1283_02 (ENG)

Improving and maintaining softness of breadmaking products

Abstract

Softness in breadmaking products is the result of several properties (suppleness, tenderness, elasticity, *etc.*), the many combinations of which give rise to different types of softness, such as: the supple and elastic crumb of a baguette, the soft and "melt-in-the-mouth" texture of a sandwich loaf, *etc*. Focusing on softness in a breadmaking product therefore means paying attention to the product as a whole. Everything that can affect its texture must be analysed: ingredients, processes, preservation parameters. It is the balance between these different components, along two lines, which makes it possible to attain the objective sought after. These two lines are: the improvement of the initial softness and its shelf life being maintained for a maximum duration for the purpose of consumption. Depending on the desired softness, many ingredients can be added (enzymes, emulsifiers, hydrocolloids, fats, *etc.*). Nonetheless, it is still necessary to make the right choices in order to obtain a tailor-made result! ■

Introduction

Softness in breadmaking is important for a wide range of products: from the sandwich loaf to the crumb of the baguette bread, doughnuts and brioche. Furthermore, the scope of its application continues to expand. Softness is often associated with the notion of freshness and is thus considered as a quality indicator. The sensation that it provides is appreciated by the consumer, but expectations in terms of softness vary, especially from country to country. This is why it is important to define the type of softness looked-for based on the type of products manufactured and the targeted consumers, and then to adapt the recipes and processes in order to achieve the optimum softness and to maintain it over time.

1. Softness, a complex notion

Since expectations in terms of softness vary from country to country, across cultures, and depending on consumer preferences, softness is a complex characteristic of bread products, and it must be well-defined.

1.1. A strong cultural dimension

Softness helps create texture in the product. It is a parameter marked by a cultural dimension specific to each country. Consumers' expectations vary widely, as illustrated, for example, in the case of Africa where all types of textures coexist (Figure 1).

1.2. Multiple terminology

Softness also gives rise to an important question in terms of semantics. What do we mean when we talk about the softness of a bread product? For scientists, this refers to *"the sensory and functional manifestation of the structural, mechanical and surface properties detected by the visual, tactile and kinaesthetic senses"* (Szczesniak, 2002). For bakers, on the other hand, the softness of a bread product relates to a particular issue: slowing down the hardening of the crumb and prolonging the shelf life of the product. Lastly, for the consumer, the softness of a bread product will not only be an indicator of organoleptic quality, but also of freshness. Therefore, the varying expectations with regard to softness depends on the nature of each category's knowledge: that of the consumer (layperson knowledge), researcher (scientific knowledge) or baker (business knowledge) (Roussel *et al.*, 2006).

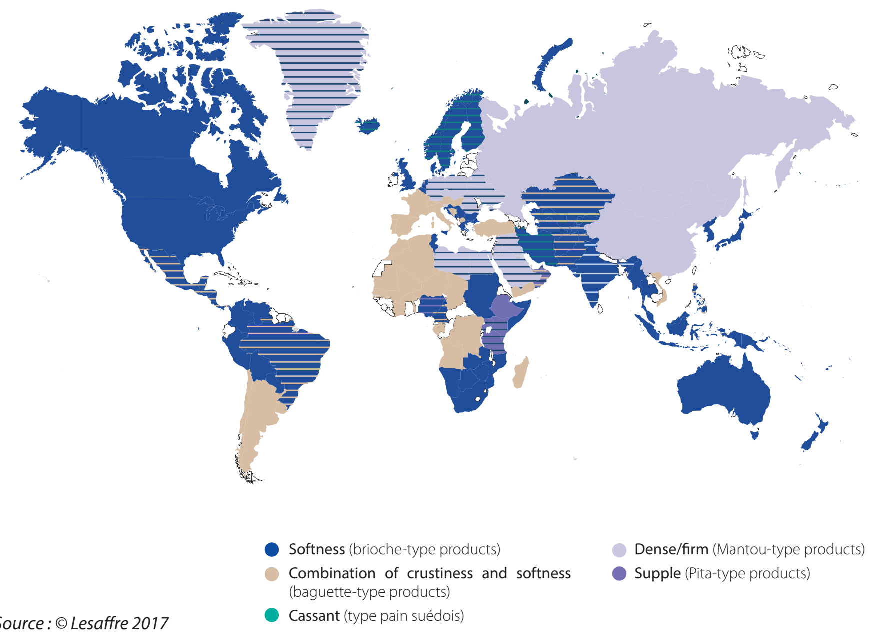
These differences in perspectives are also explained by the multi-dimensional aspect of the sensory experience, which involves the sense of touch, the "chew" characteristics (decreased elasticity, moisture, creaminess, silky texture), the appearance (volume, air holes), long shelf life, *etc.*

