CHEESE WITHOUT THE COW

Laurens Antuma (Food Process Engineering) received a PhD at the end of March for research on artificial casein micelle formation in protein from precision fermentation. The micelles are needed to make cheese. Text Dominique Vrouwenvelder ◆ Photo Shutterstock

'We can use precision fermentation (a process using genetically modified micro-organisms to create e.g. milk proteins, ed.) to make casein, the key protein in the production of cheese,' explains Antuma. 'But that process results in separate protein molecules whereas cheese makers — making hard cheeses — use the protein in the form of micelles, little balls of protein.' He studied ways of forming micelles from the loose molecules of the non-animal protein, with the ultimate aim of letting producers make non-animal dairy products.
Antuma compares the micelles to hairy tennis balls. 'Cow's milk contains four important variants of the protein casein. They are all a bit different, but we can replicate them all using precision fermentation. Three of the protein variants react with calcium phosphate crystals to form the ball's internal structure. The fourth variant attaches itself to the outside of the ball, sealing it, to create a stable, "hairy" ball, the micelle.' In the cheese-making process, an enzyme cuts off the micelle's hairs, making the globules stick together. 'The resulting sticky mass is curd, an intermediate product in cheese-making.'

Scalable

'In principle, you could simply put the casein variants together with calcium and phosphate ions in water and get micelles that way,' explains Antuma. 'But then you don't have any control over the process.'
He took a more scientific approach. 'We started with water and added the four casein variants in varying proportions plus varying amounts of calcium phosphate in order to replicate the micelles in cow's milk. That works fine on a small scale in the lab, but you need more efficient processes to do it on a large scale in the food industry.'

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Antuma therefore made a scalable experimental set-up with membranes. 'If you add only small amounts of calcium and phosphate ions and the casein molecules to the water, you don't get crystallization of calcium phosphate and so no micelles are formed. Slowly removing water from the solution increases the concentration and so micelles are eventually formed after all. This method gives you very fine crystals and lets you create better micelles in a controlled way. Two other major advantages are that it's much faster and a continuous process.'
The PhD candidate is leaving the actual cheese-making to others. 'My thesis contains new fundamental knowledge about micelles and also offers insights and solutions to practical problems. The actual production of cheese using non-animal casein micelles is now up to commercial companies.'