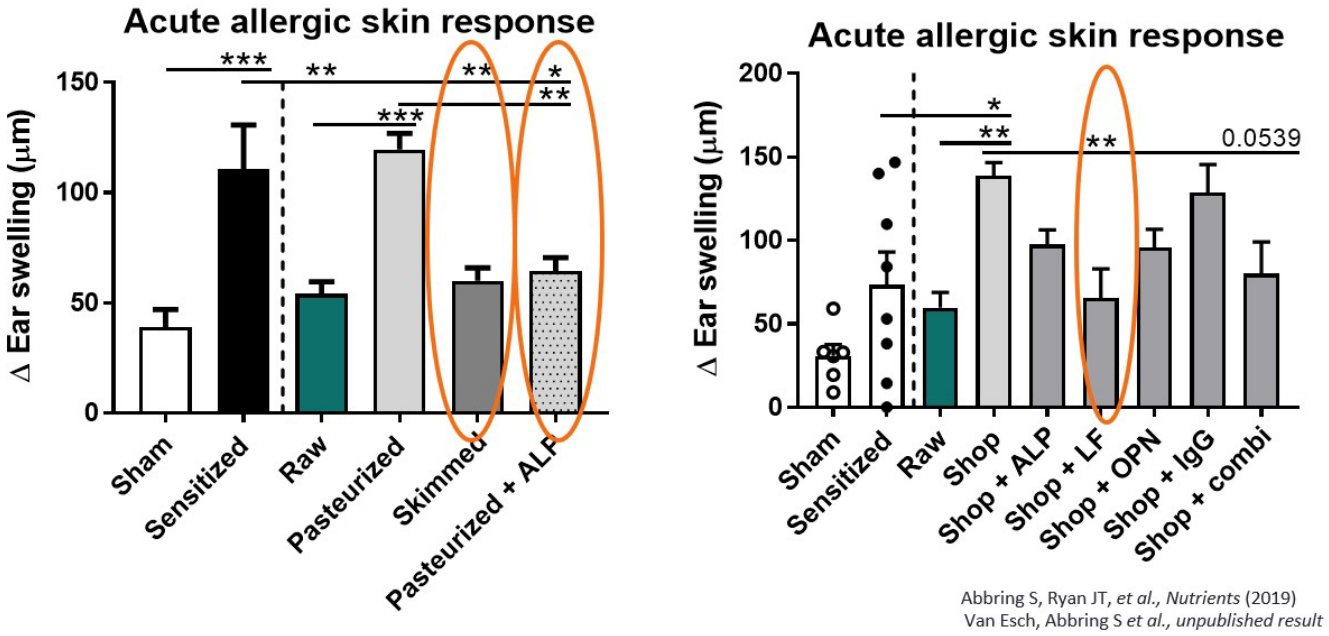

Figure 4.2: Factors influencing the allergic response

Influence of milk heating, fat content and addition of native, heat-sensitive milk proteins (ALP = alkaline phosphatase; LF = lactoferrin; OPN = osteopontin; IgG = immunoglobulin G) on the allergic response in a mouse model for ovalbumin allergy. Ear swelling is an indicator of allergic response. 'Sham' is the control, treated with phosphate-buffered salt solution. 'Sensitised' indicated the allergic response to ovalbumin. Raw: Raw milk. Pasteurized: Pasteurized Milk (78°C /15 s). Skimmed: Raw skimmed milk. Shop: Pasteurised milk from the retail shop.

The effect of heat on milk proteins was investigated in more detail. Raw milk was heated to 50°C, 60°C, 65°C, 70°C, 75°C and 80°C for 30 min in each case and then cooled in ice water. According to liquid chromatography mass spectrometry LC-MS/MS proteomics, whey proteins with immune-related functions were denatured from 65°C. The allergy-protective effect was present up to the heat treatment at 60°C, and absent from 65°C.