In the absence of a single definition, it is, therefore, the texture components that make it possible to characterise the softness: suppleness, tenderness, pastiness, elasticity, *etc.*

2. The Origins of Softness

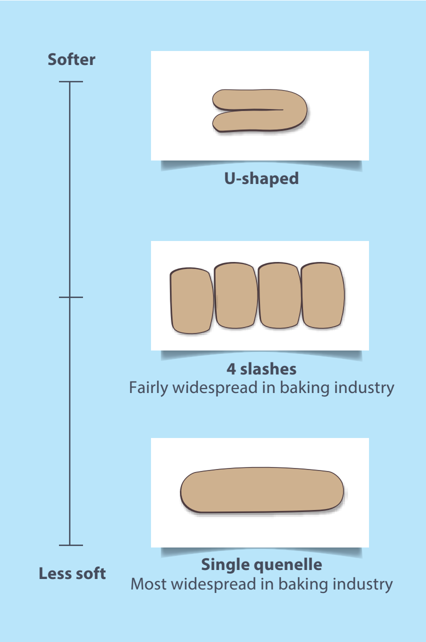
The softness of a product depends mainly on its moisture content, fat content, volume and the structure of the crumb. These factors are the result of the ingredients used in the recipe and the manufacturing process used. They give the product its initial softness, perceived by the consumer as a sign of quality.

Figure 1. World distribution of the main bread textures.



Source : © Lesaffre 2017

Figure 2. Main ways of shaping



U-shaped and snail-shaped shaping is seen as producing a significantly softer crumb than other shapes.

Source : © Lesaffre

2.1. Influence of ingredients

All the ingredients used in breadmaking influence the softness of the products.
As the foremost ingredient in breadmaking, **flour** chiefly contributes to the presence of air holes in the bread crumb and to the tenderness of the bread crumb. For example, a low-protein flour will produce a dense crumb, whilst a high-protein flour will produce a more resistant and elastic crumb. It is, therefore, important to know the flour quality in order to sketch out the recipe and the process in such a way as to achieve the desired softness.
Added fat, especially in brioche or puff pastry products, will influence the creaminess of those products. Fats having a melting point of around 30° C will be producing a sensation of softness in the mouth, hence the importance of taking the melting temperature into consideration when choosing this category of ingredients.
Eggs will also play an important role in creating softness and air holes in such types of products. Egg yolk helps create a stable emulsion, while egg white proteins, which coagulate at 70° C, helps with the keeping of a short cooking time and, therefore, the preservation of a maximum amount of moisture.
Sugars increase the tenderness and moisture of the crumb by lowering the quantity of free water (measured by A_w). As a result, they help increase the shelf life of the product.
Lastly, the use of **sourdoughs** generally creates firmer textures. Some types of sourdoughs have a positive action on the softness thanks to the polysaccharides they release into the dough. The latter are complex sugars produced by certain sourdough bacteria. They act in almost the same manner as hydrocolloids: exopolysaccharides are thought to allow better water retention, interacting with the starch and gluten in the dough (Jakob *et al.*, 2012). In so doing, they might, in some cases, reduce the strength and elasticity of the dough (Galle *et al.*, 2012) and improve bread preservation.

