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Enhancing YOUTH (18-26)
Employability in Bakery Sector
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Best Bread Production Handbook

2018

Contents

1. A new old story - short introduction in bakery 4

1.1. Traditional baking – things to keep in mind 5

1.2. Baking in our days – new challenges 6

1.3. How to maintain a good balance between old and new 7

2. All stuff we need – raw materials and others 8

2.1. Flours – different cereals and sustainability 9

2.2. Yeast and leaving procedures – how to obtain the best flavors 10

3. What about E-numbers? – main additives used in bakery 13

3.1. Flours correction – direct from the mill 14

3.2.Technological additives – role and necessity 15

3.3.How to replace E-numbers 19

4. Dough processing route – first steps of the technological flow 21

4.1.Mixing, fermentation, dividing, final proof - main processes involved 23

4.2. Specific parameters – definitions and importance 26

5. From dough to bread – baking steps 27

5.1.Transformations during baking 28

5.2.Ovens types – how to assure the products individuality 30

6. Bread cooling 31

6.1. Importance and parameters 32

6.2.The ageing of bread – modifications and prevention 33

7. Packaging and shelf life 36

7.1.Keep the product integrity – packaging materials and techniques 37

7.2.Short or long shelf life? – how to manage 39

8. Technological scheme – how to draw it and how to follow it 41

8.1. Estonian bread – typical product technological scheme 42

8.2. Romanian bread - typical product technological scheme 43

8.3.Turkish bread - typical product technological scheme 44

9. Let’s analyze our work – evaluation of bakery products 45

9.1.Pay attention from the beginning – raw materials control 46

9.2.Monitoring the technological flow – phases control 47

9.3.Think as a consumer does – final products control 48

10. Innovation and new trends 49

10.1.Research and development role 51

10.2.Consumer’s needs and expectations 53

References 55

Chapter 1

1.1. A new old story - short introduction in bakery

The history of the bakery is parallel to the history of human civilization - the bread could have been one of the first foods processed by man and was certainly is the first to be produced on a large scale. Even there are no records of when the bread was originated, but the bread has been around for thousands of years. Rustic breads consisted of crushed grain, soaked in water, kneaded and letting it fermenting with natural yeasts to be baked. Loaves of bread were buried as funerary offerings, and have been found, dated at 5,000 years old in predynastic Egyptian tombs. Archaeological evidence shows that a quite evolved baking production existed in Egyptian civilization, about 5,000 years ago, possibly being the staple food of the laborers working in pyramids construction (the process of making bread in the bakery of Pharaoh is described on the walls of the tomb of Ramses III – fig.1).

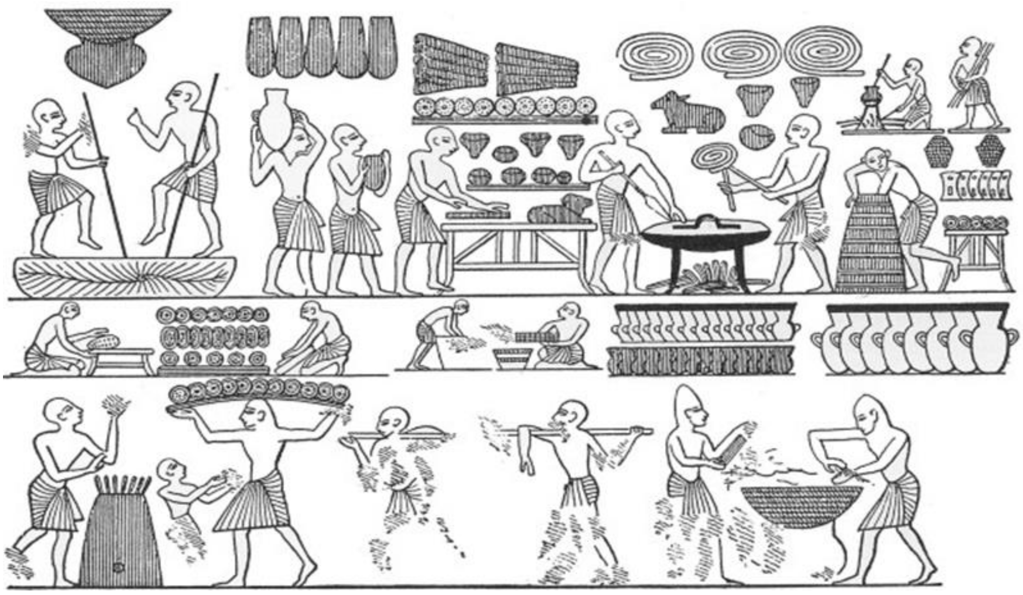

Figure 1. Bread making process in Egypt, 3,000 B.C
(source: http://www.historicalcookingproject.com)

In ancient Rome, grain milling and baking the dough into loaves was a well-established practice. Before appearing compressed yeast, the seeding system of dough was made with natural yeast. Natural yeast was the fermentation base until the seventeenth century when begins the addition of brewer's yeast.

Enhancing YOUTH (18-26)
Employability in Bakery Sector
2017-1-TR01-KA205-039233

But it was not until the mid-nineteenth century when bread began to be manufactured exclusively with brewer's yeast. The bread obtained had a bitter taste and the baker had big problems to keep that yeast. The problem was solved later with first compressed yeasts, which possessed better preservative qualities and greater fermentative power.

1.2. Traditional baking – things to keep in mind

Before the use of brewer's yeast for fermentation stage, a dough formed as a mix of water, wheat or rye and raisins, prunes and bran, had been left soaking as a first fermentation. Then, an initial alcoholic fermentation started and after a few days of cultivation an acidic fermentation triggered. After several refreshes, this sourdough was added to the dough. From the latest batch a piece of dough was put away, and after two or three refreshments, spaced each 4 or 5 hours the natural yeast was obtained. "Dough" ready to use, in a proportion of 30 to 40 kilos dough per 100 kg. flour. The baker had to pay special attention in the development of this ferment/sourdough, because it depended on getting good quality bread. At present time, therefore, the fermented dough has lost its basic function of serving as "yeast seeding ", as this objective is achieved conveniently with the addition of yeast, focusing on other objectives. In a few words we could resume that as biotechnology has progressed it is possible to bake without the use of sourdoughs, but this is a relatively recent development. The important issue is that it has been found that when you stop using sourdough, bread is not the same. Therefore it is clear that the sourdough has a positive influence on the quality of bread, and because it improves the final product, different technologies were developed to find various types of sourdough suitable for the industrial and large scale production. Commercial products are available, both in liquid and powder forms, ready-to-use in the modern baking to improve the taste and flavor of bread, despite the decreasing of processing time.

Besides this, there is a trend in present time to come back to the raw materials used in traditional bakery, which could bring new nutritional and healthy properties to some products - old varieties of grains, various types of flour and so on.

Figure 2. Interior of a medieval bakery

Mainly the traditional bakery is characterized by a discontinuous process, every stage being effectuated in a specific place and conditions, without evident connection between them (fig.2).

1.3. Baking in our days – new challenges

The technic and technological progress, the global population continuously increasing, thus the consumption and demands for foods are in an ascendant line, the baking field has undergone huge transformations. For a better productivity and a higher products safety all the facilities related to bread production were redesigned, and the continuously process have replaced the old ones (fig.3). This is the case for the majority of bakeries, but in the same time little capacities remain to provide fresh bread in their neighbors. Without regards to the size of the bakeries, the main challenges to overcome are the same:

- higher standards for bread safety
- better products quality level
- healthy and nutrition concerns of consumers
- prolonged shelf –life
- a large assortment of products
- difficult to find workforce willing to work in shifts
- find well- trained staff

Figure 3. Industrial line for bread baked in tins production

1.4. How to maintain a good balance between old and new

For the personnel involved in the bakery industry there are permanently some questions to solve regarding the balance between the old versus new technologies with the aim to better answer to the increasing demands of more conscientious consumers. Thus consumers prefer bread with the taste, appearance and flavor specific to traditional products, but obtained in the safer conditions and with the long shelf-life provided by the new technologies. All the staff involved in bakeries have to be well-trained and prepared to deal with such problems; the right knowledge of the chemical, physical and biochemical processes involved in bakery technological flow, the influence of new operations and devices on the whole production , play a crucial role in the management of the main problems.

Chapter 2

All stuff we need – raw materials and others

Basically bakery products are manufactured from:

- flour: wheat, rye, barley, quinoa;
- sugar and sweeteners;
- milk products: whole or skimmed milk, butter, whey;
- fats and oils;
- yeast or baking powder, jelly, dry fruits, various essences, flavoring, etc.

As sweeteners in bread making could be used granulated sugar, dextrose powder, liquid sucrose - syrup, dextrose - syrup, mixtures of syrups - which include combinations of sugar, dextrose, syrup obtained by converting some polysaccharides into simple sugars, honey, brown sugar (residual molasses sugar).The sugars listed above contribute to:

- confer taste, flavor and aroma characteristic to each source,
- provide feed for yeast cells,
- enhance the color of the finished product ,
- soak the consistency of the dough.

