New possibilities for improving sustainability of cheese production

Modification of process management

Author: Peter de Jong – Professor of Dairy Process Technology, Van Hall Larenstein Leeuwarden/Velp, Principal Scientist NIZO food research Ede

Dairy products are known for their relatively low impact on the environment per unit of nutritional value. The carbon footprint of cheese from the Netherlands has been reduced in recent years by minimizing energy and water consumption. However, there are other options for further improving the sustainability of cheese production. The dairy research team at Van Hall Larenstein University of Applied Sciences is revealing new possibilities.

The Netherlands as a leading country in sustainable cheese production

The Netherlands wants to be a leading country in the global dairy sector. As part of this aspiration, it requires the knowledge and experience required for the sustainable production of cheese. One example of this is the availability of technology to completely eliminate process water wastage – in which membrane filtration is applied to reprocess the water into high-quality water for cleaning equipment. Smart process control ensures that the protein is added to the cheese as effectively as possible (1). In addition, other energy savings have been implemented in various parts of the cheese process. Table 1 provides an overview of existing procedures for improving sustainability, which have been used, for example, by NIZO food research.

New possibilities

All of the measures stated above relate to improving process management. Recent research has shown that the ingredients used can also substantially improve the sustainability profile. After all, a large part (>80%) of the carbon footprint comes from milk from

Table 1. Overview of possible procedures to reduce the carbon footprint of cheese

Measure	Sustainable effect
Recycling of process water through membrane filtration	Reduced water wastage per kg of cheese
Data analysis and optimization of cheese process	Efficient transition from protein in milk to cheese (more cheese per ton of milk)
Optimization of cleaning	Faster cleaning with fewer chemicals and reduced energy consumption
Optimum design of cheese milk pasteurizer	Longer running time before cleaning is required, leading to reduced energy consumption and reduced product loss
Quantitative analysis of microbial risks using computer simulations	Increased hygiene levels in cheese process, reducing product wastage

the primary chain (see Figure 1). Applying measures to ensure a higher cheese quality is achieved with a reduced loss of product, i.e. loss of milk, can have a huge impact. Rennet, especially, affects the structure and the moisture level distribution of the cheese. Additionally, the rennet itself has a carbon footprint and the quantity of rennet added to the milk also affects the overall carbon footprint of the cheese.

Case study: a new type of rennet

At Van Hall Larenstein, a new type of rennet has been studied (DSM, Maxiren® XDS) and evaluated regarding its contribution to sustainability. This rennet consists of the enzyme chymosin and is not obtained from a calf's stomach, but through fermentation of the yeast Kluyveromyces lactis. The rennet contains no benzoate and has a kosher, halal and vegetarian status.

- Lower dosage – The enzymes in the new rennet are more effective than rennet from a calf's stomach (or identical) as they only cut the casein of the milk where required to build up a good gel structure. As a result of this, a lower dosage is needed with an overall impact of 40-50 grams CO_2 equivalent per kg of cheese. Although this is only 0.5% of the overall footprint of cheese, it still represents 6% of the carbon footprint of cheese production itself.

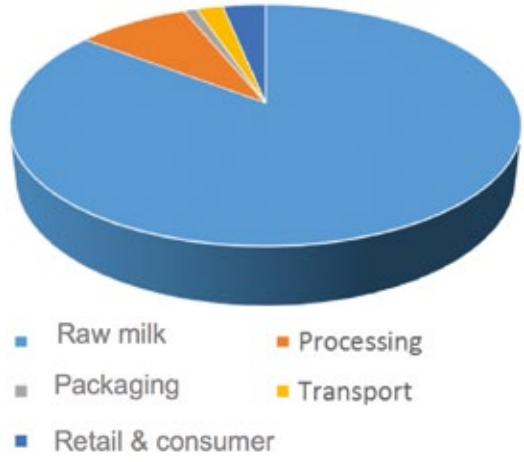

Figure 1. Carbon footprint of cheese broken down into various parts of the chain. Overall footprint is estimated at 8.8 kg CO_2 equivalents per kg of cheese (2)

- Reduced variation in moisture level – The new rennet is less sensitive to variations in calcium content and pH. It appears that this also reduces the variation of the moisture level in cheese. After use in

80 batches of Gouda cheese, the standard deviation had dropped from 0.6 to 0.5% moisture. If the requirement is for more than 90% of cheeses to meet the maximum moisture level of 42.5%, this reduces the footprint of the cheese by 0.2% (twice the difference in standard deviation). In relation to cheese production, this constitutes a footprint reduction of more than 2%.

- Reduced cutting losses – The texture of cheese becomes smoother with the new rennet. Furthermore, the moisture distribution in the cheese is more consistent, reducing rind losses for pre-cut cheese. Various industrial cheese production processes show that this reduces cutting losses by an average of 15%. A conservative estimate is that these losses are now 2%. If these are lowered by 15%, this will reduce the cheese production footprint by 3.5%.

Overall, the use of a new rennet will yield a substantial footprint reduction of almost 12%. Dairy companies have set themselves the target to reduce the footprint of dairy processes by 20% in 2020. The use of this new rennet already achieves a large part of the target for cheese production.

Modification of process management

The use of a new rennet requires a minor modification of the process. The new dosage has to be adjusted to suit the rest of the cheese process and parameters will have to be modified. The whey composition will also change, including less curd dust and reduced amounts of protein decomposition products.

Collaboration in the chain is essential

The results of the study show how important it is to collaborate in the chain to achieve sustainability targets. A cheese manufacturer focuses on the production plant: How can I save even more energy? How can I fine-tune my processes even more? In this way, a relatively large amount of effort is put in to achieve the footprint reduction percentage. The composition of a rennet falls outside the scope of a cheese production plant, even though substantial sustainability gains appear to be possible there.

Cheese process

Cheese is a concentration of milk (about 10x) and consists of a milk protein (casein) matrix containing fat, salt, minerals and water. Casein are spherical micelles with a diameter of 20 to 200 nanometers (nm) and are made up of different types of casein. Research has shown that kappa-casein can be considered as the protective colloid of the casein micelle. After adding chymosin (rennet) to the milk, the casein micelles quickly lose their stability and form a gel under the influence of calcium ions. The coagulation of the milk is initiated with the specific enzymatic effect on the kappa-casein at the surface of the micelle. The gel is then cut and divided into whey and curd-particles. Specific bacteria (starter cultures) are added to the milk to ferment the lactose. The release of whey is promoted and the whey is separated from the curd. The curd particles are transferred to cheese molds and, after pressing and salting, the cheese is matured until the desired taste is obtained.

References

1. *P. Valk et al., Optimization of cheese preparation with (big) data analysis. VMT 2016*
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Manufacturer of Mozzarella cheese making equipment acquired

Tetra Pak

Tetra Pak has acquired Johnson Industries International, a company specialising in the design, development and manufacture of equipment and lines to produce mozzarella cheese. The company also manufactures a range of cheese cutting, shredding and brining equipment. These additions broaden Tetra Pak's wide-ranging cheese technology portfolio and strengthen its position as a leading global provider of cheese manufacturing solutions.

Based in Wisconsin, U.S., Johnson Industries International, is one of North America's principal suppliers to the high-quality, high-volume segment of mozzarella cheese manufacturing.

Johnson Industries International will remain in its current location and will continue to focus on its core business. **tetrapak.com**

(photo: Tetra Pak)