2.2. Process influence

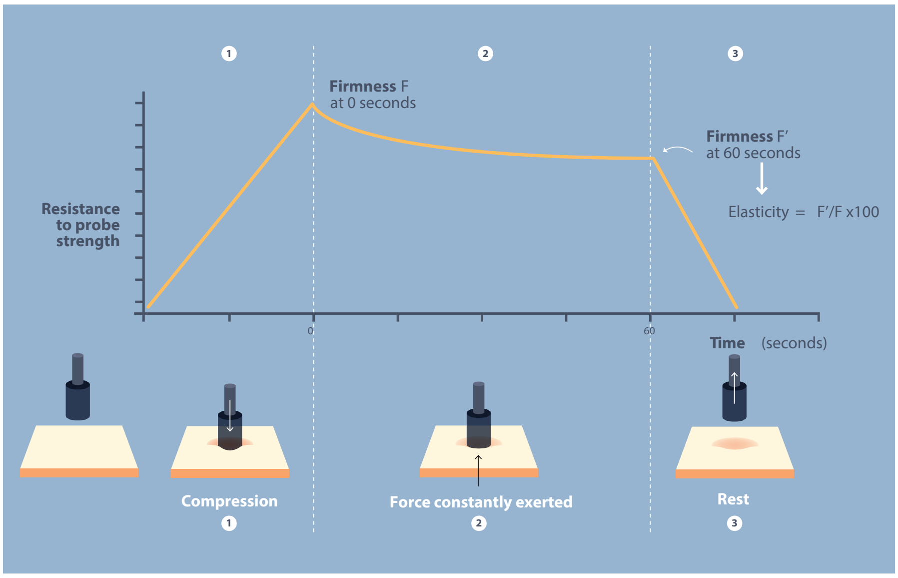
Kneading is a key component where softness is concerned since the addition of air trapped in the dough at this stage will result in air holes being incorporated in the baked bread. The different kneading techniques influence the structure of the air holes in the bread. The rate of mixing will impact on the incorporation of air, while the use of the partial vacuum will favour the formation of a crumb structure with very fine air holes.
With regard to the sandwich loaf, the **shaping** of the dough will also impact on the crumb structure. A U-shaped shaping produces more uniform and finer air holes than when shaping the dough into a ball or quenelle (Figure 2).
Fermentation, too, has an impact on the air holes and the volume of the crumb. Indeed, the use of the American process for breadmaking called "Sponge & Dough", characterised by two successive kneading and separated by a dough rest time of several hours, allows for a better hydration and development of the dough. The result is a fine, even-sized crumb with air holes which are smaller in size than the ones produced when the straight dough process is used.
Other techniques may also change the softness, such as the addition of **scalded flours** (*Lesaffre Technical Library* 1289. Softness in rye bread). For example, in Russia, Zavarka is added to the manufacture of rye bread. The scalded flour improves the organoleptic qualities, the softness, the chewiness, the sense of freshness in the mouth, as well as the preservation, of the finished product.
Sweating is another key step which influences the texture of the bread. It refers to the cooling period the bread is allowed after baking. At this stage, the moisture in the crumb escapes in the form of water vapour. For packaged products, therefore, the risk of moisture being present inside the wrapping in the case of a much-too-quick packing after baking (risk of greater mould growth) must be evaluated and balanced against the risk of the product surface drying out, which can occur in the case of a much-too-slow packing (excessive loss of moisture, which decreases the softness).

