TATE & LYLE

Mastering Food Texture

with Tate & Lyle TEXTURE-VANTAGE® Expert Systems

Perfecting textures in next-generation products

Consumers are constantly on the lookout for new and satisfying sensory eating and drinking experiences. Changing perceptions of food and beverages has created a more adventurous consumer with an appetite that goes beyond taste, seeing a shift in preference towards all-rounded sensory experiences including texture.

With over 160 years of experience in research, development and innovation with food, Tate & Lyle is a leading market innovator in helping food and beverage manufacturer partners create proven texturant solutions to overcome their formulation challenges.

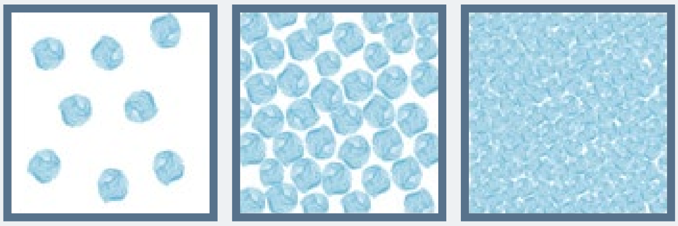
Gain mastery of starch-thickened food textures with TEXTURE-VANTAGE® Expert Systems

Choosing the right texturiser can be a lengthy and difficult process. To address this challenge, Tate & Lyle has invested in a suite of TEXTURE-VANTAGE® Expert Systems to help food and beverage manufacturers with the formulation process.

As a leader in specialty starches, we have a comprehensive portfolio of over 250 corn, tapioca and potato products, offering a range of distinctive functionalities such as thickening, film-forming, gelling, and emulsifying, designed for specific product categories, from sauces, soups, dressings, yoghurt to fruit fillings and more.

For food products texturised by starch thickeners, the textural properties are dictated by the **phase volume (cq), a combination of starch concentration (c) and swelling volume (q)**. Starch-thickened food textures vary from low to high phase volumes (Fig. 1).

- In the diluted system where phase volume **cq < 1**, starch particles are sedimented.
- In the close-packed system where phase volume **cq = 1**, starch particles begin to make contact, accompanied by an increase in viscosity.
- In the concentrated system where phase volume **cq > 1**, starch particles are more deformed to fill the space, resulting in a notably thickened, firmer, and denser system.



Dilute (cq < 1) | **Close-packed (cq = 1)** | **Concentrated (cq > 1)**

Fig. 1. Starch-thickened products can be modelled after, and behaviour-predicted by the particle phase volume (cq).

Predict textures reliably with Tate & Lyle TEXTURE MAPS

Tate & Lyle uses scientifically-backed, simple texture maps to help formulators visualise and predict the viscosity and sensory characteristics of starch-thickened foods. With the help of our technical service team, formulators can efficiently optimise product formulations for consumer preference, accelerate product development and reduce the need for extensive consumer trials.

Starch-thickened foods via particulate suspensions will have food textures that vary according to their **Phase-Volume (cq)**. With increasing starch concentrations, the food's viscosity increases, but starches with higher swelling volumes tend to have even higher viscosity when the starch concentration is fixed. Concurrently, the food textures will develop varying degrees of shear thinning (viscosity drops while shearing), elasticity (density and firmness), and cohesiveness (stringiness).

Understanding the Texture Map (Fig. 2) would be helpful for food formulators to select the right starch (with unique swelling volume) at the right concentration level to create desirable food textures, streamlining the product development process cost-efficiently.