Milk and dairy products category includes: whole milk or skimmed milk, skimmed-milk powder, condensed milk, butter, sweet condensed whey and whey mixes. Milk products contribute to the aroma, nutritional qualities, prolongation of fermentation, improvement of crust color (due to lactose), water absorption (due to proteins) and texture of bakery products.

Fats and oils are essential raw materials for the bakery industry - commercial oils and fats are mainly coming from plants (fruits and seeds) and animals (milk fat, tissues) and can be divided in five categories depending on their origin:

- vegetable oils are liquid and are specific to tempered areas: soya oil - is the principal oil in terms of volume produced globally, rapeseed, sunflower and corn are also oils of great economic interest

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2017-1-TR01-KA205-039233

- tropical oils are mostly coming from Malaysia and Indonesia - palm and palm kernel oils are solid fats coming from the flesh and the kernel the same fruit, and coconut oil
- exotic oils are also grown in tropical areas of Africa and Indonesia, with typical representatives Illipe butter and Shea butter
- animal fats are mainly coming from mammals (milk fat, lard and tallow). Fish oil is also important in some areas. Fish oils are very prone to oxidation
- other oils are locally produced and in smaller volumes but are important mainly for a nutritional point of view. Olive oil is widely known; also flaxseed oil has turn to be of great nutritional interest as a source of ω-3 fatty acids.

The following effects have been witnessed by increased fat incorporation in bread: different crumb structure, softer bite, shelf life extension by slowing the staling process, softer crust - when more than 3 % flour weight fat is used, improving slicing of finished product -a minimum of 1 % is recommended for sliceable bread, gases expansion and improved handling of dough, improved palatability.

2.1 Flours – different cereals and sustainability

Cereals - a family of Gramineae, grown for their edible grains, composed of endosperm, germ and bran. The most used cereals in bread making are wheat, rye, triticale, barley, oats, maize, sorghum, millet and rice; in recent years an increasing use of pseudo cereals, with similar properties but belonging to other families, as buckwheat, quinoa and amaranth are noticed. The type of cereal/pseudo cereal is important for the nutritional value and for the gluten content – in the case of gluten free products. Wheat varieties suitable for production are *Triticum durum* wheat for bread and pasta and *Triticum aestivum* wheat with bakery attributes. There are some varieties of wheat: hard red, soft white and hard red (fig. 4). New trends are dictated by the rationale for increasing nutritional value and in this approach ancient varieties are involved: *Triticum turgidum* spp turanicum - commercial name kamut and *Triticum dicoccum* - farro – with superior nutritional properties. Sustainability requires focusing on eco-friendly crops, reducing the water usage in the cereal processing, the use of various cereals and their varieties.

Figure 4. Different flours from various types of wheat
(source: melskitchencafe.com)

An important fact for bakers to be aware is that of the gluten intolerance and celiac disease; currently, the only treatment for is lifelong adherence to a strict gluten-free diet, people must avoid foods with wheat, rye and barley, such as bread and beer. For them the wheat flour had to be replace by rice, oat flour, or other flours that do not develop gluten.

2.2. Yeast and leaving procedures – how to obtain the best flavors

Yeast is a cell biomass of the genus *Saccharomyces cerevisiae*, capable of sugar fermentation process in the dough, being used as a biological agent in the manufacture of bread, bakery products and pastry; it is responsible for the production of CO_2, acids and alcohols during fermentation; acids and alcohols resulted during fermentation influence the gluten fading and this allows easier dough processing during manufacture. The main types of yeast used are the compressed yeast (high humidity, can be added as such in dough or maybe in suspension) and the active dry yeast (shows much less moisture than compressed yeast); the active dry yeast must be hydrated with water at a temperature of 32 - 38 ° C (fig.5).

Figure 5.Compressed and dry yeast (source: internet)

Sourdoughs with baking yeast – some examples are poolish, biga and sponge (fig.6).

The poolish is made with water, flour and pressed yeast which, except for minor variations, is achieved with the proportion of 1 liter of water per kilogram of flour; the result is a composition quite liquid.

Biga is a solid ferment, originary from Italy - the water level will be 45%-50%, therefore a lower hydratation than poolish, which also contains yeast (0,5-1%); the fermentation time is between 12 and 18 hours.

The sponge - the principles of preparing a sponge are similar to the preparation of a sourdough; the fundamental difference is that the sourdough incorporates all of the ingredients of the formulation, while the sponge is made with a part approximately between 1/3 and 1/4 of the flour .

Poolish

Biga

Sponge

Figure 6. Sourdoughs with baking yeast

If we consider the definition of sourdough in the strictest sense, should be defined as the mass of flour made from wheat or rye fundamentally, water (50-55%) and a small amount of salt (0.5-1%). This mass is maintained at room temperature (25 ° C) in such a way that promotes the growth of microbial flora and thus favoring the various fermentations that occur in the mass. If the temperature is greater would be enhanced lactic and butyric fermentations. Another sourdough definition according to Katina (2005) - a process in which flour and water (and other ingredients) are fermented with microbes originating from preceding sourdough, commercial starter culture, bakery equipment or from flour.

Spontaneous dough fermentation starts by mixing flour and water without adding a starter culture or portion of a preceding sourdough (mother dough). The effect and mechanisms of sourdough fermentation are complex and numerous, a lot of changes occur in the flour and dough matrix – as the biochemical reactions presented in fig.7.

Yeasts $\rightarrow$ co2 + Ethanol

Lactid acid bateria $\rightarrow$ Lactic acid + Acetic acid + Propionic acid

Figure 7. Biochemical changes in dough

Chapter 3

What about E-numbers? – main additives used in bakery

Consumers often don't trust what they see on the food packages- recent studies reveal a consumer need to build trust and to have ingredients information on the naturalness of products, and a global demand for natural, healthy food with a clear, clean front-of-pack claim. But what exactly do consumers understand by 'naturalness' in relation to packaged/convenience food products? Here's what most of them said:

- 75%: Natural food should contain no additives
- 72%: Packaged food can be natural
- 64%: Natural and healthy food are the same

Natural = no artificial colours - When asked about the meaning of 'natural' food, the top answer worldwide was a lack of artificial colours, followed by no preservatives or artificial flavours. E number - any of a series of numbers with the prefix E indicating a specific food additive recognized by the European Union and used in some foods and drinks to improve their flavour or colour or to make them last longer. In the European legislation for every E number there are specified the maximum levels of use for every cathegory of food in which is alowed a certain additive.

Why do we need improving agents? A lot of reasons leads to the use of additives in bakery -here below are listed some of them:

- to facilitate the technological process
- to modify product characteristics
- to improve volume, texture and shelf-life
- to use more economical ingredients
- to add value

Any ingredient which we add to improve the baking potential of flour may be called an 'improver'. Different processes have different flours and varying optimum improver formulations. Improvers of one form or another have been used by bakers for over a hundred years so it is wrong to think of them as only applied to modern bread making processes. Today the products we call improvers are a mixture of a number of different materials that are also considered under the general heading of 'functional ingredients'. Modern improvers formulations are matched to different ingredients, products and processes so that substituting one improver for another can have seriously adverse effects on final product quality. Improvers dosage levels are also tailored to specific ingredients and process combinations and in addition to the quality complications in some cases there may be legal implications involved in switching improvers with the possibility for non-permitted ingredients making their way into some breads or maximum levels of addition being exceeded.

3.1. Flours correction – direct from the mill

There are two main aspects regarding the use of improvers in bread making, due to type of the bakery. For the big companies, with large automatic production lines, it is possible to add in a controlled way all the ingredients and additives, adequately weight and dosed by specialized devices. Therefore in such facilities the bakers could realize by themselves the mixture they need, starting from singular additives, making their own recipes of improvers, tailored for different type of products. In small bakeries it is quite difficult for the bakers to manage the mixture of such small quantities of additives for each batch, then it is more convenient for them to purchase from the suppliers flour which is already corrected (with ascorbic acid, some enzymes, emulsifiers, etc.) or more, the final products they need – fig. 8.

Figure 8. Flours for different applications: bio-bread, rye bread, pastry

Many mills are selling flours for different purposes – on the technological flow of the flour milling all the special additives tailored for a special product are added carefully weight and the final product is designated to a certain type of bakery product: bread, cake, croissant, cookies and so on.

3.2. Technological additives – role and necessity

Main types of improving agents:

Oxidising agents. The role of oxidants in bread making systems is that of improving the gas retention abilities of the dough through better gluten development. With the addition of suitable oxidizing materials to the dough we can reduce the development time for doughs from many hours to less than 10 minutes and achieve most of the changes in the mixer. If we use a high speed mixer we can achieve full dough development in less than 5 minutes. The benefits of oxidizing agents have been known for over 50 years and many different types have been, and are being used around the world. Slow acting ones such as potassium bromate have been used widely and were common throughout Europe. The faster acting ones such as potassium iodate, calcium iodate, and azodicarbonamide are more widely used in USA. However with a greater awareness of food additives by the general population, and a greater understanding of their function, a number of changes to legislation on Europe have been made with the result that we are left with ascorbic acid (or Vitamin C or E 300) as the sole oxidizing agent for use in the baking industry. At present the level of use is quantum satis =use as much as required. These oxidizing agents are commonly added as part of the bread improver, but they can also be added to flours by the miller. Bakers need to be aware that they do not over-dose bread dough by adding oxidizing agents from several sources.