3. Measuring softness

3.1. The instrumental techniques

The most common instrumental technique for measuring the softness of a bread is the texture measurement technique using a texturometre. Indeed, since the softness of the bread correlates with the ability of its crumb to be compressed, mechanical compression/relaxation devices can be used to evaluate the softness. Two principles must be taken into account:
• the fresher the bread, the lower the compressive strength;
• the higher the bread density, the lower the compressive strength.
The texturometre is comprised of a probe which exerts pressure on a product slice placed on a tray. The response of the product slice is measured for a length of time set by a standard process (Figure 3). A curve representing the stress (force divided by the surface area of the compression module), as a result of the deformation, is obtained for each sample measured. The slope at the beginning of this curve gives the value of the Young's modulus of the sample and represents its firmness. The larger the Young's modulus, the firmer

Figure 3. Principle of instrumental measurement of the crumb's resistance to deformation (texturometre).



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the product. Elasticity is expressed as the ratio between the forces generated by the crumb between compression and relaxation (final/ initial force).

The texturometre also helps to evaluate other attributes of texture, such as:

- cohesiveness: the force which causes the crumb to yield under the weight of the probe;
- stickiness: the resistance exerted by the crumb on the module when it is lifted.

A very common method for analysing the structure of the crumb is the image analyser, which gives information on the texture of the bread. The apparatus generates very precise images of the crumb and calculates the size of the air holes, their depth, their distribution, *etc*.

Other instrumental methods, which are more anecdotal in nature, make it possible to evaluate the softness of the bread and the staling phenomenon by measuring various parameters associated with the structure of the crumb. These parameters include: differential scanning calorimetry, near-infrared reflectance spectroscopy, nuclear magnetic resonance spectroscopy, X- ray crystallography, colorimetry or impedancemetry (Fadda *et al.*, 2014).

Biochemical parameters, such as the starch and water content of the breads, or their hydration properties (water absorption capacity, hydration kinetics), also provide information on the softness of the bread.

3.2. Sensory measures

Sensory analysis makes it possible to delineate different types of softness, identify typical profiles for the bread products and to know consumer preferences. For this, a precise procedure must be developed for each characteristic which needs to be described (suppleness, elasticity, crumb firmness, creaminess in the mouth, *etc*.).

The use of relevant and discriminating descriptors makes it possible to accurately distinguish between the sensations. Lesaffre has thus developed a range of descriptors to describe different types of softness. These descriptors constitute a benchmark for establishing sensory identity cards (Figure 4) (*Lesaffre Technical Library* 1286. Mastering the taste in breadmaking).

Other methods for faster sensory evaluation, such as Temporal Dominance of Sensations (TDS), have been recently developed (Pineau *et al.*, 2009). The TDS describes the sequence of sensations perceived during the tasting of a product. In the TDS, panellists have to select the dominant attribute perceived at each moment of consumption from among a list of attributes. Each attribute is then linked to a dominance rate at a given time. This helps to obtain dominance curves for each attribute over a length of time and to, therefore, visualize the perception dynamics during consumption (Figure 5).

3.3. Complementarity of measurement methods

Instrumental and sensory methods are complementary. When combined together, these methods can give rise to correlations which help understand the dynamics involved in the product perception pro-

Figure 4. Example of sensory identity cards for the "elastic" and "gummy" type of softness (shape memory upon compression)