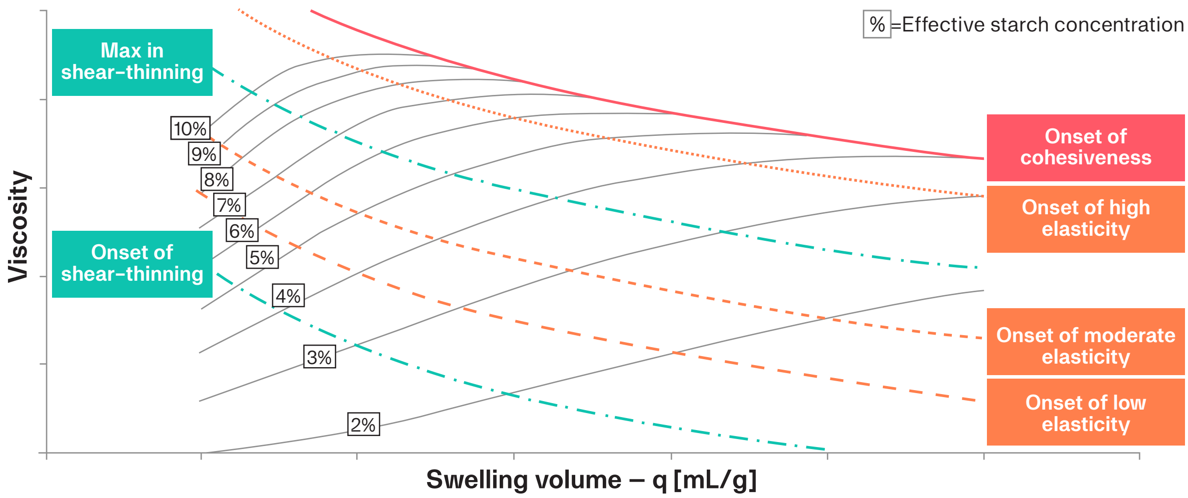


Fig. 2. Texture Map which explores the starch concentration and swelling volume in relation to various textural properties.

Overcoming challenges to achieve desired outcomes for Fruit Fillings

Many shelf-stable bakery products contain assorted fruit fillings. In such applications, starch is usually used as it provides bake and freeze-thaw stability to fruit fillings. Several non-starch hydrocolloids such as pectin produce glossy and translucent textures but does not provide bake stability, or jelly-like textures which cause difficulties in piping and syneresis after thawing. Using starch in fruit fillings is a cost-effective solution that can provide various texture with shelf-stability, bake-stability and freeze-thaw stability.

Challenge #1: Handling
Achieving easy-to-pipe capability with minimal tailing

Long and stringy textures are associated with cohesiveness. Food systems that are overcooked or have undergone a harsh process will lead to overswelling or rupture of starch granules, causing the phase volume to fall into the cohesive regions. (Fig. 3)

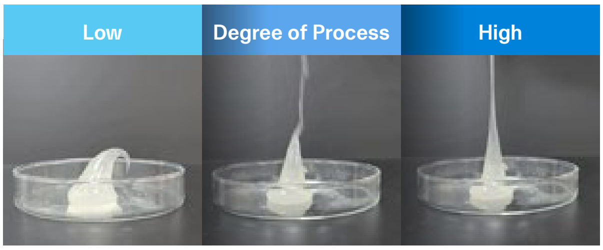


Fig. 3.

Challenge #2: Clarity
Achieving an appealing appearance with good clarity, glossy and smooth surface

Starches with higher swelling volume will have better clarity. High sugar contents suppress starch granule swelling but can be prevented by gradually adding sugar. (Fig. 4)

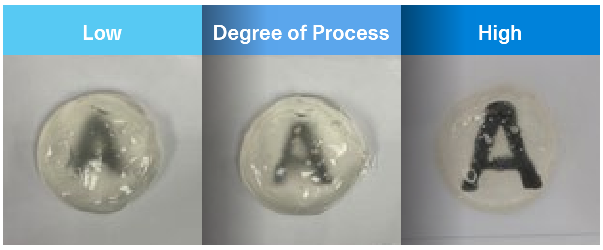


Fig. 4.

