22 Production of Baked Goods from Wheat and Rye Flours – Methods and Analysis of Faults

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When we take a look at the bakery products made from wheat flour we find there are a number of products that have worldwide significance. We may assume that:

- wheat loaves
- toast loaves
- sandwich loaves
- baguettes
- flat bread

are produced in every continent. That means there is a global demand for the corresponding flours. Rye bread is also produced in many countries, and we shall discuss its special features in a separate section.

22.1 The Bread Production System

Mixing water and flour together triggers processes that follow the natural laws of biology, physics and chemistry:

- The flour absorbs water; it swells, binds water, and an input of mechanical energy results in the formation of a dough.
- The microorganisms present in the flour, and also the added yeast and bacteria, step up their metabolism and multiply.
- Enzymes naturally present in the grain and added enzymes change the ingredients of the flour together with those of the microorganisms.

These initial processes and all those that follow have to be controlled in such a way that they result in products of the same quality every day. To ensure this it is necessary to specify the parameters clearly.

When mixing starts, the times for the further steps in the process are clearly defined. If the wheat dough is processed directly, the time at which the dough portions have to be placed in the oven can be determined exactly. In factories with continuous plant this production sequence works well every day, and so it should also be feasible at bakeries that make bread in batches. Besides the direct production method there are also procedures in which the preparation of the bread is interrupted by refrigeration or freezing at the dough stage. Interruption of the baking process is likely to become more and more common in future too. Par-baked loaves and rolls are heated to inactivate the enzymes and microorganisms, then stored for completion of the baking process at a later date, near the time of sale (after days, weeks or even months if they are frozen). The once simple process has become increasingly complex, and this results in ever greater demands on the raw materials. Just as there is no uniform method, so there is no uniform flour for all baked goods; the flour has to be prepared more and more specifically to meet bakers' requirements.

We have to view the production of baked goods as a system that works according to definite scientific principles. The incredible diversity of bread types throughout the world is a result of systematic exploitation of the possibilities offered by constantly changing combinations of steps in the process or elements of the system. There are countless possible variations, from the choice of a flour through to the baking process. There is no single course that leads to ideal bread; the art is to optimize the individual elements. By that we mean ideal interplay of the elements within the system. If, for example, we change the ratio of flour to water (dough yield), this simple modification has effects on the temperature of the dough, the mixing and kneading process, the dough resting time and the further stages of the process. Using his empirical knowledge, the experienced baker almost automatically adjusts the individual processes to the situation at the time (ambient temperature, delays in preparation etc.); but as mechanization increases, the effects of every change have to be predicted and taken into account systematically

in all the following stages of the process. Only systematic working can prevent process control from degenerating into a matter of trial and error.

The Bread Production System is meant to show the general knowledge required for making bakery products – the basic philosophy, you might say. It does not give instructions for individual cases, nor does it include recipes. In this context the description of the processes is limited to the principles of processing wheat flours. Tab. 113 shows the individual steps necessary for turning raw materials into bread.

Tab. 113: General system of bread production, showing changes to the ingredients during the individual steps without interruption of the process by temperature reduction

Stage	Step in the process	What happens
1	**Selection of raw materials**	Collection of raw materials Determination of quantities Determination of quality
2	**Preparation of the raw materials**	Cooling or warming (water or flour) Preparation of a slurry (yeast, salt) Mixing (different flour types) Maturing (storage of flour) Cleaning (oil seeds, flour) Aeration (flour) Cutting and grinding (return bread) Swelling (sponge doughs, soured or unsoured)
3	**Dosing of raw materials**	Exact weighing of the individual components
4	**Dough making**	Wetting of solid ingredients (starch grains) Dissolving of water-soluble ingredients (sugar, proteins, pentosans) Swelling (gluten, pentosans) Gluten formation Enzymatic breakdown (starch, protein, pentosans)
5	**Dough maturing**	Continued swelling Structuring of the gluten Fermentation (formation of leavening gas, flavour formation) Enzymatic breakdown (protein, pentosans, starch)
6	**Intermediate kneading**	Removal of the leavening gas Increase in the number of pores Structuring of the gluten
7	**Dividing of the dough**	Removal of the leavening gas Determination of the weight
8	**Dough shaping**	Removal of the leavening gas Structuring of the gluten Tautening of the surface (rounding) Tautening of the lateral surface (moulding) Structuring for the proof time Structuring for the final shape Determination of the shape of the baked product
9	**Proving**	Fermentation (formation of leavening gas, flavour formation) Enzymatic breakdown
10	**Baking (determination of the shape)**	Fermentation Crumb formation (denaturing, gelatinization) Crust formation (release of water, Maillard reaction)
11	**Storage of baked products**	Release of water vapour Maturing of the baked product Exchange of water between crumb and crust Loss and equalization of flavour Staling