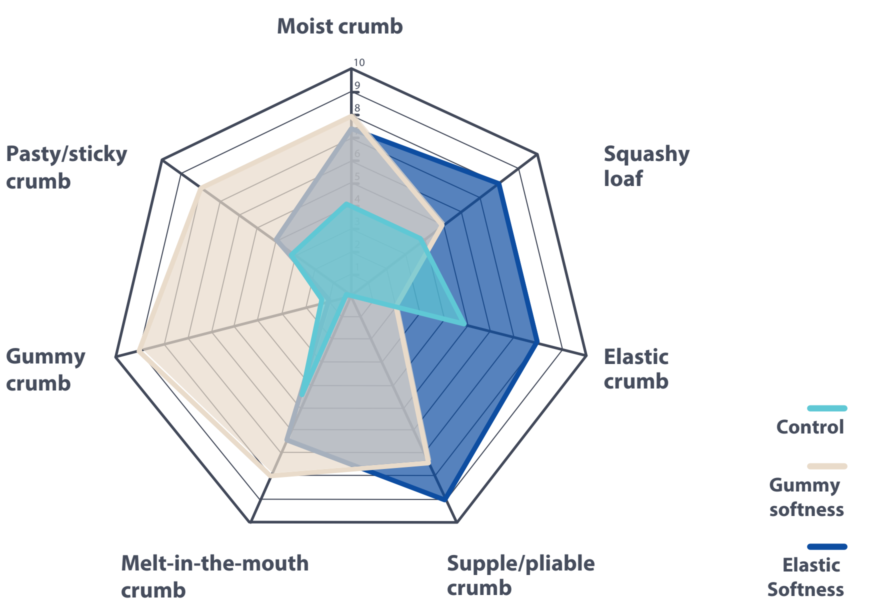
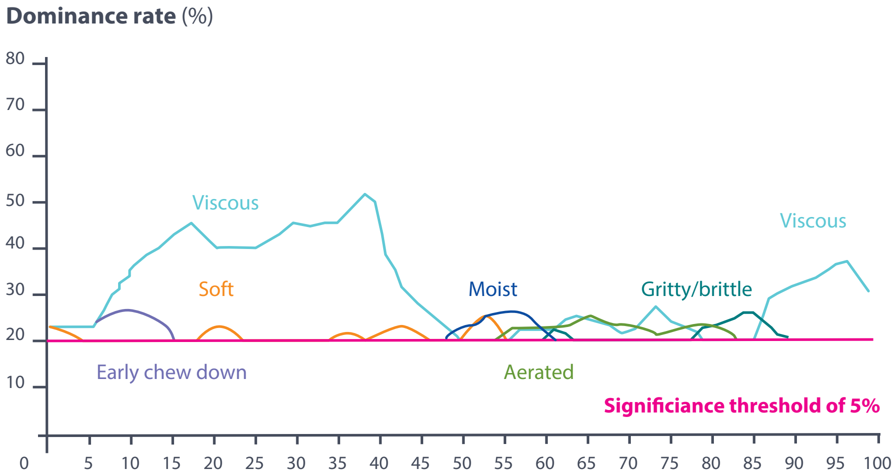
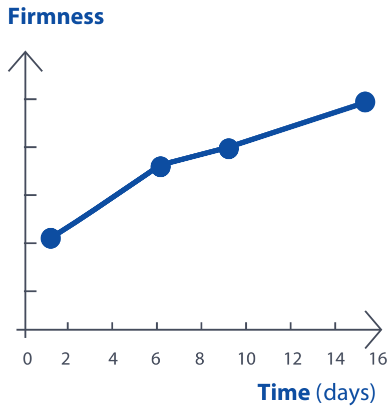


Figure 5. Example of measurement curves obtained through the use of the temporal dominance of sensations (TDS) method on a gluten-free bread.



Source : Référentiel Lesaffre, 2016

Figure 6. Example of the progression of firmness on a sandwich loaf over time.



Staling intensifies over time, with an increase in the resistance of the crumb.

Source : © Lesaffre

cess, irrespective of the type of sensory criteria considered (appearance, touch, chew). Thus, the fineness of the crumb and the homogeneity of the air holes, evaluated by a panel, correlate with the fineness of the crumb measured by image analysis, while the suppleness of the crumb often correlates with the Young's modulus of the crumb obtained after a compression test (Lassoued *et al.*, 2008). Some other examples, in the course of sensory evaluations, include: the firmness measured with the texturometre positively correlates with the resistance to deformation, while the relaxation rate (always measured with the texturometre) positively correlates with the elasticity. These correlations remain dependent on the recipe and the age of the breads.

4. Loss of softness

4.1 The staling processes

When stale, the crumb becomes firmer and less elastic. It dries and crumbles. This results in the consumer refusing to purchase the bread over time.