Challenge #3: Bake Stability
Achieving shape retention upon baking

Fruit fillings with high solid content (regardless of viscosity) are more likely to have greater bake stability. A harsher process induces greater swelling volume which leads to lower bake stability for certain types of starches. A low-stability starch will have a higher tendency to be unstable during the baking process. (Fig. 5)

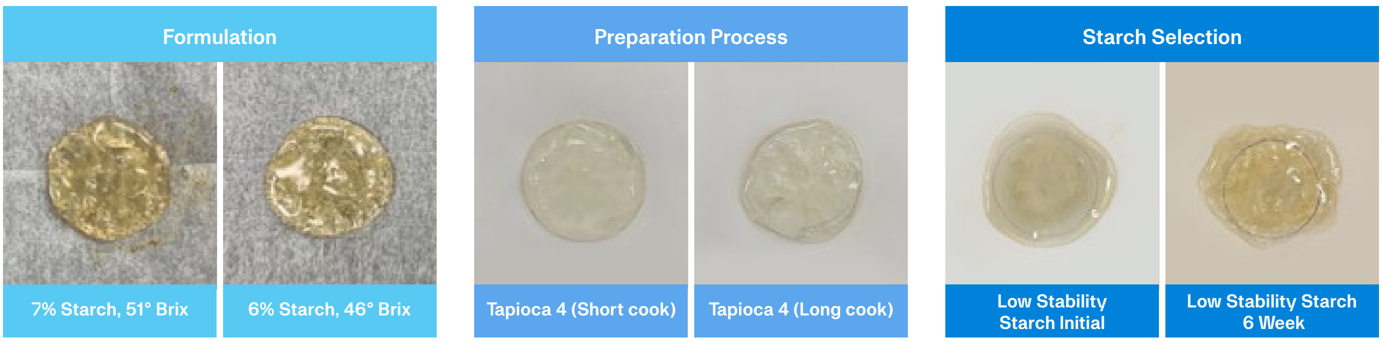


Fig. 5.

Understanding fruit fillings' textures in relation to texture maps

Key Considerations

Functionality
- Handling
- Clarity
- Bake stability

Formulation
- Sugar content
- Solid content
- pH
- Choice of Texturants

Process
- Temperature
- Processing time
- Shear rate
- Type of equipment

Storage conditions
- Chill
- Ambient

Factors Affecting Starch Swelling

Understanding the phrase volume (cq) could help solve these challenges by selecting the right starch, adopting the correct formulation, and optimising the necessary conditions.

Take a look at the following simplified Texture Map (Fig. 6) – with starch concentration level fixed at 7%.

In this example, starch is the sole texturant and fruit fillings are prepared with different types of starches.

The swelling volumes, or power (q), of selected starches, fall into the range of 25-65 ml/g after cooking. Therefore, the textures of fruit fillings can be expected to fall within the elastic and cohesive regions.