The Utrecht research group are the first to demonstrate that unprocessed cow's milk, in contrast to heated milk, reduces allergic symptoms in food and asthma allergy models as well as in a pilot study with humans. Eleven children

took part in this pilot, nine of whom were allergic to cow's milk. The children with a cow's milk allergy were able to drink the maximum dose offered of 50 mL raw milk without showing symptoms. In contrast, they tolerated only 8.6 mL of commercial, heat-treated milk without symptoms. This human pilot study was able to show that heating increases the allergenic potential of milk in humans. Various native bioactive components in untreated milk play a part in this protective effect. Studies in recent years have focussed on the potential of raw milk kefir as a safe nutritional concept for treating allergic conditions. The fermentation and associated reduction in pH involved in the production of raw milk kefir significantly increases food safety. Raw milk kefir was found to reduce allergy symptoms in a food allergy model.

The various studies show that raw milk and raw milk kefir have strong immunomodulatory capabilities which can be beneficial in the prevention and treatment of allergies.

4.3 Poster presentation

According to Baars *et al*., the positive effect on health is the main reason for the growing interest in raw milk kefir. The Raw Milk Company from De Lutte in the Netherlands has been making various organic raw milk products such as kefir, yoghurt, protein kefir and protein yoghurt, low-fat curd cheese and ghee for more than ten years. These products are sold from their farm shop and via organic wholesalers throughout the Netherlands and Belgium under the brand name RauwPower. They also supply conventional outlets. Sales of raw milk kefir soared after the pandemic, from around 640 t in 2020 to 800 t in 2022 and an estimated 1300 t in 2023. The health benefits are thought to be the main drivers of the increase in sales. The effects of consuming raw milk kefir on human health were studied on the basis of a retrospective survey of more than 400 adults (average age: 54). Participants were recruited via an appeal on the packaging, so this study is not representative of the population as a whole. After consuming raw milk kefir for at least two months, the consumers reported a significant, clinically relevant improvement in general health and perceived immune functioning as well as a reduction in diarrhoea, constipation, skin and mood complaints. The largest improvement was reported by subjects with poor health (either being immuno-deficient or suffering from a chronic disease). The effects were more pronounced in women than in men. Supportive research showed differences in the kefir microbiota, the bio-active peptides and the immunological response between kefir made from raw and heated milk.

5 Microbial biodiversity

5.1 Presentation by Céline Delbès on microbial transfer

Microbial transfer from grass to cheese – this complex issue was addressed by Céline Delbès (Figure 5.1), Scientific Director of INRAE (France's national research institute for agriculture, food and environment) in Aurillac, Auvergne, France.

Microbial communities affect the safety and quality of our food. Against the background of major changes to production systems – due to climate change or new agricultural practices, for example – there is an urgent need for a better understanding of microbial communities. Due to the interlinking of ecosystems on dairy farms – from grassland to milk – they are the point or origin for environmental and food microbiota, including the raw milk cheese microbiota. The aim of the research was to understand the factors influencing microbial systems along the value chain. In her presentation, Céline Delbès drew on her research findings to shed light on three aspects:

A group of INRAE researchers studied over 1200 raw milk cheeses and 370 milk samples as part of a large-scale study named MétaPDOcheese. They also collected comprehensive metadata relating to season, feeding practices and farm size. Different cheese varieties from across France were included in the study. Over 1200 species of bacteria and fungi were detected in the milk samples. The most important factor was the animal species (cow, goat or sheep), followed by the AOP factor (equivalent to PDO, Protected Designation of Origin), which should correspond to the terroir. In most cases, it involves the cheese varieties. However, one cheese variety can sometimes have several AOPs.