Reducing agents. Reducing agents make dough more extensible. They are deliberately added to 'weaken' structure in specific products. The major material used in bread dough is an amino acid known as L-cysteine. It can only be used at low levels in improvers but by reducing dough resistance to deformation it helps in molding and shape forming, such as rolls and baps, without structural damage. L-cysteine can also be used in pan breads at low levels where its ability to reduce resistance can help reduce streaking caused by molding faults. Other ingredients such as deactivated yeast and proteases have a similar effect. Reducing agents soften dough by breaking the cross-links between amino acid chains in the gluten network rather than by breaking the chains themselves. This reaction is finite and so the process is inherently more controllable than that using enzymes. A wide range of recipes use this technology and reducing agents are sometimes used in conjunction with enzymes.

Emulsifiers. Emulsifier is a general term we use to describe ingredients which are able to assist in the mixing together of two dissimilar materials. A range of emulsifiers may be added to bread to improve its quality, each one acting slightly differently and having its own special effects. We will briefly consider some of them:

- Glyceryl monostearate GMS – has a softening, anti – staling effect
- Diacetyl esters of tartric acid DATEM – gives better bread volume, not permitted in all countries
- SSL sodium stearoyl lactylate / CSL calcium stearoyl lactylate – affective but expensive
- Lecithin – natural but less effective

Starch complexing agents, emulsifiers, have been used as anti-staling agents for many years (DATEM, SSL/CSL, GMS) to reduce the apparent staling of the bread. Emulsifiers complex with the amylose and inhibit the rate of starch crystallization.

Stage of processing

Mixing

Improved machinability

Proving

Better gas retention

Shorter fermentation

Greater shock tolerance

Baking

Better gas retention

Better crumb structure

Shelf-life

Improve softness

Longer shelf-life

Figure 9. Effect of emulsifiers during bread processing stages

Hydrophilic – Lipophilic Balance , HLB is a system of classifying surfactants/emulsifiers by how much water-loving or fat-loving character the molecules possess, on a scale of 0 – 20; some examples: oleic acid 1.0, mono- and diglycerides 2.8, DATEM 7 – 8, SSL 10.0. In addition to single emulsifier systems, the use of multi-emulsifier gels in cake making is quite widespread, because mixtures of emulsifiers tend to produce better results than individual materials, and a wider range of HLB can be covered. Using polyglycerol esters, sorbitan esters or propylene glycol esters in conjunction with GMS can give further improvements.

Enzymes. Enzymes are biological catalysts – all known enzymes are proteins. They are large molecules made up of chains of amino acids linked together by peptide bonds. Enzymes active materials have assumed a greater importance in improver formulations over recent years. Factors affecting enzyme activity are:

- temperature
- pH
- concentration of substrate
- inhibitors.

Malted barley and wheat flours, often called diastatic malt flour, have been and are still used as an improver by bakers to give better gas retention and other benefits in doughs. The traditional role for malted barley flour was to improve gas production in long fermented doughs but today with our more rapidly processed doughs this function is largely irrelevant. Soya flour has been used as a bread improver for many years. It contains lipoxygenase which 'bleaches' the natural pigments in flour to create whiter bread. Other enzyme active materials have assumed a greater importance in improver formulations. In 1996 the use of enzymes in bread was 'de-regulated' - this means that we can use a much wider range of enzymes than before, provided they have been shown to be safe for use and human consumption. This will allow the baking industry to make even greater use of the special properties of enzymes for improving dough performance and bread quality. The main enzymes in bread are presented in fig.10.

- α-amylases - Cereal* Fungal Bacterial Maltogenic

  * *Occurs naturally in wheat*
- Hemicellulase/Xylanases - Increase volume
- Lipoxygenases - Whitening/Oxidising
- Lipases - Emulsifier
- Transglutaminases - Strengthens protein

Figure 10. Enzymes in bread

Cereal α-amylase is naturally present in flour. It breaks the starch into simple sugars to feed the young plant. Levels will vary depending on the quality of the wheat and the weather conditions during harvest. Cereal α -amylase can be a beneficial bread improver, but at high levels can cause stickiness, most noticeably in sandwich breads; the levels are measured in seconds using Hagberg Falling Number (HFN), where 60s is a very high level and 450s is a very low level. Flour millers control the level in flour by blending the wheats. The term alpha-amylase is used to describe a range of enzymes, which are capable of breaking down damaged starch granules into materials known as dextrins and in combination with beta-amylase they will produce maltose. Alpha and beta-amylase work in combination. Beta-amylase attacks the ends of the amylose and amylopectin chains breaking off individual maltose sugar molecules. Most wheat flours contain adequate levels of beta-amylase so it is the alpha-amylase that controls the reaction. Additions of alpha-amylase to doughs via improvers and even in flour mills are preferred in the fungal rather that the cereal form. This is because the fungal form is inactivated at lower temperatures in the baking process and reduces the risk of the formation of high levels of sticky dextrins. Excess cereal α- amylase reduces bread quality. Cereal alpha-amylase is produced during the growing cycle and can achieve quite high levels if the period around harvesting is wet. The dextrins which are produced by the action of alpha-amylase on damaged starch are sticky and if their level is high enough in the finished bread they build up on the slicer blades and can reduce their efficiency to such an extent that loaves will collapse.

The other widely used enzyme is hemicellulase, also known as pentosanase and xylanase. This was added to the list of permitted enzymes in 1996 and has already achieved widespread use. They react with a complex group of flour components we call pentosanes which are present in white flour at levels of around 2% of the total flour weight. The significance of the pentosanes in dough structure becomes apparent if one examines the distribution of water in bread dough. Although pentosanes represent only about 2% of the total flour by weight, they bind roughly ten times their own weight in water. Hemicellulases help to increase volume, improve dough handling but little or no anti-ferming effect – the overall mechanism is probably similar to that for the amylases, enhancing gas retention and delaying the setting point of the bread in the oven.

Gums. Xanthan gum, Guar Gum are water binding agents. Bread softness can be influenced by increasing the water content of the crumb, therefore moisture in dough can be increased (2-3%). For the same purpose it could be used also stronger flours which have higher water absorption and hydrocolloids. But there are some problems regarding the use of gums:

- water being a non-structural ingredient can lead to less volume
- increasing water can increase water activity and reduce mold-free shelf-life.

3.3. How to replace E-numbers

Main chemical preservatives used in bread making - weak organic acids such as propionic, benzoic, and sorbic are used to suppress the growth of microorganisms and to lengthen usable life of bakery products.

Propionic acid and derivates have action against molds, yeasts and some bacteria (inhibits *Bacillus Mesentericus* – the bacterium that causes rope in bread); propionic acid and calcium propionate are usually employed at concentrations of 0.1 and 0.2 per cent respectively. At these levels, molds can be inhibited for 2 days or more and the formation of rope can be prevented. Higher amounts of propionates are necessary to achieve a sufficient preserving action, but these concentrations give the bread a distinct odor.

Sorbic acid has activity mainly against yeast and molds, is effective to control mold growth in bakery products at level of 0.125% to 0.3% and is sometimes

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Employability in Bakery Sector
2017-1-TR01-KA205-039233

used in combination with propionates to suppress their bad sensory properties and to gain a broader spectrum and more effectiveness against bread deteriorating micro-organisms. The residual taste is less than other preservatives, but it has an adverse effect on yeast activity and thus on dough rheology, producing a serious reduction in loaf volume and making dough sticky and difficult to process.

In order to avoid the use of these chemical preservation substances, lactic acid bacteria (LAB) are recommended as bio-preservation organisms - inhibit mold growth in bakery. Bio-preservative means the use of microorganisms and their metabolites to prevent spoilage and to extend the shelf life of foods (fig.11).

