Improved low fat cheese with use of new developed ripening cultures

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CSK has recently conducted a large study to determine the attributes required for the development of low fat cheese with an appealing flavour, texture and functionality. This research has resulted in the Health Plus™ concept aimed at both foil and naturally ripened premium low fat cheese varieties.

Health and wellness remains an important trend within the consumer market. Consumers are becoming more aware of the importance of a healthy and balanced diet. This increased awareness of the positive impact of healthy food is leading consumers to change their eating habits and more carefully consider what they consume. The potential growth opportunity for low fat cheese is significant. As many people increasingly focus on fat-reduced diets, health is an important purchasing factor, but consumers do not trade off completely for taste. Therefore, the development of consumer acceptable low fat cheese is a strong consumer demand in the market.

Impact of fat reduction on cheese

Removing part of the fat from cheese can negatively affect its flavour and texture and its functionality. Many low fat cheeses tend to have a flat and non-characteristic flavour, more translucencies, poorer melting and baking properties and more rubbery and gummy texture and mouth feel. Low fat cheeses also show less change in viscoelastic properties during ripening.

The amount of fat in a 48+ cheese gives a significant contribution to the cheese flavour. Besides this, the fat phase of the cheese mass is an important carrier of flavour compounds, mainly produced by the aromatic strains of the starter culture. Fat is also responsible for the richness and mouthfeel of cheese. When reducing the fat content, the balance of fat, protein, moisture and salt changes, which results in deficiencies in not only milk-fat derived flavour compounds generated from interaction of degradation products of lipolyis and proteolysis. The rate of development of uncharacteristic flavours increases with decreases of fat content of cheese. Low fat cheese is therefore also more susceptible for the formation of bitter taste.

Besides, the texture of low fat cheese is perceived to be waxier, fractural, chewy, hard and springy, less sticky and cohesive, less meltable and less smooth. As cheese is considered as a material that consists of a hydrated protein matrix with interspersed fat particles. The greater the amount of fat in relation to protein, the more interruptions there is in the protein matrix and increased interference of long-range interactions between proteins. Likewise, an absence of fat allows protein interactions to be very extensive resulting in a rubbery texture.

Flavour improvement by using adjunct cultures

Low fat cheese has been characterised as having a lack of in flavour and often has the presence of

undesirable flavours, including bitterness. These differences in flavour relate to the different balance of flavour-contributing compounds. As the biochemical processes are altered, low fat cheese has an entirely different flavour profile. In particular, there is a distinct change in the volatile compound profile in low fat cheese. By using specific adjunct cultures that have the desired characteristics, the same volatile compounds can be replicated in low fat cheese that normally are developed in full fat cheese. In the research study CSK has focussed on raising flavour compounds like diacethyl, which is well known as the key aroma of butter, and aromatic compounds from the proteolysis by making a wise selection of starter cultures and adjunct cultures. These cultures comprise selected strains, which are tailored for cheese ripening to develop specific flavours with different organoleptic characteristics. They modify the cheese flavour towards an intense and full cheese flavour with more mature or sweet flavour notes.

As a result of the research study it can be concluded that specific types of starter cultures in combination with different adjunct cultures result in a rise of the diacethyl perception of cheese. In figure 1 the perception of diacethyl in a reference cheese (with index 10) and different adjunct cultures are presented. Diacethyl is recognised as a strong “creamy” flavour.

To improve the overall flavour intensity of low fat even further, a more ripened flavour in cheese is often desired. Adjunct cultures can strongly improve the taste of cheese as you can find in figure 2. In figure 2 we can find the effect of adjunct cultures on the flavour of low fat cheese. In the central vertical axe the score of the neutral reference low fat cheese is presented, scores to the left represent a *ower* score and scores to the right represent a *higher* score.

As you can see, some adjunct cultures (like Adj I) introduce more sweetness and reduce bitterness where other gave less sweetness than the reference (Adj III) and a higher score on bitterness. This explains why we have to carefully the adjunct cultures for low fat cheese.