The same conditions still apply basically if the process is modified, for example by refrigeration or freezing of the dough portions, or by par-baking. If the process is lengthened in this way it is important for the dough portions or par-baked products not to dry out. A current of air during cooling or baking may easily cause a high water loss and greatly impair the quality of the products.
All the steps in the process are the same for bread made from wheat or rye flour.

22.2 Wheat Bread

Bread from wheat flour is made and eaten around the world. The attributes of the products may differ greatly; on the one hand they depend on the flours obtainable locally, and on the other there are differences in both production methods and consumer expectations. Even with international products like toast slices, bakers have often made adjustments to meet the regional standard. But in spite of the many differences it is possible to describe basic characteristics of wheat bread in respect of quality and production methods.

22.2.1 Quality Attributes of Wheat Bread

A decisive factor in rating quality and describing possible faults is the expectations of the consumer. They differ greatly from one region to another, and even with products sold throughout the world the same standards do not necessarily apply everywhere. A baguette in France will be different from a similar "French" loaf made in Japan, where crispness is not considered quite so important and the texture is much finer than in the country of origin. So the following information is only of a general nature and intended to demonstrate basic trends.

22.2.2 Constituents of Wheat Bread

Wheat bread is made from wheat flour, water, yeast and salt. These ingredients alone are sufficient to make products that meet the highest quality standards under optimum process conditions. But the flours must be suitable for the products and methods. Enzymes, emulsifiers, oxidizing or reducing agents, gluten, hydrocolloids, mineral salts, amino acids and other substances may be added to optimize the flour or to made production more reliable.
The bread made from these basic ingredients may be good or not so good. The quality depends to a great extent on suitable flour, i.e. flour optimized for the particular product. Ideally, optimization of flour quality with the above active substances should take place at the mill. If they are added later, malt products, enzymes or emulsifiers are less effective, since it is the mills rather than the bakeries that have the skills needed for even blending with ingredients in such small amounts.

22.2.3 Shapes of Wheat Bread

Wheat loaves are made in very different ways. The dough portions may be placed directly on the hot surface of the oven (hearth bread) or baked in pans (toast or sandwich loaves). They may be flat (flat bread) or elongated (baguettes) or sold as products stamped out into a rectangular shape (ciabatta). The weight of the loaves differs, and so does the appearance of the surface. It may be smooth and glossy, or it may be floury. Making cuts in the surface is a well-known way of increasing the proportion of crust.
In spite of regional differences in the concept of quality, some requirements are the same everywhere. So products like toast slices or baguettes that are produced throughout the world should be judged according to internationally recognized standards. The following sections describe some bread types with regard to their quality attributes.

22.2.4 Quality Attributes of Wheat Loaves

Generally speaking, the crust of wheat loaves should not be too thick. It should be evenly brown and not too dark. More and more consumers prefer a light-coloured surface.
The crumb should be light-coloured too. Throughout the world there is a preference for white bread with a soft crumb that is not too tough. The softness of the crumb depends on the texture. The finer the pores, the softer the crumb can be. It must not be dry, and should keep its moisture as long as possible; in the

case of freshly baked bread the crumb may be termed "succulent". Fig. 204 shows the crumb of a wheat loaf with a very long shelf-life resulting from a high dough yield. This quality attribute is determined by the speed of retrogradation (re-crystallization) of the gelatinized starch in the crumb.