This natural phenomenon is mainly due to the process of starch retrogradation (Fadda *et al.*, 2014) which results from the migration of water from the crumb to the crust. In fact, staling begins at the moment of bread sweating and continues throughout storage. Indeed, during this process, amylose rapidly regroups and hardens the crumb structure, and amylopectin rearranges into a more crystalline structure.

It is the above-described double modification of structure which is called starch retrogradation and which makes the crumb firm and brittle (Figure 7). This phenomenon can be countered by subjecting the crumb to a new warming stage (toasting), which again frees the amylose and amylopectin chains.

It is posited that gluten proteins also participate in the staling process. Indeed, it is believed that there is an inverse relationship between the protein content of bread and its rate of staling (Kim and D'Appolonia, 1977). As a result, it is advanced that bread rich in gluten would harden less quickly. The role gluten plays with

Starch, amylose and amylopectin

Starch is a reserve polysaccharide found in many plant species. It is in the form of grains (or granules) in its dry state. These granules may be of different shapes and sizes, depending on the origin of the starch. Moreover, it is composed of two types of molecules made up of glucose units: amylose, which is of a linear structure, and amylopectin, which has a dense and highly branched structure.

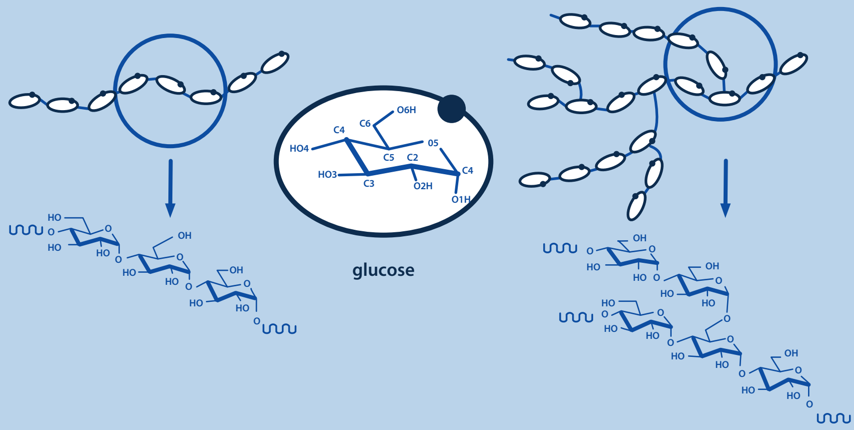
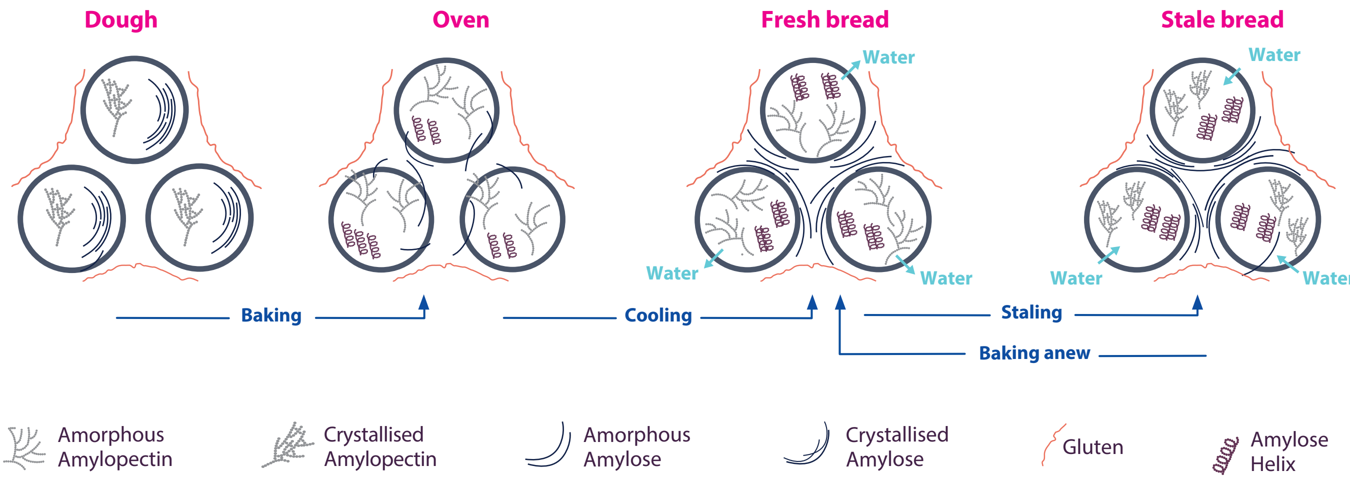