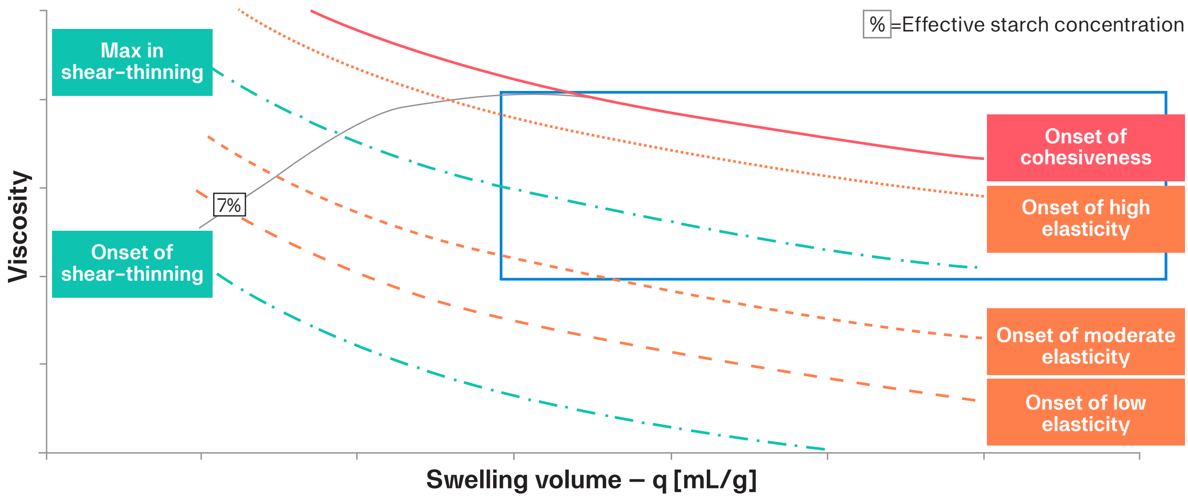
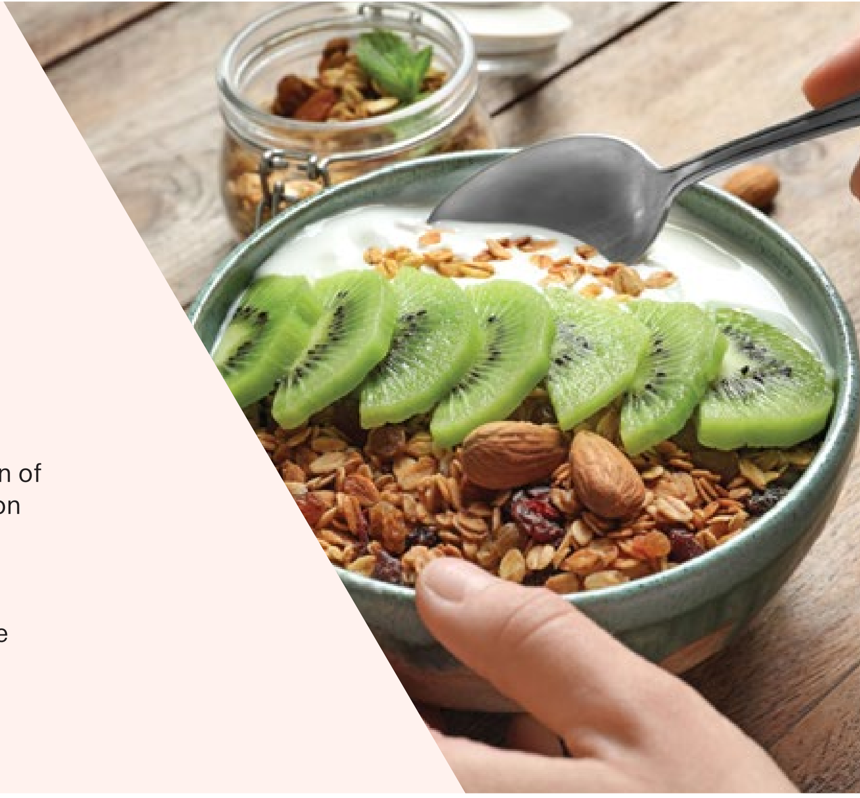


Fig. 6. Texture Map which explores the viscosity level in relation to the starch swelling volume.

Addressing difficulties in achieving desired outcomes for

Yoghurt



Dairy yoghurt is produced via lactic acid fermentation of milk which leads to a decrease in pH level and gelation of casein micelle molecules. The addition of starch, usually tapioca or corn starches, into yoghurt is common. Usage levels are usually controlled by food regulations which vary across countries, although the typical amount of starch used is 1-2%.

Challenge #1: Presentation

Achieving the ideal textural appearance

Starch selections that fit the production process will lead to the perfect degree of granule swelling. Together with formulation contents such as protein and starch, a glossier and smoother surface will be achieved.

Challenge #2: Syneresis

Preventing or reducing syneresis without using stabilisers (e.g., pectin, gelatin)

Pectin and gelatin are commonly used in yoghurts to stabilise proteins which prevent and reduce syneresis. High process tolerance and high stability starches with the right degree of swelling can reduce syneresis through its water-holding capacity.

Challenge #3: Mouthfeel

Achieving desirable mouthfeel

The right starch selection at the right degree of swelling could enhance the mouthfeel (creaminess, firmness and fast melt-away) of yoghurt.