Figure 5.1: Céline Delbès (centre) visiting the culture production facility in Liebefeld

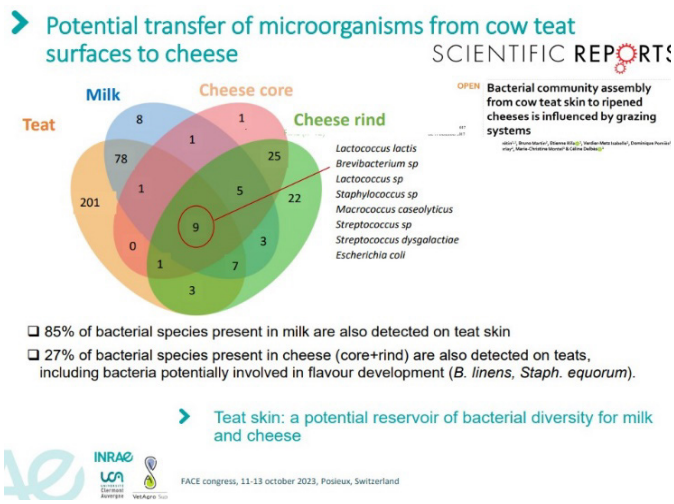

Figure 5.2: Transfer of microorganisms from teat surface to cheese

The teat surface is an important reservoir for a wide range of microorganisms relevant to cheesemaking.

- 85% of bacteria species present in raw milk and
- 27% of bacteria species present in cheese (core + rind)

were also detected on teats (Figure 5.2), including bacteria potentially involved in flavour development (*Brevibacterium linens, Staphylococcus equorum*). This reservoir is influenced by the type of pasture feeding. Variations in the composition of the grass microbiota thus have a direct influence on the composition of the cheese microbiota and on the sensory characteristics of the cheese.

Microbial diversity in raw milk could have an inhibitory effect on pathogens. A study conducted at INRAE looked at the influence of a bacterial consortium comprising *Hafnia alvei*, *Lactiplantibacillus plantarum* and *Lactococcus lactis* on the growth of Shiga toxin-producing *Escherichia coli* (STEC). A STEC reduction of 2.8 log cfu/g was obtained, regardless of the initial concentration. The microbiota composition had a significant influence on STEC growth. The

genera *Romboutsia*, *Paeniclostridium* and *Turicibacter* are common intestinal microbes that support STEC growth. *Lactococcus*, *Lactobacillus, Leuconostoc*, *Acinetobacter*, *Serratia* and *Hafnia* have an inhibitory effect.

The majority of these findings were obtained as part of the TANDEM project coordinated by Céline Delbès (Holoflux metaprogramme – flagship project TANDEM (2021-2023) (inrae.fr)).

5.2 Presentation by Elena Bancalari on a new approach to evaluating the quality of milk

Elena Bancalari (Figure 5.3), Associate Professor at the University of Parma (Italy), talked about a research project she has undertaken in close cooperation with the Parmigiano Reggiano cheese association. Parmigiano Reggiano is a hard cheese made in the Emilia-Romagna AOP area from raw milk. Association members include around 2300 dairy farms which supply raw milk to some 300 cheese dairies, which in turn produce 4 million cheese wheels a year. To be awarded the AOP designation, the cheese must be produced according to a strict set of rules. Not only raw milk is an important source of lactic acid bacteria, but also the whey culture produced each day, which serves as the starter culture.

The aim of the joint research project was to develop a new approach that modified the quality score of the milk to also take account of the desirable lactic acid bacteria count. In other words, farmers should no longer be penalised for a high bacterial count per se, if the load primarily consists of lactic acid bacteria. Recognition should be given to a high-quality raw milk microbiota rather than to the presence of microorganisms alone.

Figure 5.3: Luca Bettera and Elena Bancalari

The chosen method was impedance microbiology, which enables microbial growth to be monitored via their metabolism (e.g., lactic acid fermentation) by measuring changes in electrical conductivity (increased conductivity or decreased impedance). The one-year study involved 120 dairy farms and 8 cheese dairies. A total of 1500 milk samples were analysed three times at 25°C. The method is not new, but its application in the field of microbiology as a means of analysing total growth curves is unusual (Figure 5.4). The aim is to estimate bacterial counts by using the Gompertz function to predict growth curves from measured curves. Preliminary evaluation of the data shows that season has a significant impact on the lag phase, which was significantly longer in winter ($p < 0.05$). There were no significant differences between summer and winter for the two other parameters (rate and yEND).