Figure 6. Microscopic changes during staling: starch retrogradation.



During baking, starch hydrates: amylose and amylopectin solubilize (gelatinisation). During cooling, amylose recrystallizes (retrogradation): amylose helices form double helices and release water molecules. During storage, amylopectin, in turn, recrystallizes.

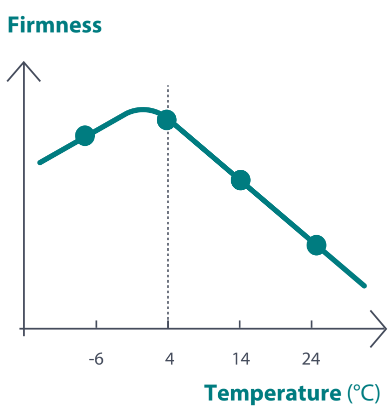
Source : © Lesaffre

regard to the staling process is thought to be due to interactions with starch (Curti *et al.*, 2014).

4.2. Impact of storage conditions

Storage conditions determine how well the softness of the crumb is preserved. The goal is to minimise changes in the structure of the crumb during storage in order to preserve its suppleness. Staling intensifies over time, bringing about an increase in the resistance of the crumb (Figure 6).

Figure 8. Effect of the storage temperature on stale bread.



Starch retrogradation reaches its maximum speed at a temperature of 4° C.

Source : © Lesaffre

An inadequate storage temperature will impact negatively on the preservation of the softness. Indeed, starch retrogradation reaches its maximum speed at a temperature of 4° C. Hence, if the product is kept at a low temperature (near 4° C), staling will be rapid (Figure 8). This explains the fast staling of bread in winter, why filled sandwich loaves need to be preserved in refrigerated display cases and why storage warehouses maintain a temperature of 20-25° C and a humidity level of about 65%, which are the optimum conditions for the preservation of the softness of bread.

5. Improving and preserving crumb softness

As seen previously, the ingredients and the breadmaking process play a key role in developing the optimum softness. However, this softness can be further increased through the addition of functional ingredients or sourdough, which also help delay staling. The shelf life of certain bread products can thus exceed three weeks, without there being any negative change to the softness of the product.

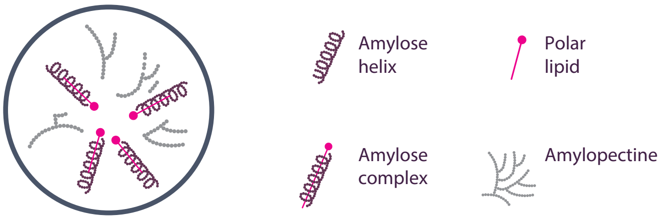
5.1. Enzymes

The staling phenomenon is slowed with the help of different types of enzymes. The enzymes interact with the matrix components during the baking process. The main types of enzymes involved are the **amylases**. These will be acting on the starch during baking by severing the amylopectin chains, in either a controlled manner or on a larger scale, by producing smaller molecules called dextrins. This limits the recrystallization of amylopectin. The crumb remains supple and hardens much less. Furthermore, dextrins also help to lower water activity. However, amylases should be chosen carefully so that they are not denatured before they can act. Indeed, the inactivation temperatures of these enzymes vary depending on their nature and their fungal or cereal origin.