The leavening of the crumb differs according to the type of product. Wheat loaves usually have a crumb that is not too fine in texture but does not have big "holes" either, so that it can be spread or filled easily.
Toast and sandwich bread is expected to have a fine to very fine texture. With the exception of wholemeal bread and bread enriched with dietary fibres, the crumb should be very light in colour. The fine structure is a requirement for the softness of the crumb and also for uniform browning of the slices when toasted. In the case of sandwich slices the fine, even texture is necessary to prevent penetration by fillings such as mayonnaise.

A quality attribute of baguettes and ciabatta is a very coarse texture with unequal and sometimes very large "holes". In these products the crumb may appear slightly "glassy" and a little darker than in toast slices, which customers expect to be very light. Regional specialities such as large loaves sold as "farm-baked bread" may have an uneven, fine-and-coarse texture as a typical characteristic. Flat bread is quite often unevenly leavened, but as a rule the pores are of medium size.

Fig. 204: Wheat bread with an open texture and a long shelf-life resulting from a high dough yield

As we said above, the structure of the crumb should be soft and stay soft for as long as possible. But it must also be elastic. That does not mean "tough"; it means that the crumb should return to its original shape after being squeezed. Elasticity is an important criterion because inelastic crumb tends to stick together when chewed and is difficult to break up. The technical term is "balling" of the crumb in the mouth. The crumb does not dissolve properly and impairs the consumer's enjoyment of the product.
Wheat bread is expected to have a "bland" smell and taste. That means it should not have an acid taste that distorts the flavour of the filling or spread. But the sensory impressions should not cause it to be judged "insipid" or "empty". All wheat bread has a distinctive aroma, with a definite but not excessive yeasty note. In both taste and smell the yeast component is part of a complex bouquet that must not be dominated by individual components such as "acid" or "salty".

22.3 Production of Rye Bread

By rye doughs we mean, in this context, doughs in which the proportion of rye flour is over 50% of the total amount of flour. This percentage of rye flour causes a shift in the dough properties from viscoelastic to plastic. Although the constituents of rye are much the same as those of wheat, the technological properties of rye doughs are totally different.
The pentosans of the rye prevent the formation of a gluten network. As a result, a portion of rye dough has much lower stability. In order to keep its shape it either has to ferment and bake in a pan or prove in a "basket". Rye doughs also bind much more water; at up to 1000 percent the water-binding capacity of the pentosans is far greater than that of the wheat gluten, with 200 to 300 percent. Although the gluten content of wheat doughs is greater, the water content of rye doughs has to be increased. However, the dough yield also

depends on the degree of extraction of the rye flour. The finer the flour and the more outer layers it contains, the more water should be provided for swelling.
For the development of rye doughs, long swelling times involving slow kneading and sufficiently long resting times have to be planned. Rye products are often found to lack the necessary quality because they contain too little water, i.e. the dough yield is too small. In this case the bread stales more quickly, the crumb soon becomes dry. In the case of loaves baked in pans, dough yields of 200 % based on the amount of flour are not unusual. Such doughs are very soft, almost fluid, but the loaves baked from them have a soft, moist crumb with a long shelf-life.

In the specialist literature we often find the opinion expressed that rye doughs only produce a good, elastic crumb and a characteristic flavour if the pH is reduced. But breeders' efforts have resulted in rye qualities whose baking properties are nearly always so good, because of low enzyme activity and high stability of the starch, that no acidification is necessary to inactivate the α-amylases during baking.