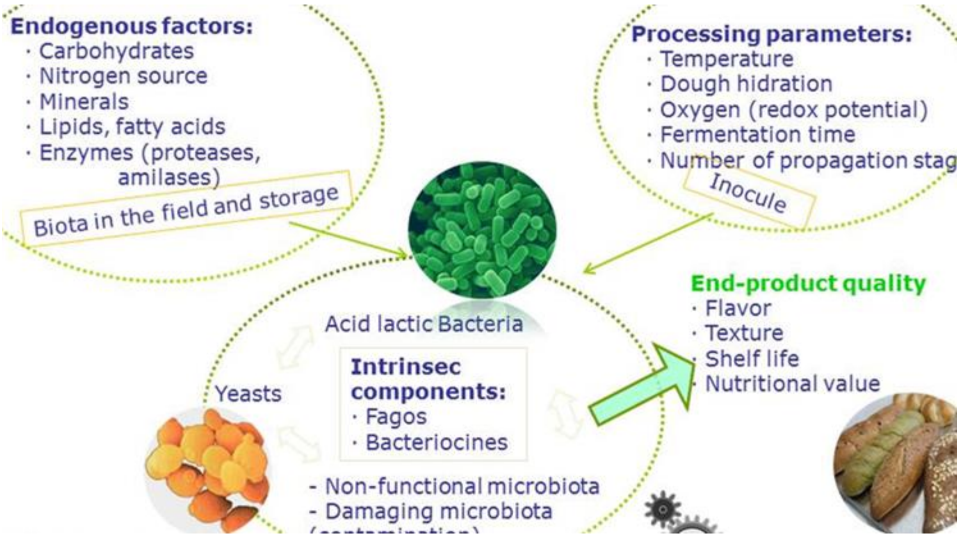

Figure 11. Influence of acid lactic bacteria (LAB)

Another example for replacing chemical additives is the use the effect of fungal alpha-amylase FAA on loaf height during baking. The mechanism by which these improvements are obtained: increased oven spring is due to the action of fungal alpha-amylase on starch in the loaf (the temperature being 55 to 60°C which lowers dough viscosity). Observations on doughs during baking show that this allows them to continue to expand later on into the baking process – fig. 12.

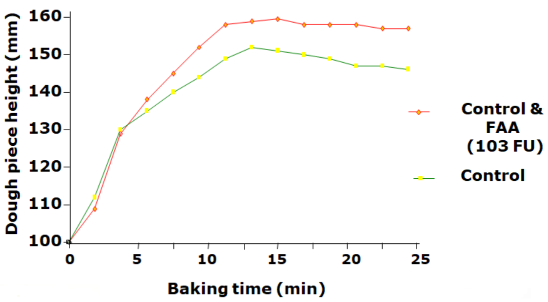

Figure 12. Effect of FAA during baking (Campden BRI)

Chapter 4

Dough processing route – first steps of the technological flow

Flour, water and yeast or others ingredients (as presented in chapter 2.3) are mixed, to obtain the dough; after the bulk dough fermentation is following: the operation of dividing in smaller pieces, the shaping of dough pieces in the desired final product form, and the final proof step. For traditional bread making, after mixing, the dough must be fermented for a period of time (could be 2/3/4 hours – depends on the technology type) before final processing. During this period of time occurs a significant contribution towards gluten development. If an oxidizing agent is used, the gluten is developed in the mixer, saving a considerable amount of time. The use of ascorbic acid in bread making is not as straightforward as other former permitted oxidants. Ascorbic acid can only function as an oxidizing agent in dough after it has been itself oxidized to another form known as dehydro-ascorbic acid and to achieve this conversion oxygen is required.

Needs oxygen (from air)

↓

Breaks disulphide bonds

↓

Develops gluten

↓

Helps gas retention

↓

Helps loaf volume

Figure 13. Effect of ascorbic acid

With sufficient oxygen available the ascorbic acid first converts to the dehydrate form to oxidase the proteins and then having done so changes back to the original ascorbic acid form (fig.13). The cycle continues as long as sufficient oxygen is available. Oxidation of bread dough promotes cross-linking of the protein molecules causing the dough to become stronger, more elastic thus helping with texture and shape of the final product. Other dough ingredients use oxygen during mixing - most notably the yeast which will remove oxygen so fast that by the end of most dough mixing systems no oxygen remains in the dough for ascorbic acid conversion. The net change of gases in the dough is from a mixture of oxygen and nitrogen to a mixture of carbon dioxide and nitrogen. Therefore the contribution of oxidants to bread quality is significant, by improving dough development we will get larger product volume and improved crumb softness. In some processing environments we can also get finer cell structure which will give soft bread and a whiter crumb color. Ascorbic acid has a significant advantage over other oxidants in that since oxygen availability limits its action it is very difficult to over-treat by increasing the added level. At best the ascorbic acid remains inactive once the oxygen has gone from the dough though it can now act as a reducing agent and break rather than create protein bonds. The action of ascorbic acid is temperature-sensitive and as we lower dough temperatures it becomes less active and therefore gives less dough development. In bakeries there is always the temptation to reduce dough temperature in order to reduce yeast activity and make doughs easier to handle but in doing so there is a danger of reducing dough development and bread volume.

Emulsifiers such as glyceryl monostearate GMS, diacetyl esters of tartric acid DATEM, sodium stearoyl lactylate SSL and calcium stearoyl lactylate CSL, are sometimes seen as alternatives to the addition of hard fat in bread doughs (fig.14). They certainly do improve gas bubble stability and like fat they align themselves with the air bubbles in the dough. However, they have quite different melting points and melting profiles and cannot be used to directly replace solid fats with absolute certainty.

- Dough handling 0.3-0.5% DATEM
- Loaf volume 0.3-0.5% DATEM
- Antistaling 0.5-1% Monoglyceride

Figure 14. The emulsifier's actions

4.1. Mixing, fermentation, dividing, final proof - main processes involved

Dough preparation could be made mainly in three methods:

- Direct method – all the ingredients are mixed in a single phase
- Semi – direct method – the dough is obtained also in a single phase, but a certain quantity of the previous fermented dough is added
- Indirect method – there are two phases: in the first a pre-dough is prepared (could be biga or poolish) what is added in the second phase to the dough already fermented, together with the others ingredients.

Bread making starts by the formation of viscous dough developed in a mixer (fig. 15) - during mixing, gluten structure is developed and starch particles are wetted. Gluten formation is the main physical –mechanical process that occurs during dough formation. As mixing progresses, air is incorporated and distributed in small fine cells. Yeast is producing CO_2 during mixing and subsequent steps of bread making that is diffused in these fine cells, which are inflated by the rising of internal pressure.

Figure 15. Different mixing devices (source: internet)

Biochemical processes occur also in this phase of dough formation: lipids, carbohydrates and proteins transformations, facilitated by the enzymes (from flour and yeast) presence. Various bonds formed between the gluten proteins and others components, as soluble proteins, mineral salts, starch, lipids, lead to the formation of a homogeneous and uniform mass – the dough.

The microbiological processes, that involve the dough microbiota, are represented by the yeast cells and lactic bacteria multiplication, followed by the alcoholic and lactic fermentation. The fermentation goal is to obtain such a dough that could optimum perform during developing, fermentation and baking phases. During fermentation the processes initiated in the mixing period are going on: the proteins molecules in gluten swell and absorb the CO_2 formed by the yeast, therefore realize a network between them and conferring a spongeous structure. Under the reaction of proteolytic enzymes more malleable dough is obtained.

During the fermentation, the dough had undergone a temperature increasement of 2 - 3 °C, due to the sugars decomposition by the yeast. In the same time the dough weight at the end of the fermentation is lower with 2-3%. The losses are caused by the fermentation of sugars (solid) in volatile substances (CO_2 and ethyl alcohol) that partial evaporate, and by the water vaporization.

After mixing and bulk fermentation, the dough pass through other operations as dividing, rounding (fig.16), resting, conveying, sheeting, curling, elongating, cutting, folding and panning – depending on the shape of the final product - that could damage the gluten formed. If the dough is squeezed, sheared or screwed the structure breaks down - the result in the loaf is streaks of coarse, firm texture with poor color. If dough structure is weak from the use of low protein flour, high starch damage and high water addition, it needs to be handled very gently to get the best performance. If the structure is strong from the use of a combination of good quality high protein flour, moderate starch damage and water addition, properly formulated and fully developed, there is a high built-in resistance to changing shape - particularly from a ball to sheeting and more relaxation time is required between these molding operations.

Figure 16. Different shaping operations performed on divided pieces of dough after bulk fermentation (source: internet)

Levels of added fat used in bread dough is little but highly functional and the effects of fat are also combined with the functionality of native wheat lipids and added surfactants. Liquid oils are known to have a negative effect in volume of bread especially under no time dough method. They are destabilizing the air cells so loaf volume is reduced and crumb structure is damaged. The solid fat has proved to assist gas retention - these solid platelets tend to orient themselves around the air cells and stabilize the foam, providing a solid wall around the air cell.

During the shaping operations the dough is formed according to the final product specifications; then a fermentation phase – the final proving, is developed to assure an optimum volume to the product (fig. 17).

Figure 17. The final proving phase

4.2. Specific parameters – definitions and importance

Temperature – is an important parameter that has influence on the entire technological flow, from the raw materials to the final product storage space. Every recipe has the specific temperature for each step in the process, but there are some milestones to be kept in mind and to be used for the calculation of others temperatures. The optimum temperature for the yeast multiplication is 25 - 30°C, therefore for facilitate the multiplication, the dough temperature should be between 25 and 28°C, depending on the dough type: 25°C – soft dough, 27°C – very soft dough, 23°C – dry dough. The final dough temperature depends on: ambient temperature, flour temperature, water temperature and the increasing of the temperature caused by the mixing device. On the other hand, the water temperature could be calculated depending on the final dough temperature, ambient temperature, flour temperature and so on.