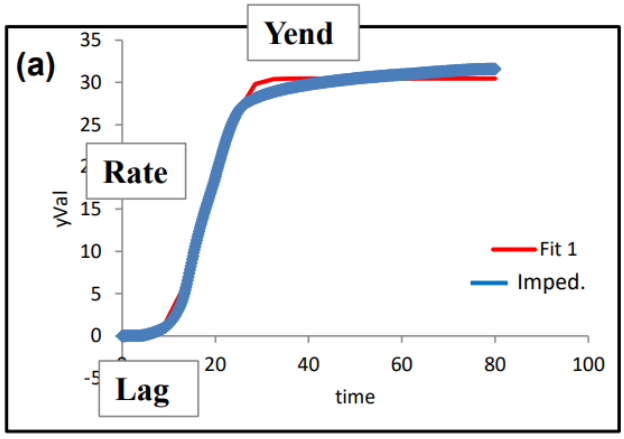

Figure 5.4: Line diagram of an impedance measurement (blue) and the fitted curve (red)

The lag phase, maximum growth rate μ (Rate) and maximum value obtained (yEnd) are the three key parameters that describe the curve.

If other external influences such as climate or geographical location are taken into account, the location of the cheese dairy also appears to be a highly significant factor in distinguishing between summer and winter milk. However, Elena Bancalari and her research group found that, contrary to expectations, weather – temperature, humidity, dew point, wind speed – and geographical location are not accurate predictors of the lag phase.

5.3 Poster presentations

Manzocchi *et al*. conducted a study of two different pastures: one with a high botanical biodiversity and one less diverse. Cantal cheeses were made from milk produced from these pastures and their microbiota were compared. From a total of 1055 ASVs (amplicon sequence variants), 67 were found in the milk, in the core and the rind of the cheese, and in the grass. Some ASVs were specific to each cheese group: 21 to the highly biodiverse and 14 to the less biodiverse. Among the most abundant ASVs common to both, 3 can be detected along the entire chain from grass to cheese. An amplicon sequence variant (ASV) is a sequence that can be distinguished during analysis. Analysis at this level provides better resolution of the microbial communities than species-level analysis and thus enables more accurate measurement of diversity.

There is no doubt that microbial diversity makes a significant contribution to the character of the cheese. For this reason, substantial efforts are being made to boost diversity, especially in the case of AOP cheese varieties. However, the use of clearly defined commercial cultures consisting of one or a few strains often has quite the reverse effect. Couderc *et al*. addressed this issue in their poster. The French research group set out to develop a culture for Rocamadour, a French AOP goat's milk soft cheese. To this end, they isolated 24 strains of *Lactococcus lactis* from raw goat's milk from the Rocamadour AOP area. Strains were preselected based on genetic and phenotypic traits and three were selected for the culture. A comparison of cheese made either from the test culture or a commercial culture revealed that the test culture makes a valuable alternative and provides a richer sensory signature. This poster won the Best Poster award (Figure 5.5).

Figure 5.5: Christel Couderc and Hans-Peter Bachmann

As far back as in the 1970s, cheese makers and scientists began to observe a slow but steady decline in microbial diversity due to more strigent hygiene conditions during milk production and increased demand for defined cultures. In her poster, Tancoigne explains why requests to build up strain banks and to drive research on food microorganisms had become louder in the 1980s. She went on to compare Agroscope's (Switzerland) and Actalia's (France) different approaches to strain conservation. While Agroscope promoted raw mixed cultures comprising a blend of unselected – and occasionally undefined – strains, Actalia focussed on defined, ready-to-use, multi-strain cultures of carefully selected strains tailored specifically to the AOP cheese. The Swiss variant called for a great deal of knowledge and experience on the part of the cheesemakers to produce their own distinct cultures. Actalia is a French centre of expertise for the food industry specialising in dairy products and food safety.