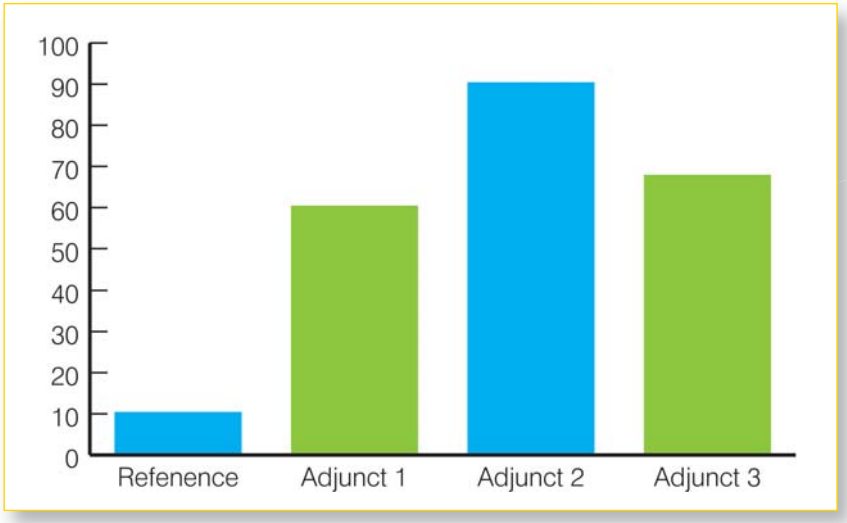

Figure 1: Diacethyl perception (indexed) of low fat cheese with a selection of adjunct cultures

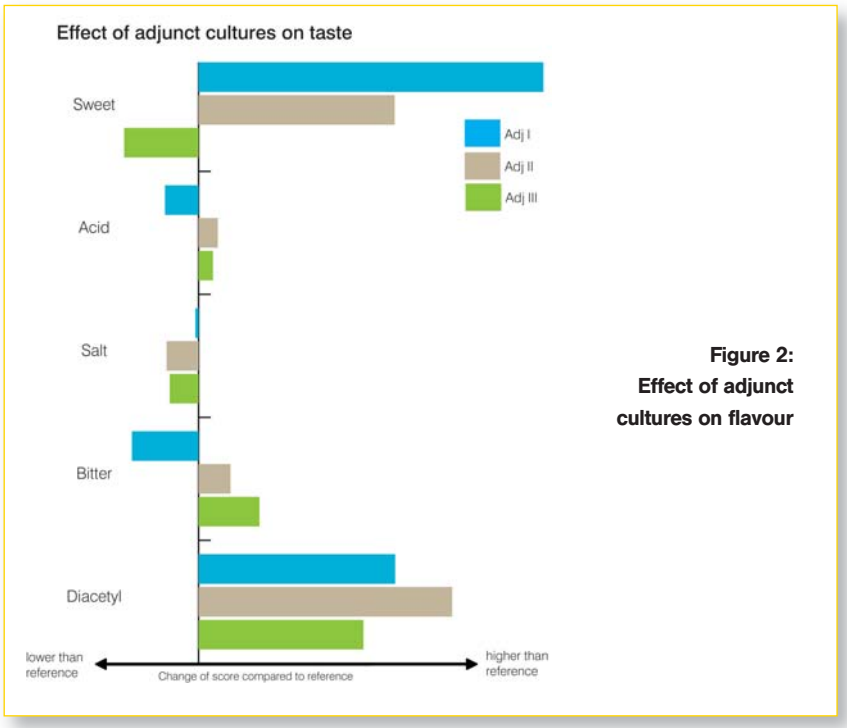

Figure 2: Effect of adjunct cultures on flavour

Bitterness prevention

Low fat cheese is more susceptible for the formation of bitter taste, due to the raised water content. CSK has developed a range of adjunct cultures which have strong debittering properties. Bitter taste is related to the lysis of lactic acid bacteria, which play a crucial role during proteolysis in cheese. Bacterial lysis ensures these debittering properties are caused by lysis sensitive strains. Lysis of lactic acid bacteria plays a crucial role during proteolysis in cheese. Bacterial lysis ensures the involvement of intracellular starter enzymes in the forma-