Duration – time involved for the developing of phases, operations – is an important parameter too. The time for fermentation of the pre-dough is variable, depending on the consistency and temperature of the mixture; it could be very long, even 48 hours for certain types of biga. The mixing time is also different, depending on the method (direct, semi-direct and indirect), on the mixer type (spiral, fork form or hands movement imitation), on the rotation speed - but in every case it is important to set and follow the optimum time that assures a homogenous dough.

The fermentation time depends on many factors (product type, yeast quality, dough characteristics, ambient conditions, the obtaining dough method, flour properties) and it will be decreased when:

- the yeast quantity in the recipe is high
- high temperature and humidity of the ambient zone
- dough hidratation is high
- the flour is weak

The fermentation time will be increased when:

- the flour is too strong
- dough humidity is low
- low temperature and humidity of the ambient zone
- the dough content is rich in sugars, fats.

Chapter 5

From dough to bread – baking steps

Baking is a high temperature process applied to fermented pieces of dough, that transform the dough in the baked form, the bread. During baking several phenomena occur: product volume development, crumb and crust formation, flavor delivery, bread color formation, moisture and weight loss.

Dough pieces during baking receive heat from the furnace surfaces (in different ways: conduction, convection and radiation, depending on the type of oven), which are already at about 100 ° C, and the temperature is constantly increasing. The heated superficial layer extends the warmth to the inner layers that in the end of the process reach 100°C also.

Furnace humidity is also very important for heat exchange, not only for the bread's properties (volume, shape, appearance, color and crust thickness), but also the speed of baking. More moisture in the oven, more condensed water on the bread surface and, at the same time, increases the heat so that the temperature of the product grows fast. The water condensation process follows until the surface temperature reaches 100° C (water evaporation) and the opposite process begins, the water evaporation from the superficial layer and then from the inner ones. It is important to stop the baking at the optimum moment, therefore a certain amount of humidity has to remain inside the bread loaf; this internal moisture will migrate to the upper layers during the cooling process.

The baking time is directly proportional to the weight of the dough, so the higher the weight of the dough pieces is, a longer baking time is needed. The same relation is seen in the case of the height of the products, at a certain baking temperature a longer time is involved for bread with larger dimensions.

5.1. Transformations during baking

Microbiological, colloidal and biochemical processes develop during the baking phase.

Microbiological processes. Fermentation processes have a major evolution during dough proving phase; during baking the microorganisms are partially inactivated by the oven temperature. Only in the core of the product, where the temperature is not so high, a certain microorganisms activity is noted. In the center, till the temperature reaches 35° C, the yeasts are also active, producing CO_2. At 35° C the alcoholic fermentation is at the maximum. The yeast activity remains still high up to 40° C, then a significant decrease occurs, and at 50-53°C when the yeast metabolism is stopped. Mesophilic lactic bacteria are inactivated at 35°C and thermophilic at 54°C, so in the first part of baking, lactic fermentation is still taking place.

Biochemical processes that occur during baking are:

- CO_2 and ethyl alcohol production under yeast action (fig. 18);

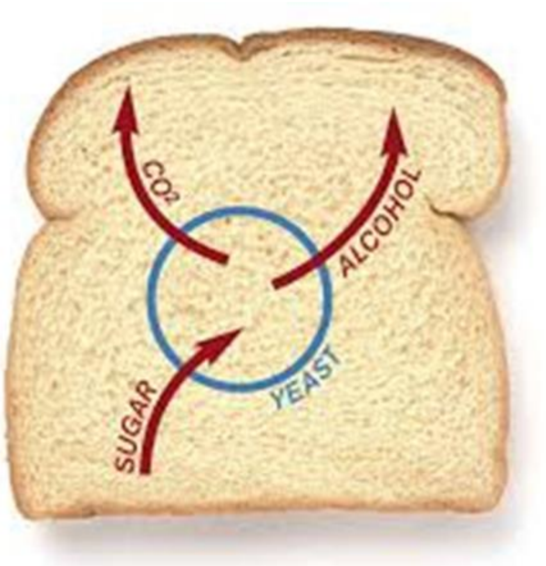

Figure 18. Sugars are consumed by the yeast that produces CO_2 and ethyl alcohol (finecooking.com)

- lactic, acetic and butyric acid production under lactic bacteria action;

- gelatinizing of starch, first in bread crust and then crumb, at 56 - 60°C; starch is easily attacked by amylase, and as long as they are active, it is converted to dextrins, maltose and glucose;
- the pentosanes reduction into soluble forms
- at 60-70°C the gluten proteins denaturation begins, through their coagulation the bread structure is stabilized
- proteolytic enzymes are resistant to temperature, so active up to 80-85°C, and convert proteins into peptides, and these in amino acids
- in the initial stage of baking some of the starch formed sugars are consumed by the yeast; the remainder (2-3% on the dry substance of the product) is caramelized on the crust of the product, a part is bound to the previously formed amino acids, forming the melanoidins. In this stage the acrylamide is also formed (fig. 19). These products resulting from the transformation of sugars give the product the crust brown color, taste and smell so specific to bread.

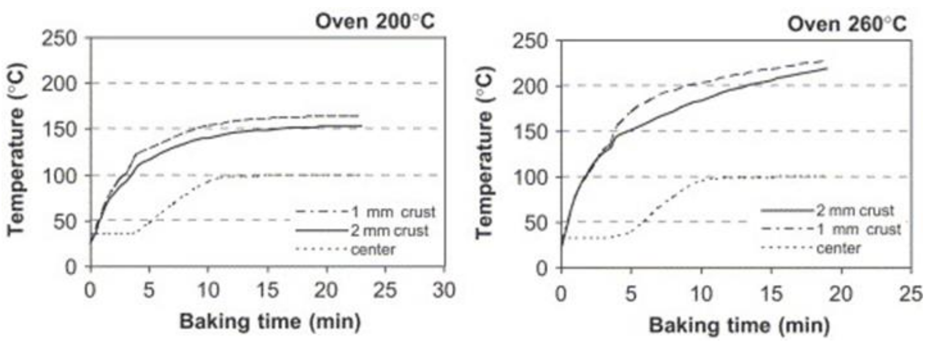

Figure 19.Influence of temperature on acrylamide content (Ahrné et. All, 2007)

- in the crumb and crust of bread , volatile flavoring substances are formed, resulting from organic acids and ethyl alcohol, and evaporate giving an intense aroma of the finished product

Colloidal processes.

- gluten transformation - at 30°C gluten shows the highest water absorption capacity; this capacity decreases with increasing temperature, therefore at 60-70 °C the proteins are denatured, releasing the previously absorbed water.

- starch modification; the starch, unlike gluten, increases the water's ability to absorb water at increasing temperature , reaching a maximum of 50-60°C, when the starch gelizes, and its grains are broken. Absorbing a lot of water, the granules inflate progressively, creating an internal pressure that destroys the protective coatings.

Therefore, in the temperature range 50-70°C, there are simultaneous processes of protein denaturation and starch gelatinization, which explains how the dough is transformed into the crumb of bread.

During baking, air cells are inflated even more by the increase in the pressure of gases, vapor pressure of water and additional CO_2 leaving water phase due to decreased solubility. This is the oven spring. At some point during baking air cells rupture as elastic properties of cell walls cannot cope with the inflation. This gives the fine interconnected cell structure of bread. Many variations in baking performance and volume that have been noticed in aged flours have been assigned to alteration in the nature of native lipids due to oxidation and action of lipases. Two well-known problems in bread making have been linked to variations in native lipid nature: lack of oven spring while proofer volume is fine and appearance of blisters in the surface of baked bread.

5.2. Ovens types – how to assure the products individuality

The above-mentioned general principles are applicable to the baking process, regardless of the types of ovens. These may differ by the way heat is transmitted, the materials from which they are made, the presence of steam, the principle of operation, etc. The process of baking and the type of oven have great influence on the finished product, conferring those characteristics that make the difference between products, categories.

The correct choice of oven type is not only to ensure the consistency of the technological flow, to ensure the preloading capacity of the pieces of dough for baking, to obtain an adequate productivity of the work. According to the quantities we are talking about there is difference between industrial and handcraft.

Figure 20. Types of bakery ovens (static and continuous)

Besides, the appearance of the product as a result of the baking process may be very different if steam is used or not, or on the succession of zones with different temperatures.

Chapter 6

Bread cooling

After baking two processes take place:

- perspiration - consists of cooling and complete drying of the product after baking; at the end of baking, in any baked product, some moisture remains in the crumb, which then comes out sooner or later, depending on the size of the product;
- bread aging, characterized by:
    - retro gradation of starch – the water previously absorbed by starch is released, being absorbed by either gluten or migrated to the crust
    - water passing from the crumb to the crust, and from here to the environment
    - part of the water remains in the crust, so that the crumb becomes more and more dry and the crumb softens
    - the increased percentage of water left on the crumb is a factor that favors mold growth.