Key Considerations

Textural Preference

- Drinking yoghurt
- Stirred yoghurt
- Gelled or Greek-style yoghurt

Formulation

- Fat & protein contents
- Regulations*
- W/WO stabiliser
- Choice of Texturants

*Type & usage level of approved ingredients

Process

- Type of equipment
- Temperature
- Homogenisation pressure (up/downstream)

Storage conditions

- Chill
- Ambient

Understanding yoghurt textures in relation to texture maps

Tate & Lyle's texture maps will be a useful guide to help you predict the textures of yoghurt products depending on the relative ratio of milk protein concentration to starch phase volume (cq).

Protein concentration (%)	Starch phase volume [cq]: Low (0–0.4)	Medium (0.4–0.8)	High (>0.8)
High (>6%)	Very firm gel	Firm, cohesive gel	Firm, cohesive paste
Medium (4–6%)	Cuttable gel	Firm gel	Firm paste
Low (2–4%)	Drinkable / Very soft gel	Soft gel	Soft paste

Take a look at the 3 samples of stirred yoghurt below (Fig. 7). The samples were prepared using the same formula and method but with different types of starches. The yoghurt samples contain low protein (2.55%) and all 3 selected starches have similar swelling power, resulting in similar phase volumes (cq).

A higher phase volume (cq) will lead to better shape retention and produce firmer textures in yoghurt products.

Fig. 7. Samples of stirred yoghurt prepared with the same formula and method but with different starches.

Tips for optimising processes & starch selection

One major influence of starch selection for yoghurt application depends on the process, as it is usually involved with shear forces from the homogenisation step. High-shear homogenisation operates at a high velocity with high temperatures and application of heat during the preheating and pasteurisation process. Therefore, high to very high process tolerance starches are preferred in yoghurt applications. On the other hand, the shelf-life of yoghurt is another key factor for consideration during starch selection. To ensure a long shelf-life, high-stability starches are highly preferred.

Influence of pre-heating temperature

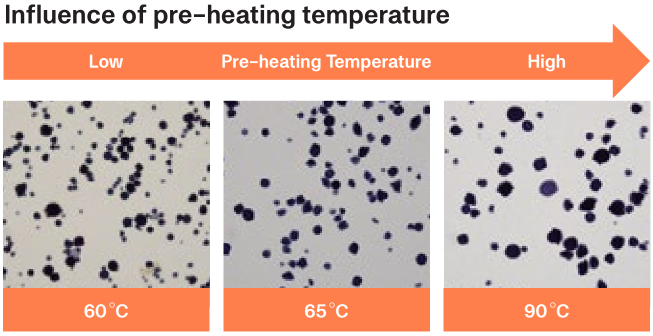


Fig. 8. Yoghurt model system which shows the degree of granule swelling with various pre-heating temperatures.

Take a look at the following yoghurt model system (Fig. 8) which demonstrates the degree of granule swelling due to different pre-heating temperatures. The selected starch has a very high process tolerance, therefore pre-heating at 60°C might be too low for this starch. It is important to find a suitable pre-heating temperature which facilitates starch granule swelling volume to its optimum without rupturing. High pre-heating temperatures enable starches to swell greater, however, granules may rupture during the later steps – homogenisation and pasteurisation.

Overcoming textural challenges for

Sauces, Soups & Dressings (SSD)

SSD products provide consumers with varying degrees of viscosity and elasticity. The addition of starch is a common cost-effective way to mastering SSD textures. Having a good understanding of the relationship amongst starch concentration, starch swelling volumes, and SSD textures is key to making product developments successful.

Challenge #1: Low viscosity

Solution: Selecting the right starch with greater swelling volume

Selecting the right starch is key to resolving issues with low viscosity. In some situations, we may have SSD products with thin, flowing textures (Fig. 9A). Instead of increasing starch concentrations that increase viscosity levels, we can select the right starch with greater swelling volume at the same concentration. With better mounding properties, both viscosity and elasticity can be improved significantly (Fig. 9B).