Nowadays a reduction of the pH of rye doughs through the addition of sour dough or dried sour (powder), dough acidifiers or food acids, is usually only carried out in order to achieve the acid flavour typical of rye products. If, at the same time, a large proportion of the flour is swollen in a sour dough process, this naturally results in a noticeable improvement in quality. Because of the procedures that used to be necessary to process sour doughs, the production of rye bread was confined to those regions where rye was the main crop. But the function of the sour doughs was not restricted to reducing the pH; the process was such that good leavening of the bread was ensured by the addition of a large proportion of yeast. Through the activity of lactic acid bacteria and yeasts, sour doughs bring about the typical flavour and succulent, well-leavened crumb of rye products. Rye products made by the IGV rye process also have a succulent crumb and a long shelf-life. But if the flour contains a larger proportion of outer layers, they have a stronger flavour than comparable wheat products. Fig. 205 shows a loaf made from mixed wheat and rye flour, with 20% wheat flour.
The production of rye doughs does not only differ in respect of the sponge dough process (sponge doughs with lactic acid bacteria and yeast, or sponge doughs with yeast only); there is also a difference in the kneading method and subsequent make-up. Rye doughs have to be kneaded slowly for a long time, and mixed rather than kneaded. It is not necessary to work energy into the dough. This means that if rye doughs are kneaded properly there is no rise in temperature. An interruption of the kneading process is also recommended in order to allow the doughs time to swell and achieve maximum water absorption. After kneading, the doughs should be left to swell during a bowl fermentation time of 15 to 30 minutes so that they can be made up easily in spite of a very high dough yield.

Rye doughs are no problem to make up because of their plastic behaviour. The doughs can be divided with simple equipment, irrespective of pressure, and then rounded and moulded. There is no need to fear damage from mechanical stress as in the case of wheat doughs. Very soft doughs are not shaped at all; they can be portioned straight into the baking pans, for example through an extruder. If the dough portions are not proved in the pans they have to be stabilized by baskets or other containers at this stage in the process.

Fig. 205: Loaf made from mixed wheat and rye flour, with 20% wheat flour

They are then transferred to the hot oven surface just before baking.
In the case of rye bread baked without pan the loaves have to be further stabilized in the oven. In contrast to wheat loaves, crust formation is promoted at a very early stage of baking. This is achieved by removing the moist atmosphere that was created at the beginning of the process by introducing steam. The subsequent atmosphere is dry, and the dough portions are stabilized from the outside.

22.4 Causes of Faults in Bread Making

Millers are quite often confronted with faults in bread, especially if the baker is of the opinion that it must have been the flour that caused the problem. Many millers are then faced with the task of finding the real reasons for the non-conformity on the basis of the baker's description. That may not be easy, because bakers do not always document their bread-making procedures. This section therefore contains some questions enabling an analysis of faults at the individual stages of the process described in the "Bread Production System". Millers and bakers can then use the answers to these questions for a systematic discussion of the various possible sources of error.
It is a well-known reaction that any deviations from the proper quality of the baked goods are initially blamed on the flour. In the opinion of experienced millers, this strategy on the part of some bakers does not hold water, for over 90 percent of all faults in bread making are not attributable to the raw material "flour".
The questions are followed by a consideration of the typical faults in bread, the reasons for them and possible ways of preventing them.

22.4.1 Analysis of Faults

An analysis of faults should not be dominated by the question of who is to blame; the aim must be to identify the cause or the chain of causes. The persons involved must work together to improve production. The question of sanctions must not be an obstacle to finding the source of error.

Raw Materials and Dosing of Raw Materials

- Were all the raw materials available in the proper quality?
- Had a new consignment of raw materials been received?
- Were all the raw materials weighed?
- Were all the quantities of raw materials correct?
- At what temperatures were the raw materials processed?
- Did all the sponge doughs ferment long enough (sour doughs, soaker doughs with or without yeast)

Dough Making

- Were all the ingredients put in the mixer?
- Were the mixing and kneading times adhered to?
- What dough temperatures were measured?
- Was the mixer working properly?
- How were the properties of the dough felt to be after mixing/kneading?

Processing of the Dough

- Was the proper dough resting time allowed?
- Was it difficult to divide the dough?
- Were the dough portions rounded and moulded according to instructions?
- Was the intermediate proof time long enough?
- How were the properties of the dough felt to be after shaping?

Proving and Baking

- Did the climate in the proving room conform to the specifications?
- How long did proving take?
- Were the measures for preparing the dough for baking carried out carefully?
- How was optimum proof ascertained?
- What was the temperature of the oven at the start of baking?
- Was the steam generator working properly?
- After what time was the vent opened?
- What oven temperatures were recorded at what times?
- How long did the baking process take?
- Were there problems filling the oven?
- How were the baked goods tested to see if they had baked long enough?
- Were faults found during baking?