6.1. Importance and parameters

Bread has to cool before packaging, and when it is the case, before slicing too ; otherwise, the crumb will be warm and gummy. First, it leaves an undesirable moisture condensation inside the package and could cause problems at the slicer, with the blades gumming up, and downtime cleaning the blades. Bread cooling is an integral part of industrial high-speed bread production (cooling spirals).. During the cooling process, the baked bread loses moisture, dries out and intensifies in flavor. Depending on the size and shape of the loaf, it may take up to 2 hours for the bread to completely cool. This is critical, as most bakers tend to prolong this process with excessive moisture loss. The internal temperature of the bread out of the oven is around 95° C , and the crust is somewhere around between 150° C to 180°C.

The processes of cooling and setting, can take place in the dispatch area or during transport. For cooling in the dispatch area, adequate fresh air is essential, preferably making use of forced-air turbulence, such that the loaves can cool down gradually to about 35°C. Actual transportation is not recommended until loaves of bread of 1 kg and over have attained this temperature, assuming they are not for slicing, and packaging. During the cooling of bread there is always a potential hazard of microbial infection, whether in the small craft bakery with a short distribution chain to the point of sale, or in the large industrial bakery where distribution chains are always much longer. The main cause of microbial infections is the inevitable high humidity and incidence of condensation.

All storage and dispatch areas must be kept clean, well-aerated and free from any contaminating foreign smells. Where forced convection is used, the air intake should ideally be filtered before entering the cooling area. Other aids to general hygiene in these areas are: the presence of UV-based radiation, units for the control of insects, climatic control (temperature/humidity) and ozonization devices.

The internal bread temperature should be reduced to 35 – 40°C at the end of the cooling cycle; this could be achieved with an external air temperature of

24° C and a relative humidity of 85%, with an air movement. Bread is normally packaged at the legal limit of 38 - 42% moisture. A proper cooling method (fig. 21) can avoid microbiological spoilage.

Figure 21. Bread cooling in dispatch area and in continuous mode (cooling spirals)

6.2. The ageing of bread – modifications and prevention

Fresh bread is a product with a short shelf-life and during its storage, chemical and physical alterations occur, known as staling. As a result of these changes, bread quality deteriorates gradually as it loses its freshness and crispiness while crumb firmness and rigidity increase. The molecular basis of staling is examined by reviewing what is known about the components of wheat flour, factors that affect staling rate, and the various mechanisms that have been proposed. The bread staling is a complex phenomenon in which multiple mechanisms operate – fig. 22 (Katina et all., 2006). Polymer crystallizations with the formation of super molecular structures are certainly involved. The most plausible hypothesis is that retro gradation of amylopectin occurs, and because water molecules are incorporated into the crystallites, the distribution of water is shifted from gluten to starch/amylopectin, there by changing the nature of the gluten network. The role of additives may be to change the nature of starch protein molecules, to function as plasticizers, and/or to retard the redistribution of water between components.

The storage temperature has a great influence on the rate of bread staling. For storage temperatures of −18°C water activity decreases and it is maintained at an almost constant level for 23 days. During storage, the starch molecules are associated and generate a new crystalline order. As observed with the recrystallization kinetics, at −18°C only crystal growth may occur, whereas at 25 °C and 4°C there would be not only growth but also formation of new crystals. At 4°C the rate of starch retro gradation is the highest for the studied conditions (Russel, 1983).

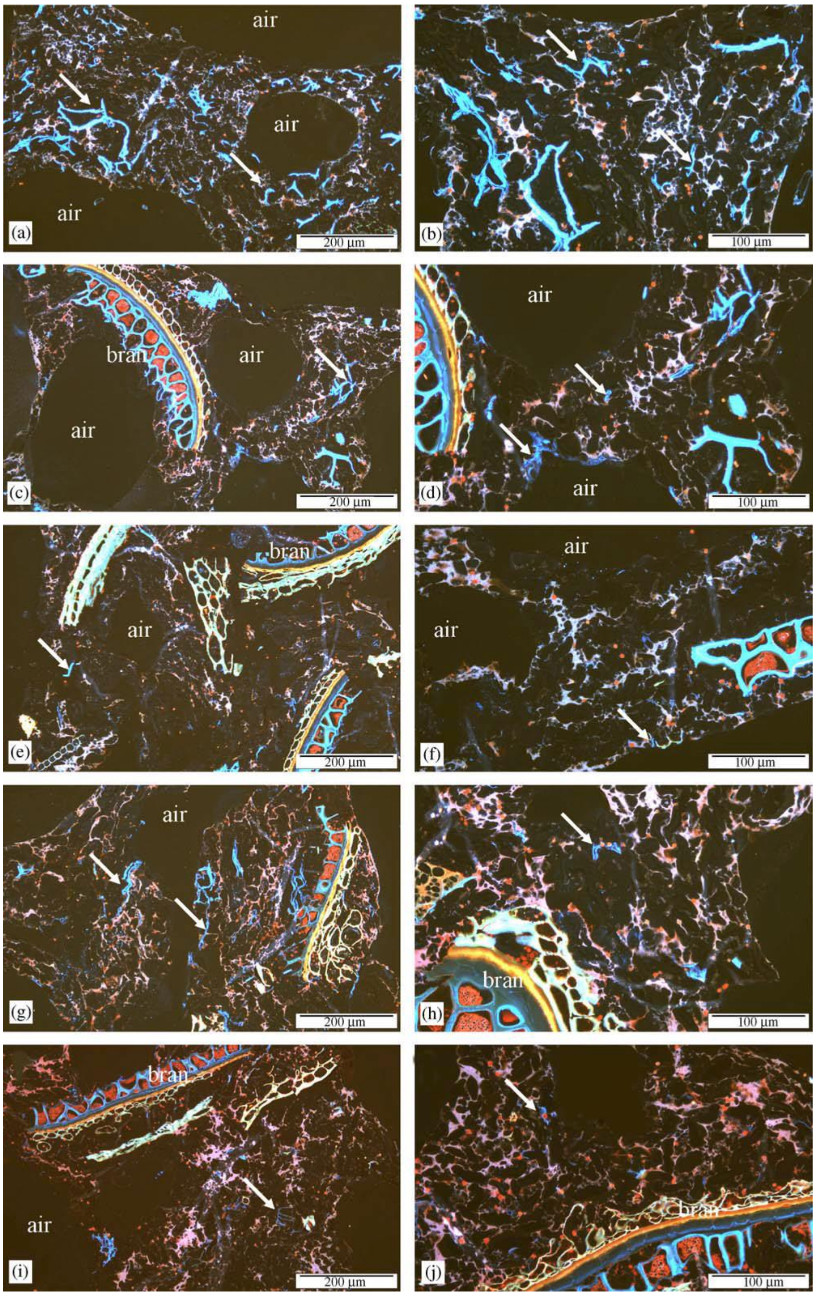

Figure 22. Micrographs of fresh bread crumb stained with Acid Fuchsin and Calcofluor to visualize protein and cell walls, respectively: (a) white wheat bread, fresh and (b) 6 days old; (c) reference bran bread, fresh and (d) 6 days old; (e) bran bread with enzyme mixture, fresh and (f) 6 days old; (g) bran sourdough bread, fresh and (h) 6 days old; (i) bran sourdough bread with enzyme mixture, fresh and (j) 6 days old. White arrows indicate fragmented cell wall components (stained blue).

Some solutions to prevent the ageing of bread:

- Maltogenic amylases can help improve the softness of bread over shelf-life and are used by bakeries to counter the effects of staling, especially in long-life products.
- Lipases produce monoglycerides and fatty acids from triglycerides which complex with starch to inhibit staling
- The combination of bran sourdough and enzyme mixture significantly improved the volume, texture and shelf-life of wheat bread supplemented with wheat bran (20 g bran/100 g of flour). The use of fermented bran improves the structure of the gluten network and may alter water migration between starch, protein and bran particles during storage. The antistaling effect of combined use of bran sourdough and enzyme mixture was due to reduced starch retro gradation rate, slowed increase in rigidity of polymer structure and due to degradation of cell wall components leading to altered water distribution between starch–protein matrix (Katina et all.,2006).

Fats are known to delay staling of breads. Research has shown that when fat is added to defatted flours where native polar lipids have been removed, the anti-staling is lost. The most prevalent theory is the complex creation with starch constituents (amylase and amylopectin) Anti-staling effect is more prevalent in fat percentages higher of 3 % from the flour weight.

- monoglycerides in the form of hydrate have proven to be the top anti-staling surfactants and surpass the performance of shortenings both on antistaling but also on softening of bread.