Chiadò Rana *et al*. conducted a study to illustrate the role of bacterial microbiota in raw milk and on the surfaces of equipment on the hygienic safety of cheese varieties with low scalding temperatures. They compared 10 cases with bacterial pathogens (*Salmonella* spp., *Listeria monocytogenes* and enterohemorrhagic *Escherichia coli*) in the raw milk with 10 cases without bacterial pathogens in the raw milk. Metadata from milk production and processing were recorded and a metagenomic analysis was performed. They showed that the bacterial biodiversity of the cheese in the non-contaminated cases was higher than in the cheese made from raw milk containing pathogens. Furthermore, the washing interval and ripening time were shorter for the contaminated cheese than the control cheeses. However,

not all differences were significant. The study also showed a dramatic decline in detectable biodiversity after starter cultures were added to the milk and a moderate increase once again during ripening. This poster was awarded second runner-up.

Rest *et al*. showed in their poster that microorganism compositions can also provide valuable information about the prehistoric spread of dairying. The team is currently studying samples from non-industrial herds in Jordan, the Alps and Mongolia and the dairy products produced from them. The researchers are keen to explore the relationship between people, animals and milk production. In Mongolia, for example, they want to investigate how the consumption of dairy products influences the gut microbiota and thus the ability to digest lactose, despite the genetically determined absence of lactase. Another aim of the work is to help to bring an end to the war on microbes by establishing culture banks across Eurasia.

6 Side programme

6.1 Visits

Five Dairy & Farm tours were organised for the first day of the three-day event, each involving a visit to an artisan cheesemaker and two of their milk suppliers.

- Tour 1: Gruyère AOP (Grangeneuve dairy)
- Tour 2: Vacherin Fribourgeois AOP (Belfaux dairy)
- Tour 3: Freiburger Alpkäse (Gantrischli alpine dairy, Schwarzsee)
- Tour 4: Emmental AOP (Oberbütschel alpine dairy)
- Tour 5: Various cheeses from Bern (Eyweid dairy, Zäziwil) (Figures 6.1.1 and 6.1.2)

Figure 6.1.1: Visit to the Eyweid cheese dairy

Figure 6.1.2: Milk from these cows is processed in the Eyweid dairy

6.2 Practical and theoretical workshops

The workshops were scheduled for the second morning. Attendees could choose from seven different practical workshops, all held at the Grangeneuve cheesemaking school dairy and technology centre:

- Hard Cheese (Fig. 6.2.1)
- Soft Cheese
- Pasta Filata (Fig. 6.2.2)
- Quark and Cottage Cheese
- Fermented Dairy Products
- Ice Cream
- Butter

All the practical workshops were fully booked and the participants were very willing to roll up their sleeves and get involved.

The programme of events also included theoretical workshops on selected topics, with participants encouraged to ask questions and exchange ideas:

- Food Safety and Swiss Regulations: the Food Safety and Veterinary Office of the canton of Fribourg explained the guidelines for producing raw milk products in Switzerland.
- Listeria: a cheese expert from Agroscope presented the latest information on measures to prevent listeria in cheese.
- Dairy Apprenticeships and Training: the Swiss Dairy Association presented their vocational training programme.
- Advisory Services and Cheese Analysis: the regional advisory service CASEi provided information on cheese advice and presented several case studies.

There was also an opportunity to visit the culture production facility in Liebefeld as an alternative to the workshops.

Figure 6.2.1: Making semi-hard cheese

Figure 6.2.2: Making Pasta Filata

6.3 Information stands

Other important institutions representing the Swiss dairy industry had stands at the event:

- Centre of Excellence for Raw Milk Products
- Advice and further training for artisan cheesemakers
- Summer grazing and the production of alpine cheese in Switzerland
- Swiss branch of the International Dairy Federation (IDF)

Links to the respective posters can be found in Chapter 9.3.

In addition, the Fromarte workstations provided an opportunity for participants to learn about the QM system and sustainability guidelines.

6.4 European Cheese Buffet

The European Cheese Buffet has become a traditional highlight of the annual FACEnetwork meetings, from both a culinary and technical point of view, as well as a social one. Attendees are invited to bring their own cheese, which invariably leads to a unique assortment; and what makes it even more interesting is that the cheesemakers are on hand to tell the story of their cheese.