Storage of the Baked Goods

- How were the goods stored after baking?
- Were the cooling times and temperatures correct?
- When were the loaves prepared for sale?

22.5 Faults in Bread

Every production process should be designed in such a way that sources of error are excluded as far as possible from the start, when the decision about the recipe and working procedures is made. Nevertheless, faulty bread is still baked even after a quality management system has been introduced. So the system should really be regarded as a means of minimizing the sources of error and finding the reasons for any faults fairly quickly on the basis of the documentation. Generally speaking, errors should be seen as a chance to learn how the production process can be made more reliable. This is an everlasting task, for every mistake that can be made will be made. The aim must not be to look for someone to blame but to make a systematic search for errors as a quality system intends.

The purpose of the following tables is to help trace back the faults found in the bread to specific causes. Besides very typical errors that should really no longer occur there are often faults that cannot be attributed to one single cause. That is why it is necessary to determine the causes of the damage systematically. The systematic identification of errors requires checking of the individual steps in the bread-making process.

22.5.1 Identifying Faults in Bread, their Causes, and Prevention

When a fault has occurred in bread, a target-performance comparison must be made. Of course this analysis can only be made in close cooperation with the persons directly involved in production. However, the suggestions for avoiding such errors in future are made with the reservation that not all causes and measures can be mentioned.

The sequence is that used in recognized testing procedures for bread. It is usual to work from outside to inside, i.e. from the shape of the loaf through the crust to the crumb, and then to the smell and taste. In the following tables, emphasis is placed on faults arising from the raw materials (Tab. 114 - Tab. 118).

22.5.2 Signs of Deterioration in Bread

In older publications the signs of deterioration in bread are called "bread diseases". The term does not fit the facts, because bread that is unfit for consumption cannot "recover". There is a far greater danger that people who eat baked products that have gone bad will become ill. Bread that has gone mouldy or that is infected with the bacillus that causes ropiness (see also chapter 18.12.4, page 263) must not be released for consumption. On no account must it be used in food of any kind; it must be disposed of properly.

Mould

The danger that whole loaves of bread will become mouldy is fairly slight if the crust is well baked. But if the crust becomes damp, mould spores that are usually transferred through the air or by contact with the hands or with surfaces used for storage may germinate on it.

There is a much greater danger of mould in the crumb, where the high level of water activity (a_W value) in addition to a wide range of nutrients offers good conditions for the germination of mould spores at room temperature. The risk of mould formation is greatest in sliced bread that has not been pasteurized after cutting. As an alternative, the addition of preservatives such as propionic acid or sorbic acid to the dough can delay attack by mould.

Mouldy bread must be disposed of. Here it is important to prevent spores on the surface of the mould from passing into the air and infecting other baked goods.

Bacteria as the Cause of Ropiness

A sign of deterioration that is not visible from the outside is ropiness. The crumb of the bread is degraded after baking. The first indication is a fruity smell that becomes stronger; the crumb then turns a yellowish to brownish colour in patches. When the crumb is broken apart, the typical threads or "ropes" form; they can be pulled out to a considerable length.

Tab. 114: Faults in the shape of the loaf

Fault	Possible causes	Preventive measures
Too flat	- Dough too soft - Proof time too long - Oven not hot enough	- Make firmer doughs - Put dough portions in the oven earlier - Start baking at a higher temperature
Too round	- Dough too firm - Proof time too short - Oven temperature too high	- Make doughs softer - Leave dough portions to prove longer - Optimize initial heat
Not enough volume	- Not enough leavening because of inadequate enzyme activity (α-amylases)	- Add enzymes such as amylases or xylanases
Side wall collapse (toast loaves)	- Too much dough for the pan - Proof time too long - Too much baking improver	- Reduce weight of dough - Reduce proof time - Reduce the amount of baking improver
Sunken surface	- For this flour quality, too much expansion of the dough portion before baking	- Improve flour quality - Reduce proof time - Reduce the amount of yeast - Reduce enzyme activity