- water activity control - water activity affects food chemistry and can be controlled by removal (dehydration or drying) or by chemically binding the water, reducing its activity. Some examples: propylene glycol, sucrose, and sodium chloride used to achieve water activities of 0.78 or 0.79 in semi-moist food; combination of sugar (7%), glycerol (2%), propylene glycol (1%) and salt (1.5%) predicted aw of 0.85 in cereal-based products; using glycerol as 15 to 45% of the food product an aw less than 0.85 could be achieved.

Chapter 7

Packaging and shelf life

In contrast to fresh bread, which stales in less than a week, frozen bread stales very slowly (bread has been held fresh for many months by storage at -22°C). Therefore, the lower the temperature, the more slowly it stales. It was reported (by Desrosier, 2006) that bread frozen quickly after baking and held for one year at -18°C, was equivalent in softness to fresh bread held for two days at 20°C. Microbiologically stable foods, such as biscuits, will have their shelf-life defined by the changes in their sensory properties. Many fresh foods after relatively prolonged storage may be microbiologically safe to eat but rejected due to changes in their sensory properties. Therefore, regarding the shelf-life we could talk about two points of view:

- Sensorial – the characteristics related to the taste, smell, color and their modifications during the shelf life - eating quality
- Microbiological - mold developing – safety quality

During shelf life water activity takes an active part in the exchange with the ambient humidity and can possibly form the ideal medium for microbiological growth on the surface which influences the microbiological stability. Theoretically the water activity is defined as the availability of "free" water in a sample and should not be directly compared with the water content (g water/ g substance) and its value ranges between 0 (absolute dryness) and 1 (condensed humidity). Migration from regions of high water activity to regions of lower water activity in combined food, bakery products filled with various ingredients as cream, nut, nougat, fruits, jam, must be considered.

The water activity also has an important effect on the chemical reactions in food. It has been known for many years that foods may pick up or loose moisture from the air during storage and that these changes can affect the texture.

Classification of baked products according to water activity value:

- 1 – 0.85: moist bakery products (bread)
- 0.85 – 0.6: intermediate foods (cake)
- 0.6 – 0: dry bakery products (biscuits)

7.1. Keep the product integrity – packaging materials and techniques

The ideal bread packaging material must: be attractive, maintain adequate shelf-life, run on automatic machinery, be strong, be inexpensive, be an adequate moisture barrier, protect the shape of the product – fig. 23.

Figure 23. Examples of packaging for cereal based products

Basic requirements of a package intended to contain bakery products include:

- water vapor permeability of packages
- oxygen exchange from within and outside a package
- aroma impermeability characteristics of packaging materials
- resistance to seepage of fats and oils
- protection against deteriorative visible and ultra violet radiation
- good printability and appearance
- physical, mechanical protection to the products against shocks, crushing and vibrations
- compatibility and safety of the packages

Some examples of food contact materials used in bakery: Polypropylene (PP), Low density polyethylene (LDPE), Biaxially Oriented Polypropylene (BOPP), Paper / Foil.

One alternative method used to extend the mold-free shelf life of bakery products is MAP - modified atmosphere packaging which are using nitrogen (N_2) and carbon dioxide (CO_2), in an optimal ratio: CO_2: N_2 = 60 : 40 (fig. 24). N_2 is an inert, tasteless gas that displays little or no antimicrobial activity on its own and CO_2 is the most important gas in the gas mixture, it is both bacteriostatic and fungi static. MAP introduction in the market caused an important impact in the packaging of processed and fresh food industries; this technology has largely improved the shelf life by controlling the permeability of air and moisture. The high barrier properties of flexible plastic packages also have reduced the influx of microorganisms into the food packages, thus enhancing the shelf life of the food products. Bakery companies in Europe commonly use gas packaging for shelf-life extension of bread and cakes. In addition to extending the mold-free shelf life of products, CO_2-enriched atmospheres have also been reported to prevent staling in many bakery products.

The main benefits associated with food products MAP are better quality retention, extended product shelf life and associated increase in market area, improved product presentation and consumer appeal, and a reduction in energy costs associated with freezing and freezer storage costs.

Some of the disadvantages of MAP technique include:

- The initial higher cost of packaging equipment
- Higher cost of package materials
- Secondary fermentation problems caused by CO2- resistant microorganisms
- Package collapse in products using a high CO2 concentration (100%)
- The potential for generating conditions favorable for anaerobic pathogenic microbiological growth.

Figure 24. Modified atmosphere packaging MAP (source: IBA Bucharest)

Active packaging employs a packaging material that interacts with the internal gas environment to extend the shelf life of a food. Such new technologies continuously modify the gas environment (and may interact with the surface of the food) by removing gases from/or adding gases to the headspace inside a package. It involves packages incorporating antimicrobials and oxygen scavengers. Active substances are released from the packaging material to the surface of the product during the whole shelf-life of the packaged foodstuff. The protective additives are added to the packaging material and remain in the material even after the food is removed, thus facilitating a more natural diet with less chemicals in it. Active packaging using natural plant antimicrobial agents - essential oils (EOs) and plants extracts - can control microbial contamination by reducing the growth rate and maximum growth population or by inactivating microorganisms by contact. More, this is an important step in developing a new "green" image to selected bakery products, besides reducing and/or elimination of chemical preservatives used to prolong shelf life of food products.

Ethanol – used as an antimicrobial agent in the form of a sachet or incorporated into the packaged material; could be also sprayed after baking on the surface of the product - this option has a negative public perception, raises the chances to develop a residual flavor and implies regulatory issues.

7.2. Short or long shelf life? – how to manage

Bakery products shelf life - from the consumer's point of view the most bakery products could be divided in:

A. Fresh products – usually, have 24 h shelf life
B. Long shelf life products – from a few days, to several months and even years.

A. The first category doesn't require special treatment for preservation, because these products are consumed fresh for their taste, aroma, smell and texture. Fresh products are sold in small, artisan bakeries, or in special dedicate corners in supermarkets. These products are appealing, the smell spread in the neighbor area is irresistible, and the appearance could be homemade look like.

Nowadays an important percentage of fresh products are actually fresh baked products, and there are some solutions where the technological flow could include frozen phases. There are two different ways of processing the dough, the first one is very simple and the second one is very much more elaborate:
– The Retarded Dough System is just normal dough that we place in a normal freezer, to be used up at a later time, may be 1, 2, or 3 days later. This dough loses some of its performance capability during the freezing process and cannot be kept frozen for more than a few days only. This is just a convenient process that we can use in some short term situations.
– The Frozen Dough Technology (fig. 25) on the other hand is a very detailed and specific way of processing the dough, that enable the user to get the optimum performance out of the dough which has been frozen for a longer period of time. This period of time could be from just a few weeks to a few months; 6 months being regarded as a maximum for a live dough containing yeast. We can differentiate several processes types:

- Ready to Prove Frozen Dough, good for most yeast dough and puff pastry as well
- Ready to Bake Frozen Dough, recommended especially for croissant and Danish pastry items
- Part Baked Frozen Dough, good for bread items, not recommended for croissant, Danish pastry items, and sweet bread and bun items
- Full Baked Frozen Dough, good for sweet bread/bun and soft roll, not recommended for bread, croissant, Danish pastry and puff pastry items.

Figure 25. Frozen dough

B. Long shelf life products need specific materials, technologies and it is important to have in mind such topics as water activity, packaging system and preservatives. A very important condition to achieve a long term product shelf life is to maintain a high hygienic status – an HACCP issue. All the factors, from raw materials to machines and devices, productive spaces and personnel are involved.

Solutions for a longer shelf life include:

- shelf Life extenders - emulsifiers and enzymes which are used also as anti-staling agents in bakery products, provide increased shelf life
- technological possibilities – prolonged duration for the technological phases in order to achieve suitable parameters
- low temperature exposure – as explained at chapter 7.1
- humectants; research indicates some of the difficulty in achieving low a_w in foods through the addition of humectants. The humectant propylene glycol has intrinsic antimicrobial properties; however, its use in food was limited (no more for bread making); according some studies the potential of polyglycerols and polyglycerol esters as humectants in food found them to be objectionable due to taste and odor characteristics. Water activity affects food chemistry and can be controlled by removal (dehydration or drying) or by chemically binding the water, reducing its activity.

Chapter 8

Technological scheme – how to draw it and how to follow it

Going over and summarizing the operations and phases on the bread technological flow, a useful scheme for some industrial bread making methods is presented in fig. 26.