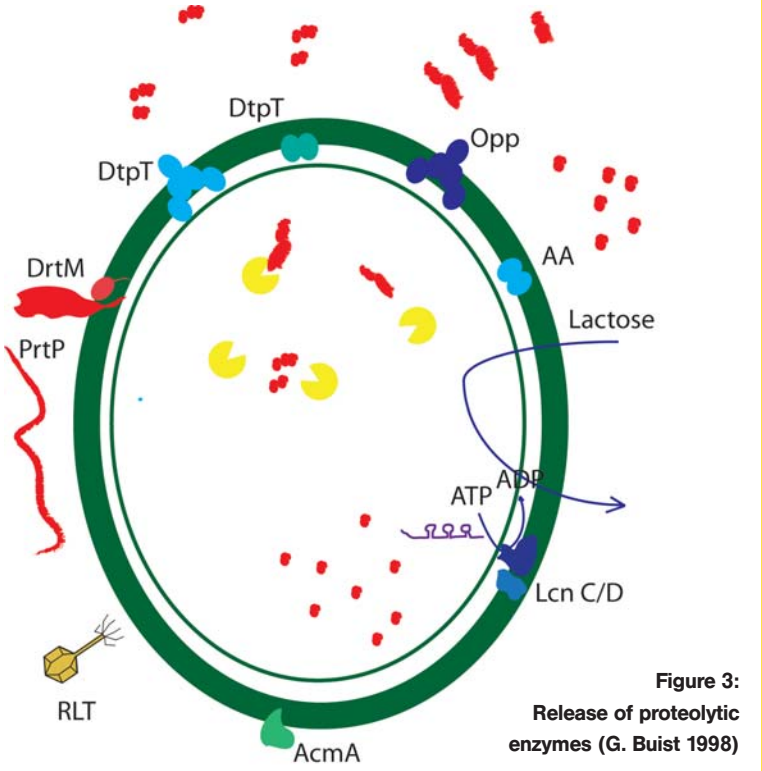

Figure 3: Release of proteolytic enzymes (G. Buist 1998)

tion of cheese flavour. In figure 3 the release of proteolytic enzymes is schematically shown. The lack of lysis during cheese ripening can result in an accumulation of degradation products of casein in the cheese matrix. This unbalanced proteolytic system, caused by faster formation than degradation of bitter peptides, results in the taste deviation bitter. To avoid this, the suitability of lysis sensitive strains as debitterering cultures have been evaluated.

In extensive laboratory tests, the degradation of a bitter substrate, the C-terminal part of ß-casein, has been determined. By incubation of selected lactococci with this bitter substrate an indication of the debittering capacity of such strains could be given. Strains with a high degradation rate of the bitter C-peptide were strains with a high sensitivity to lysis and therefore very suitable as debittering culture.

These strains do not contain protease activity at all, so they supply a net activity of peptidase activity, which is important for avoiding accumulation of bitter peptides in cheese.

The selected strains of mesophilic lactococci and thermophilic lactobacilli with the special ability of reducing bitter-tasting peptides have been organoleptically evaluated in Gouda cheese subsequently. In figure 4 the results of the taste deviation bitter in the sensory evaluation are shown.

Other causes of bitterness are the amount of rennet, pH of cheese milk, cooking temperature and ripening temperature.

Texture improvement

Melting milk fat in the protein-fat matrix, results in a smooth and pleasant mouth feel during consumption.

The milk fat plays as such a key role in the texture of cheese. If the fat reduction is not corrected, the cheese will become very tough, rubbery, less smooth and meltable.