Tab. 115: Faults in the crust

Fault	Possible causes	Preventive measures
Uneven browning; browning too light or too dark	- Uneven temperature in the oven - Baking time too long or too short - Dough portions too close together in the oven	- Get the supplier of the oven to check the adjustment of the heat distribution - Optimize oven temperatures - Place the dough portions farther apart in the oven
Browning too light	- Oven temperature too low - Baking time too short - Dough portions over-proved; the yeast has metabolized all the sugar - Dough too firm - Dough without salt	- Optimize the oven temperature - Optimize the baking time - Reduce proof time, lower the temperature of the dough - Increase dough yield - Ensure that salt is added
Browning too dark	- Oven temperature too high - Baking time too long - Too much enzyme activity - Dough portions under-proved	- Optimize the oven temperature - Adjust the baking times - Add flour with a higher falling number - Allow doughs to prove longer; raise the temperature of the dough
Dull surface	- Too little dextrin formation during baking because of too little water vapour in the initial stage of baking	- Increase the amount of steam in the initial phase of baking; check the steam generator - Brush the dough portions with water before placing them in the oven
Blisters on the surfaceof the crust	- Over-fermentation in cool rooms, and dough resting time too long - Blisters are a visible sign of long fermentation times	- Blisters are basically a quality attribute of long fermentation times; this should be explained to customers
Large holes or burn blisters	- The dough portions still show too much microbial and enzymatic activity when placed in the oven - The dark colour results from the more intensive effect of heat on the thin crust	- Allow doughs and dough portions to ferment/prove longer; reduce the temperature of the dough slightly; increase the amount of sour dough
Cracks in the crust	- Where the crust is thin, cracks may occur because of the increase in internal pressure during baking	- Allow dough portions to prove longer - Make an incision in the top of the dough portions before baking (valve effect) - Brush dough portions with water and increase the amount of steam in the initial phase of baking
Cracks in the sides of the crust	- Too little heat reached the sides of the loaves during baking because the loaves were too close together; the internal pressure caused the very thin crust to crack	- Place the loaves farther apart in the oven; in the case of ovens with a stationary baking atmosphere, turn the convection on earlier during baking

Tab. 116: Faults in the crumb

Fault	Possible causes	Preventive measures
Uneven texture	- Uneven temperature in the oven - Baking time too long or too short - Dough portions too close together in the oven - Dough portions not sufficiently proved	- Get the supplier of the oven to check the adjustment of the heat distribution - Optimize oven temperatures - Place the dough portions farther apart in the oven - Lengthen the proof times after kneading
Texture too close	- Dough too firm - Proof time too short	- Make the doughs softer with more water - Lengthen the proof time
Texture too open	- Proof times too long	- An open texture is nearly always better for quality than a texture that is too close, so this "fault" should usually be tolerated
Holes	- Dough portions not kneaded vigorously enough - Too much dusting flour - Too much oil used for dividing or rounding the dough	- Knead the dough portions more intensively - Reduce dusting flour - Adjust the amount of oil
Water ring in the crumb	- The proof time of the dough portions is too short; the enzymatic breakdown in the core of the dough portion during baking is too intensive - A water ring under the crust is caused by vibration during baking	- Allow the doughs to prove longer after kneading - Lengthen the proof time - Handle dough portions very carefully when moving them during baking
Water streaks	- Excessive activity of the enzymes breaking down the starch - Dough yield too high - Proportion of return bread too high	- Reduce the amount of baking improver; use flours with a higher falling number; reduce malt flour - Reduce dough yield - Reduce the amount of return bread
Vertical cracks in the crumb (dry cracks)	- Doughs too firm; this results in inadequate starch gelatinization and a very taut crumb	- Increase dough yield; increase the amount of enzymes breaking down starch; use flours with a lower falling number
Hollow under the crust	- Excessive activity of the enzymes breaking down the starch	- Use flours with a higher falling number; use flours with a lower degree of extraction; reduce the amount of baking improver added
Different colours in the crumb	- Too much dusting flour used, or dusting flour made up of highly extracted flours - The surface of the dough has dried before division	- Reduce the amount of dusting flour; use dusting flour with the same degree of extraction - Cover the surface of the dough during fermentation
Unnatural colour of the crumb	- Ingredients with an uncharacteristic effect on the colour of the crumb	- Remove brown-colouring ingredients from the recipe; increase the proportion of wholemeal products