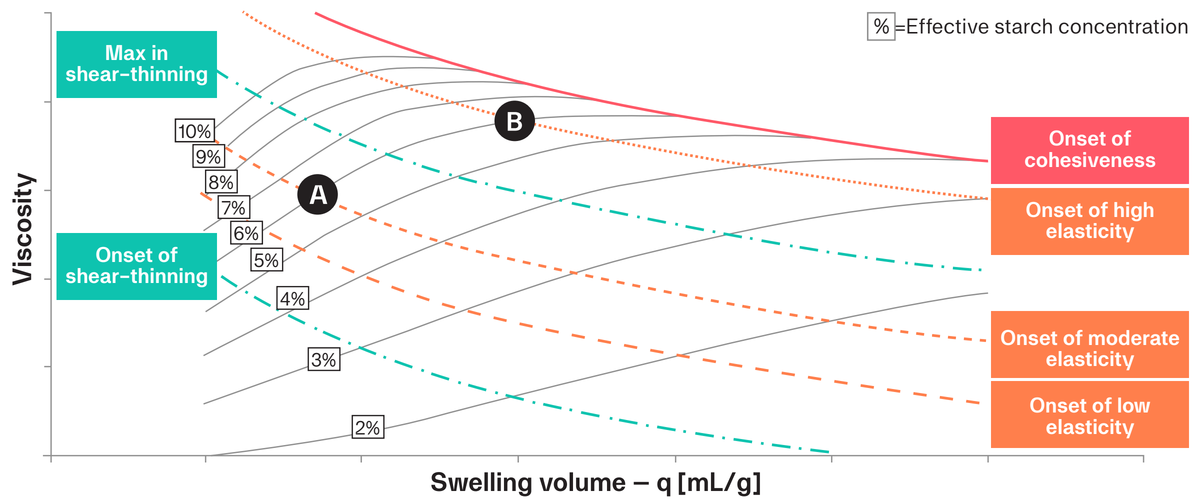


Fig. 9. Textural properties (viscosity & elasticity) of SSD samples prepared at different starch concentrations and swelling volumes.

Challenge #2: Inadequate swelling

Solution: Ensuring optimal processing conditions to avoid under-processing

Optimising the processing conditions fitted to the selected starch is important in achieving the ideal texture. When a starch is designed to have high process tolerance but is under-processed, the starch will not fully swell to provide an adequate viscosity level (Fig. 10A). Thus, it is essential to ensure that the starch is processed according to its subjected processing conditions (e.g., heat, acids, and shear) to allow the starch particles to fully swell and thicken the overall food textures (Fig. 10B).

In contrast, when a starch is designed to have low process tolerance, it is also important to ensure that the starch is not over-processed, which would cause the starch particles to break apart and cause a drop in viscosity.