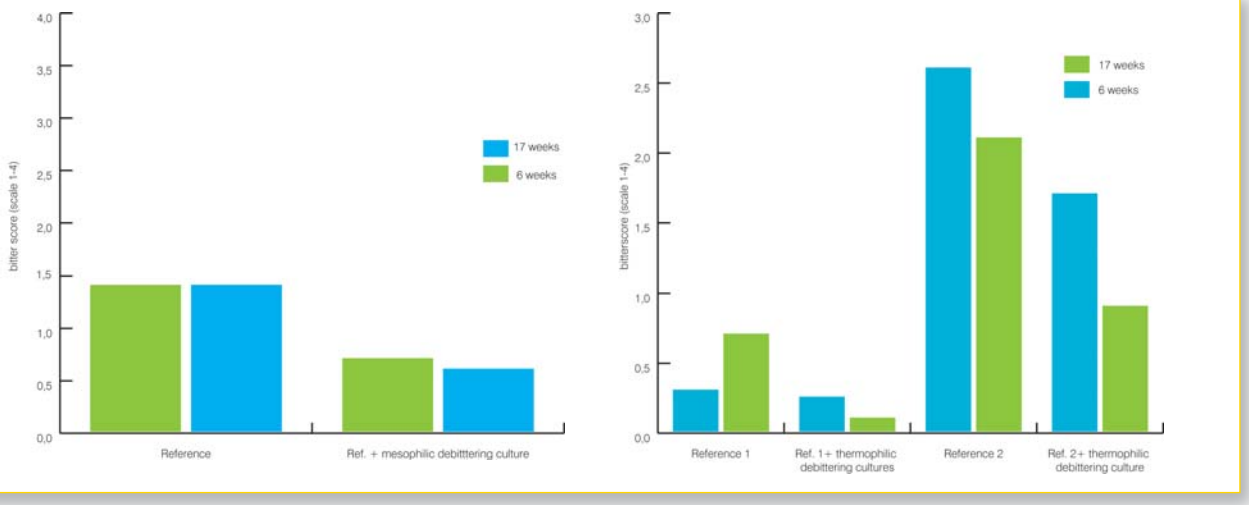

Figure 4: Organoleptic evaluation of Gouda cheese with addition of a mesophilic and thermophilic debittering culture

Corrections can be found to a certain extent in raising the moisture content of the cheese in order to make the texture softer. Another possibility can be found in modification or partly breakdown of the proteins during ripening with the use of certain adjunct cultures. This will result in a more soft texture due to the more intense proteolysis. Besides, the flexibility of the protein and fat matrix can be improved with the introduction of certain types of extra cellular polysaccharides (EPS). This EPS is naturally produced by certain lactic acid bacteria, and introducing EPS forming strains could greatly improve the texture of low fat cheese as shown in figure 5.

Measuring the force/gradient (N/mm) of cheese samples shows us the effect of changes on the texture of the low fat cheese samples. The tougher a cheese, the higher the gradient needed to cut it. In this figure 5 the results are shown of measurements on 20+ Gouda cheese that had been ripened in coating at 13 C.

As shown, the gradient is significant decreasing in low fat cheese with an EPS forming culture and the same composition for water and fat content. From left to right the gradient is measured respectively from the rind of the cheese to the centre.

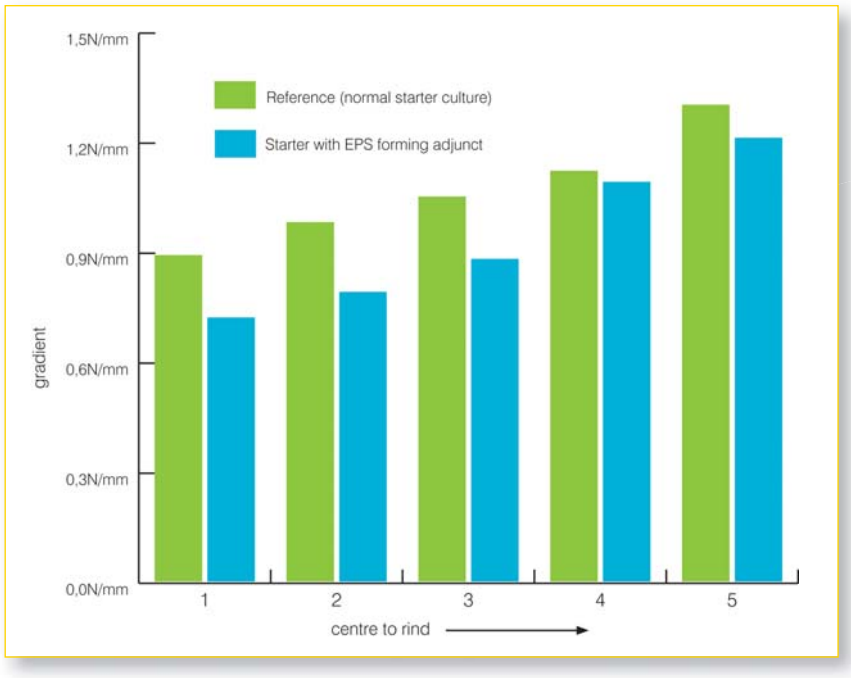

Figure 5: Gradient of low fat cheese with EPS from rind to centre

Health Plus™ cultures

- L range-thermophilic cultures with debittering and flavour- and texture improving properties
- S range-EPS forming cultures with texture improving properties.

CSK will stay focused on the development of healthy and premium cheese concepts in the international dairy market, where fundamental research in the creation of new and improved flavour and texture profiles will keep a central position.