Figure 6.4.1: European Cheese Buffet with 84 varieties of cheese from 15 countries

Figure 6.4.2: The European Cheese Buffet was presented by Fromarte

The Fromarte team headed by director Andréas Leibundgut (second from left)

7 Results of the satisfaction survey

The survey was created on the TIVIAN platform (https://www.efs-survey.com/) .

Participants rated both the organisation and the programme as good or very good.

Table 7.1: Participants' assessment of organisation and programme (rating: 1 = poor, 2 = average, 3 = good, 4 (maximum score) = very good)

Assessment of organisation 1)			Assessment of programme 1)		
Aspects	Mean	Standard deviation	Aspects	Mean	Standard deviation
Homepage	3.77	0.53	Lectures	3.82	0.39
Registration	3.77	0.43	Posters	3.73	0.46
Payment	3.85	0.37	Info stands	3.41	0.59
Venue	3.55	0.67	Podium discussion	3.43	0.68
Catering	3.50	0.51	Opening	3.62	0.67
Transport	3.74	0.56	Workshops	3.56	0.73
Signposting	3.32	0.78	Visits	4.00	0.00
Translation	3.50	0.99	Cheese Buffet	3.95	0.22
Conference documen-tation	3.71	0.46	Dinner	3.47	0.70
Overall impression	3.91	0.29	Overall impression	3.95	0.22

1) 23 out of 240 people completed the survey (= 9.6%)

8 Conclusions

8.1 Proposals to put the Centre of Excellence for Raw Milk Products on a more international footing

The FACEnetwork meeting demonstrated the importance of dialogue between science and practice, especially when it comes to the challenges of raw milk products. Following on from this, it was suggested that it would be worthwhile for the Centre of Excellence to set up an international working group to promote this dialogue.

- This working group would have to bring together scientists and practitioners from as many European countries as possible (production, consultancy, vocational training, research).
- It would meet regularly (e.g., monthly) online to exchange information. At these meetings, an academic could present new (own or published) findings and a practitioner could present an interesting case study (a practical problem, innovation or little-known tradition).
- The working group could also provide a platform for sharing experiences about how vocational training, advice, further training and research are organised in different countries or regions.
- As an option, the working group could also present a regular award to young scientists.

This working group could also serve as a very useful additional FACEnetwork working group and thus help to strengthen and enrich this important network.

8.2 Proposals for future research projects

According to the Scientific Programme Committee, research is needed in several areas:

- Raw whey is a valuable byproduct of raw milk cheese production which offers great potential for positive effects on human health, since the whey proteins are not denatured and it contains live microorganisms. Technologies should be developed for processing the raw whey into appetising foods without denaturing the whey proteins.
- There is a need for greater differentiation when monitoring the microbiological quality of raw milk, since the raw milk microbiota also has many positive effects on the quality and healthiness of raw milk products. Current methods have led to a severely impoverished raw milk microbiota. Methods such as impedance microbiology are needed to positively characterise milk quality.
- It would be very useful if artisan producers of raw milk products had simple, practical methods for selectively increasing microbial biodiversity without increasing food safety risks.
- Since yoghurt is considerably more popular in Switzerland than kefir, it would make sense to conduct studies on the allergy-protective effect of raw milk yoghurt similar to those carried out for raw milk kefir.

8.3 General proposals

The conference highlighted a need for action in other areas as well:

- Too little is known about the positive effects of raw milk products on human health in the dairy industry, among retailers and among the general population, so more active communication is needed.
- The eradication of *Staphylococcus aureus* genotype B from of Swiss dairy herds would be a huge win for milk producers, milk processors and especially for raw milk cheese.