Proteases, which can be of either bacterial or fungal origin, act on gluten. By breaking up peptide bonds, they weaken the gluten network and produce a less elastic and less resistant crumb. They must be handled with care since their actions last all throughout the process; they are only denatured during the baking process. The key is to choose a purified and highly specific protease (capable of breaking only a few peptide bonds).

By hydrolysing triglycerides, **lipases** pro-

Figure 9. Effect of monoglycerides on starch retrogradation.



The lipids form complexes with amylose helices. During coolong, the amylose complexes cannot restructure into double helices and recrystallize.

Source : © Lesaffre

duce mono- and diglycerides which are capable of creating complexes with other constituents of the matrix (gluten and/or amylose) and limiting starch retrogradation. Lastly, **xylanases** are capable of degrading the pentosans of flour. These are soluble or insoluble polysaccharides which can form strong bonds with gluten and, as a result, help strengthen the gluten network. The use of specific xylanases, consequently, makes it possible to optimise the rigidity of this network and the volume of the bread, resulting in a more supple crumb.

5.2. Emulsifiers

Emulsifiers are fat derivatives capable of stabilising a mixture of two immiscible constituents. In breadmaking, they promote the bonding between the dough constituents and improve their stability, making it possible to obtain, ultimately, a softer crumb.

Some emulsifiers, such as monoglycerides, form complexes with amylose, inhibiting their recrystallization. As a result, this limits the hardening of the crumb (Figure 9).

Other emulsifiers also play an indirect role in promoting the interactions between proteins and starch. This makes it possible to obtain a finer and well-aerated crumb.

5.3. Other ingredients which improve the softness

Hydrocolloids are macromolecules capable of binding a large quantity of water and, thus, of changing the rheology of the environment. They are divided into different categories: thickeners, stabilisers, gelling agents, *etc*. Hydrocolloids most commonly used in breadmaking are guar, carob and xanthan flours. Their ability to bind water well helps improve the freshness of the crumb. They also help combat water migrations, thus delaying the hardening of the crumb.

Humectants, such as glycerol or sorbitol, have a similar effect. Their role is to bind water strongly, thereby helping to lower the activity of water (A_w) in the finished product and improving the conservation of the bread product.

5.4. A matter of formulation

Even if all the ingredients mentioned earlier can be used individually, they are often used in combination in order to achieve an optimum result. Lesaffre's knowledge and know-how has enabled the development of solutions which combine the benefits of each component and their synergies in order to achieve the desired softness and a specific shelf life for a given product.

The performance of improvers depends on the choice and dosage of each of the ingredients included in the formulation, but the whole process must be taken into consideration (flour quality, process, type of equipment used, nature of the products manufactured). According to the formulation, a same family of ingredients can, therefore, help attain very different crumb characteristics, whether supple, elastic, tender and creamy.

Adjust the baking conditions in order to slow staling

Baking can modify the staling phenomenon through its effect on starch. Indeed, there is a link between the bread baking temperature and starch retrogradation: the higher the baking temperature, the more pronounced is the retrogradation (Giovanelli *et al.*, 1997). Some researchers have shown that slow baking at lower temperatures decreases the firmness of the crumb and, on the other hand, baking at higher temperatures and for a shorter period of time resulted in rapid staling (Bebes *et al.*, 2016).

Furthermore, the speed of the temperature rise and the baking time are likely to affect the action of the enzymes and could support the staling phenomenon.

Conclusion

Improving the softness of the product requires considering every step of the breadmaking process, from the choice of ingredients to storage conditions. Apart from the formulation of a suitable softness improver, Lesaffre provides support with regard to the following:

- defining the softness of different types of bread,
- describing the ideal softness for each category of products,
- taking into account all the parameters of the process in order to obtain air holes which will create the desired softness and shelf life.

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Other recommended publications

1289 *Softness in rye bread*

1286 *Taste in breadmaking*

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Contact : Stéphan Béague • *+ 33 3 20 81 61 00 • s.beague@lesaffre.com*

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