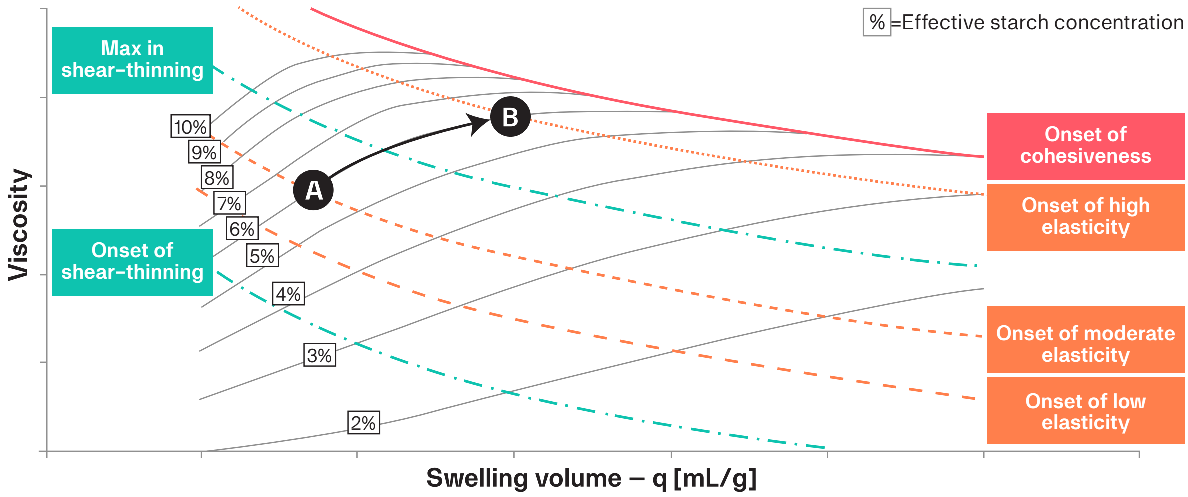


Fig. 10. Textural properties of a sauce prepared with a high-process-tolerance starch under the kettle (A) and UHT (B) cooking.

Challenge #3: : Long, stringy textures

Solution: Maintaining starch granule integrity at the right concentration

Maintaining the integrity of starch granules at the right starch concentration is essential in avoiding long stringy textures as they are usually not desirable in SSD products. The undesirable outcome is usually a result of starch fragmentation, calling a need for optimised processing conditions, and an overdose of starch.

When the concentration of a selected starch exceeds “the threshold of cohesiveness”, the food textures would become stringy and cohesive (Fig. 11A). Below this critical starch concentration, the products will be thick, firm, and dense in textures without tailings (Fig. 11B). Thus, it is essential to know the right starch concentration to use when formulating SSD products.

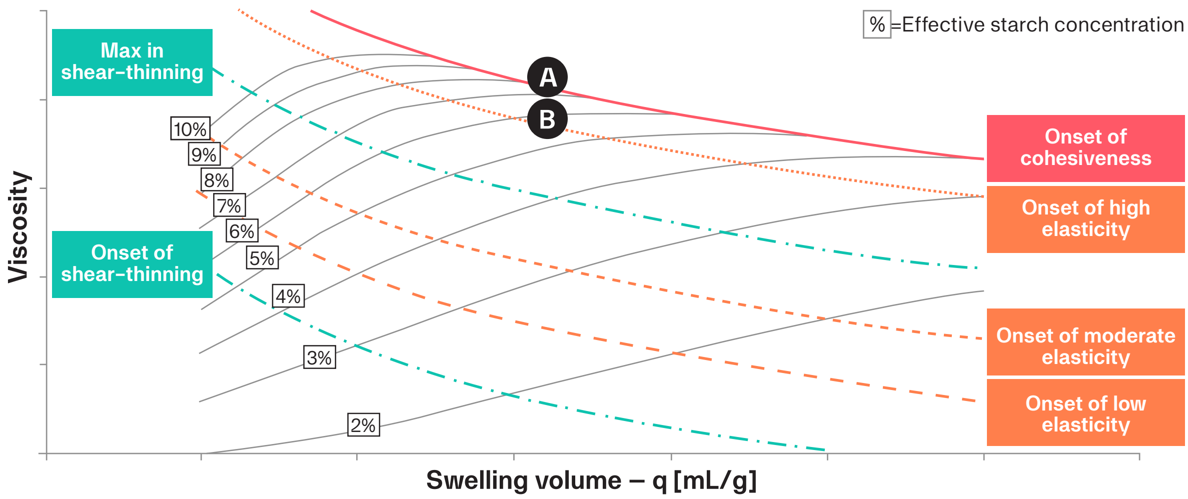


Fig. 11. Long (A) and short (B) textures of SSD textures found above and below the onset-of-cohesiveness curve, respectively.

Partner with us to create market-leading products

Multi-sensory experiences that offer novelty, over-the-top indulgence and targeted health benefits are set to drive consumer preferences in years to come. Leveraging on texture as a recently identified mega trend can differentiate your products in the market to help your customers achieve the right mouthfeel.

Through comprehensive systematic reviews and randomised control trials, Tate & Lyle's scientific-led, innovative approach uses groundbreaking research to develop new processes and solutions to help you overcome your latest texture challenges.

Speak to us and learn how our texturant experts can help you overcome textural challenges and formulate market-leading products: https://www.tateandlyle.com/texturant-form