Tab. 117: Faults in the structure of the crumb

Fault	Possible causes	Preventive measures
Poor elasticity of the crumb; crumb forms balls when chewed	- Excessive activity of the enzymes breaking down the starch	- Use flours with a higher falling number; use flours with a lower degree of extraction; reduce the malt flour added; reduce the amount of baking improver used
Firm crumb; dry and crumbly	- Too much acid in the bread dough because of too much sour - Doughs too firm	- Reduce the amount of sour; make the sour doughs softer and cooler - Increase the dough yield considerably
Crumbles when cut	- Too much acid in the dough - Doughs too firm	- Reduce the amount of sour dough or dough acidifier added; - Increase the dough yield considerably

Tab. 118: Faults in respect of smell and taste

Fault	Possible causes	Preventive measures
Not aromatic enough, not enough flavour, insipid	- Not enough sponge dough - Dough portions too close together in the oven - Dough portions not proved long enough - Not enough salt	- Get the supplier of the oven to check the adjustment of the heat distribution - Optimize oven temperatures - Place the dough portions farther apart in the oven - Extend proof times after kneading - The amount of salt should be between 1.8 and 2% of the quantity of flour and ingredients such as oil seeds
Salty	- Too much salt	- Do not use more than 2% salt
Sweet	- Too much activity of enzymes breaking down starch	- Optimize enzyme activity by adjusting the falling number
Sticky, doughy	- Baking time too short	- Check baking times and temperatures
Yeasty; fermented taste	- Too much yeast - Fermentation times too long - Unsatisfactory process for yeast sponge doughs	- Reduce the amount of yeast - Optimize fermentation times - Yeast sponge doughs may need cooling
Old, bitter, musty	- Old, over-stored flours - Storage in a damp place - Storage temperatures too high	- Buy flour in keeping with requirements - Optimize storage conditions: no more than 15% moisture in the flour; temperatures should not exceed 30°C
Sour, bitter-sour, abnormal acid taste	- Fermentation time of the sour doughs too long - Too much sour dough - Sour doughs too warm - Sour doughs too acid - Incorrect ratio of lactic acid to acetic acid	- Shorten the processing time of the sour doughs - Reduce the amount of sour dough - Optimize the temperature of the sour doughs - Check the acidity of the sour dough; reduce the amount of starter - The ratio of lactic acid to acetic acid in the sour dough should be 85-90:15-10

Ropiness is caused by the spores of the microorganism *Bacillus mesentericus*, a close relative of *B. subtilis*. For a short time the spores can even survive dry heat of 200 °C. Since the temperature inside a loaf of bread is never so high (if the bread is to be edible), the baker must always reckon with spores in the bread.

Bread with deteriorated crumb is mainly found in the summer months because of the relatively high temperatures the spores need in order to germinate. The fact that wheat bread is most often affected also has to do with the spores' environmental requirements: the critical temperature range for re-starting their vital activity is between 28 and 40 °C. But the environment must contain very little acid, for they only terminate their dormancy at a pH above 5. If these conditions prevail for about 3 days (at temperatures of 37 °C two days are sufficient), ropiness must be expected to occur. Not only are the goods then nauseating; the toxin that may be produced can also lead to illness. During the summer months there is a very considerable risk that the spores of the bacillus may germinate in wheat bread.

The best protection is afforded by the use of wheat sour, which lowers the pH of the crumb to a level well below 6. But even this measure does not guarantee complete safety, which can only be achieved if the pH is reduced to at least 4.8. However, such a value is not realistic for wheat bread. If a long shelf-life is required, e.g. for toast slices, the objective must be a pH of 5.0. A stable storage temperature of 20 °C should also be ensured.

22.6 References

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- *Freund W (ed.), 2003. Handbuch Backwaren Technologie, Loseblattsammlung, Behr's Verlag, Hamburg.*