9 References with direct links and QR codes

9.1 Lectures and summaries

Author(s) and title	Conference number	Summaries		Lectures	
		Direct link	QR code	Direct link	QR code
Bachmann H.P., Graber H.: Safety and quality of raw milk cheeses: Two sides of the same coin.	1b	https://lmy.de/jPZD		https://lmy.de/xChR	
Bancalari E.: Importance of raw milk lactic acid bacteria for cheesemaking: a new approach for their detection.	4b	https://lmy.de/dQbH		https://lmy.de/nFzg	
Delbès C.: Microbial transfers across a food chain: from grassland to cheese using systemic and multidisciplinary approaches.	4a	https://lmy.de/hqeL		https://lmy.de/GXgA	
Donnelly C.: Ending the war on artisan cheese.	1a	https://lmy.de/tvOG		https://lmy.de/pVMc	
Eugster E., Meier M., Lemola J.: Guide «Sustainability in artisanal cheese dairies in Switzerland».	2b	https://lmy.de/bfPE		https://lmy.de/wBQG	
Niggli U.: The role of sustainable grassland management for food security and maintenance of natural resources.	2a	https://lmy.de/OOCQ		https://lmy.de/nmfc	
Roth-Walter F.: Micronutrient-transport by whey proteins: A missing link to health and immune resilience.	3a	https://lmy.de/xuBF		https://lmy.de/vHbb	
Van Esch B.: Raw milk and Raw milk Kefir for the dietary management of allergic diseases.	3b	https://lmy.de/iNHF		https://lmy.de/ptVq	

All sources were accessed on 15.7.2024.

9.2 Poster presentations

Author(s) and title	Conference number	Direct link	QR code
Baars T., Mulder A., Mulder K.: Health impact is the main reason for increased interest for raw milk kefir.	H01	https://lmy.de/oeCX	
Bel N., Charles C., Couteaux J., Baudrit C., Buche P., Notz E., Lasbleiz R.: DOCaMEx - Capitalise on Know-How in Geographical Indications. *(Selected for short presentation)*	S04	https://lmy.de/YsTS	
Bettera L., Dreier M., Schmidt R.S., Gatti M., Berthoud H., Bachmann H.P.: Selective enrichment of the raw milk microbiota in cheese production: concept of a natural adjunct milk culture.	S02	https://lmy.de/HxBU	
Bisig W., Berger J., Hummerjohann J., Bachmann H.P.: Microbiological safety of raw milk yoghurt.	Q07	https://lmy.de/kqMR	
Buchin S., Puech T., Rolet-Répécaud O., Barbet P., Petitpas F., Arnould C., Coquillard M.O., Beuvier E.: Suitability of organic raw milk for cheesemaking according to seasons.	S03	https://lmy.de/YVtW	

Chiadò Rana A., Valat C., Cazeau G., Béthune K., Chochois V., Teyssier C.: Characterization of bacterial communities during bovine raw milk and artisanal uncooked pressed cheese production: Implications for dairy products safety and quality. (*Awarded as second runner-up*)	M04	https://lmy.de/eZLV	
Couderc C., Laroute V., Abi Khalil R., Codeville M., Caillaud M.A., Jardi G., Raynaud C., Cocaign-Bousquet M., Tormo H., Mourez M., Daveran-Mingot M.L.: Design of an indigenous starter for the production of Rocamadour, a french PDO cheese *(Awarded as best poster)*	M01	https://lmy.de/jewm	
Cremonesi P., Castiglioni B., Pizzi F., Brasca M., Silvetti T., Morandi S., Tringali S., Severgnini M., Crivelli M., Cipolat-Gotet C., Gandini G., Turri F.: The BIO4VERBA project - Preserve the biodiversity of local Verzaschese and Bionda dell'Adamello goat breeds through the enhancement of their productions and the creation of an ex-situ genetic reserve. (*Selected for short presentation*)	S05	https://lmy.de/eHLS	
Darnay L., Austheim L.K.M: Factors influencing biogenic amine content of European ripened cheeses. *(Awarded as first runner-up)*	Q01	https://lmy.de/SrNy	
Dreier M., Bachmann H.P., Lüscher Bertocco M., Schmidt R.S.: Influence of the season on the level of biogenic amines in Vacherin Fribourgeois PDO.	Q05	https://lmy.de/Awfd	
Dreier M., Guggisberg D., Bachmann H.P., Lüscher Bertocco M., Schmidt R.S.: The force at fracture in semi-hard cheese depends on the milk treatment and the season.	Q06	https://lmy.de/zDpT	
Ducrey C., Ouzia S., Basset B., Schlusselhuber M., Bertry A., Dieng A., Pignol C., Desmasures N., Bel N., Chuzeville S., Ledauphin J.: SO'DIFF - Identification of quality markers from Tomme de Savoie to support selection of indigenous microorganisms.	Q08	https://lmy.de/xbZZ	
Fröhlich-Wyder M.T., Aeschlimann T., Winkler H., Bachmann H.P.: Simmentaler Original: The first Swiss cheese made from the milk of a single cow breed.	S01	https://lmy.de/lefL	
Fröhlich-Wyder M.T., Bachmann H.P., Schmidt R.S.: Every cheese has its own character.	Q02	https://lmy.de/QvZF	
Guggenbühl B., Beutler E., Fleuti C., Lüscher Bertocco M., Bachmann H.P.: Vacherin fribourgeois AOP: Consumer study shows popularity of raw-milk cheeses.	Q04	https://lmy.de/lFfH	
Manzocchi E., Martin B., Bord C., Bouchon M., Bérard J., Coppa M., Delbès C., Verdier-Metz I.: Bacterial and botanical diversity of pastures affects the Cantal-type cheese sensory properties.	M03	https://lmy.de/aTtY	
Morandi S., De Noni I., Stuknytė M., Brasca M.: Influence of growth temperature on the production of bacteriocins by *Lactococcus* spp.	Q09	https://lmy.de/kmoz	
Lauber Fürst S., Bondarchuk A., Bondarchuk O., Berger T., Nemati G., Kagadiy N., Chernova O.: Partnering for innovation in quality and safety in artisan cheese making.	Q10	https://lmy.de/DFXb	
Rest M., Reichhardt, B. Hendy J., Tsolmon S., Warinner C.: Heirloom Microbes - Tracing the Diversity of Dairying Bacteria across Eurasia (*Selected for short presentation*)	M05	https://lmy.de/WEsJ	
Schmidt R.S., Somerville V., Berthoud H., Guggenbühl B., Gschwend F., Arias-Roth E.: The sensory and microbial diversity of Bernese Alp Cheese.	Q11	https://lmy.de/omsw	
Schwaiger L.: Herstellung von Frisch-, Weich-, Schnitt- und Hartkäse: Orientierungswerte und Empfehlungen für Herstellungsparameter.	Q12	https://lmy.de/MPvL	

Stoffers H., Schmidt R.S., Bachmann H.P.: New process for the ripening of cheese.	Q03	https://lmy.de/zFUm	
Tancoigne E.: Back to the Future: designing the microbial terroir of French and Swiss cheeses since the 70s.	M02	https://lmy.de/LEIm	

All sources were accessed on 15.7.2024.

9.3 Information stands

Title	Direct link	QR code
Centre of Excellence for Raw Milk Products		
- Concept	https://lmy.de/JGUk	
- First projects	https://lmy.de/ZcNd	
- Raw milk and raw-milk products affect our health	https://lmy.de/eTrU	
Agroscope		
- Consultants en fromagerie	https://lmy.de/fzaA	
- Taches noires dans les fromages causées par les obturateurs de trayons	https://lmy.de/WYBd	
SAV – Schweizerischer Alpwirtschaftlicher Verband		
- Sömmerung und Alpkäseproduktion in der Schweiz	https://lmy.de/AXGE	
- Summer grazing and the production of alpine cheese in Switzerland	https://lmy.de/pplE	
- Estivage et production de fromage d'alpage en Suisse	https://lmy.de/dxif	
International Dairy Federation Switzerland	https://lmy.de/umgb	

All sources were accessed on 15.7.2024.

10 List of illustrations

11 List of tables