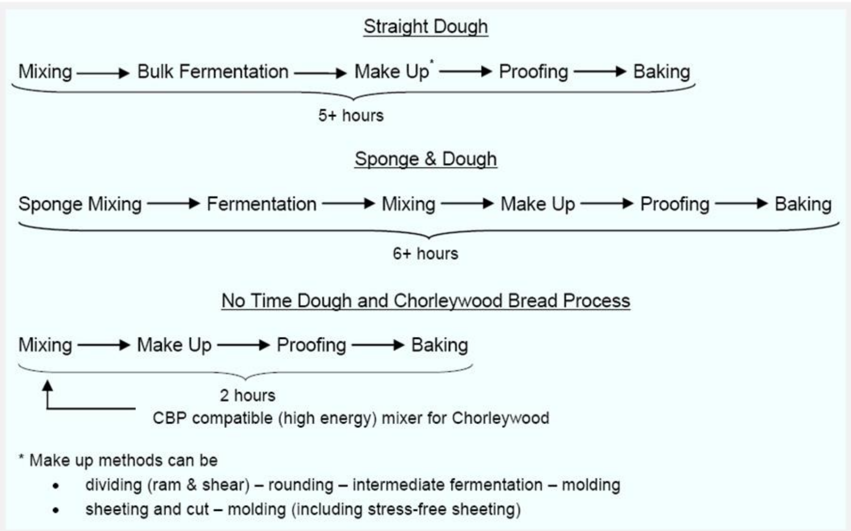

Figure 26. The main industrial methods

The logical succession of phases and operations, together with the corresponding materials and parameters is known as the technological scheme. Such schemes/diagrams facilitate the correct application and monitoring of the production flow. Every time a new product is launched it is necessary to draw an adequate scheme, in which it is important to follow the main flow of the general category the new product belongs, and to add the specifics traits.
On the other hand, once the technological scheme established, it becomes mandatory to be respected.

8.1. Estonian bread – typical product technological scheme – sourdough propagation cycle using mature sourdough to inoculate a new batch of sourdough and simplified rye bread making process common in Estonian bakeries -is presented in fig. 27 (E. Viiard, 2014)

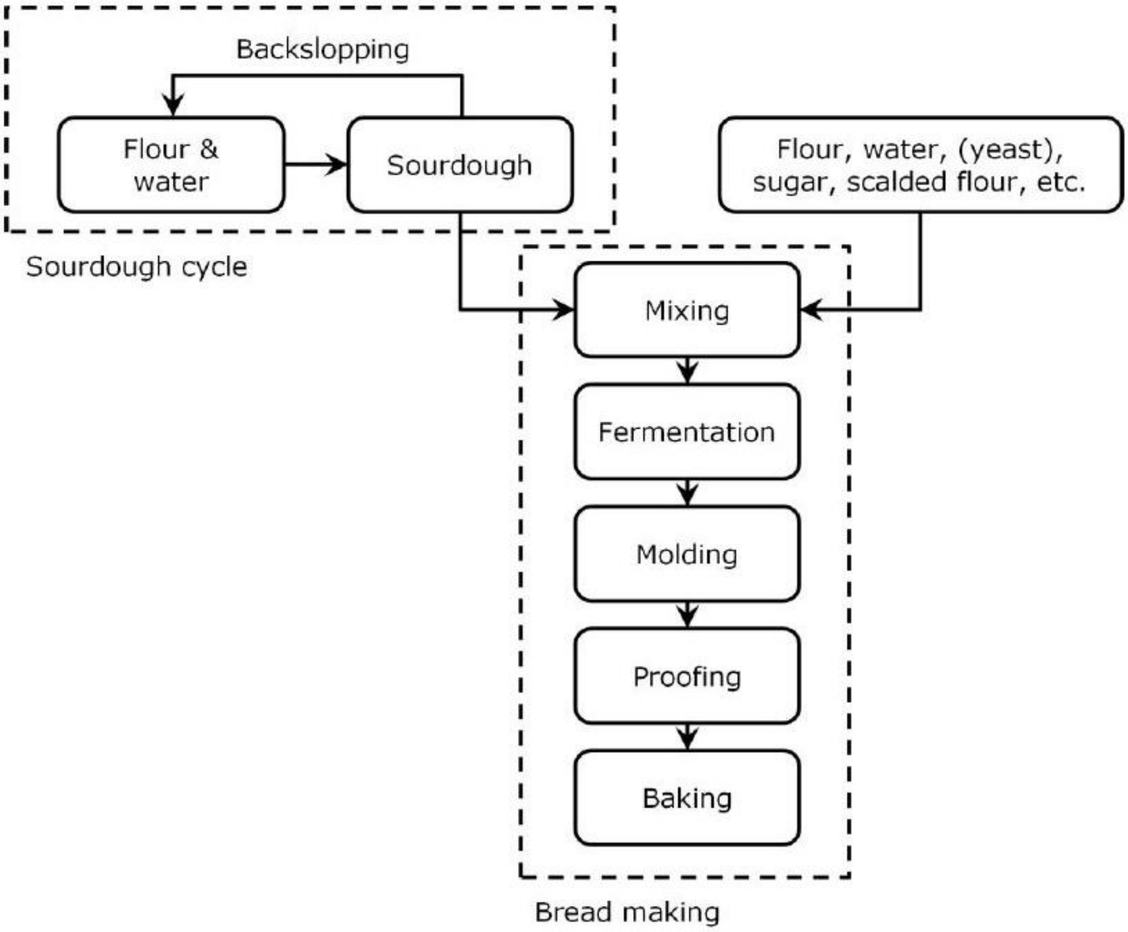

Figure 27. The technological scheme for Estonian rye bread

8.2. Romanian bread - typical product technological scheme – a white bread obtained from wheat flour – fig. 28.

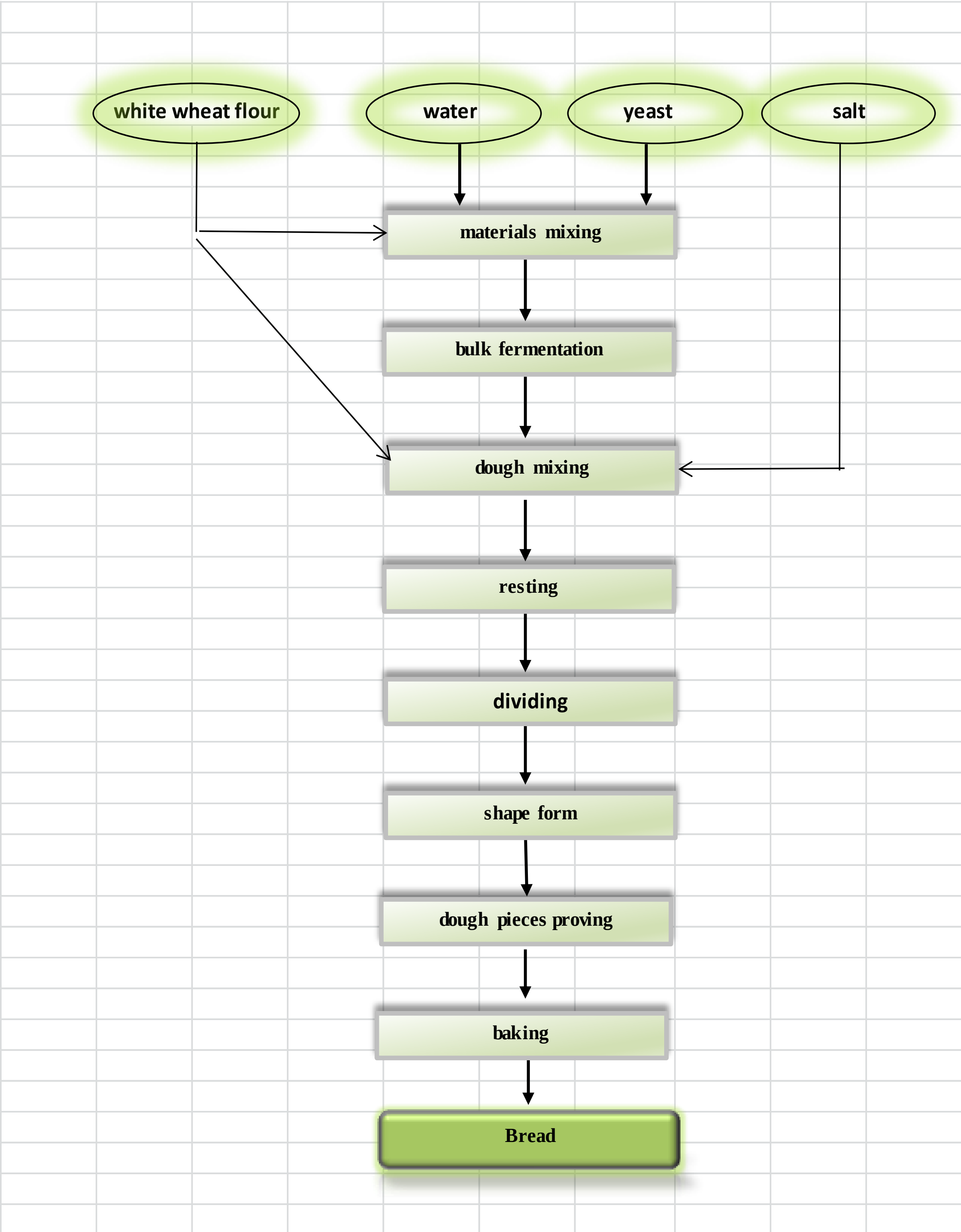

Figure 28. The technological scheme for wheat white bread

8.3. Turkish bread – pide technological scheme adapted – fig. 29.

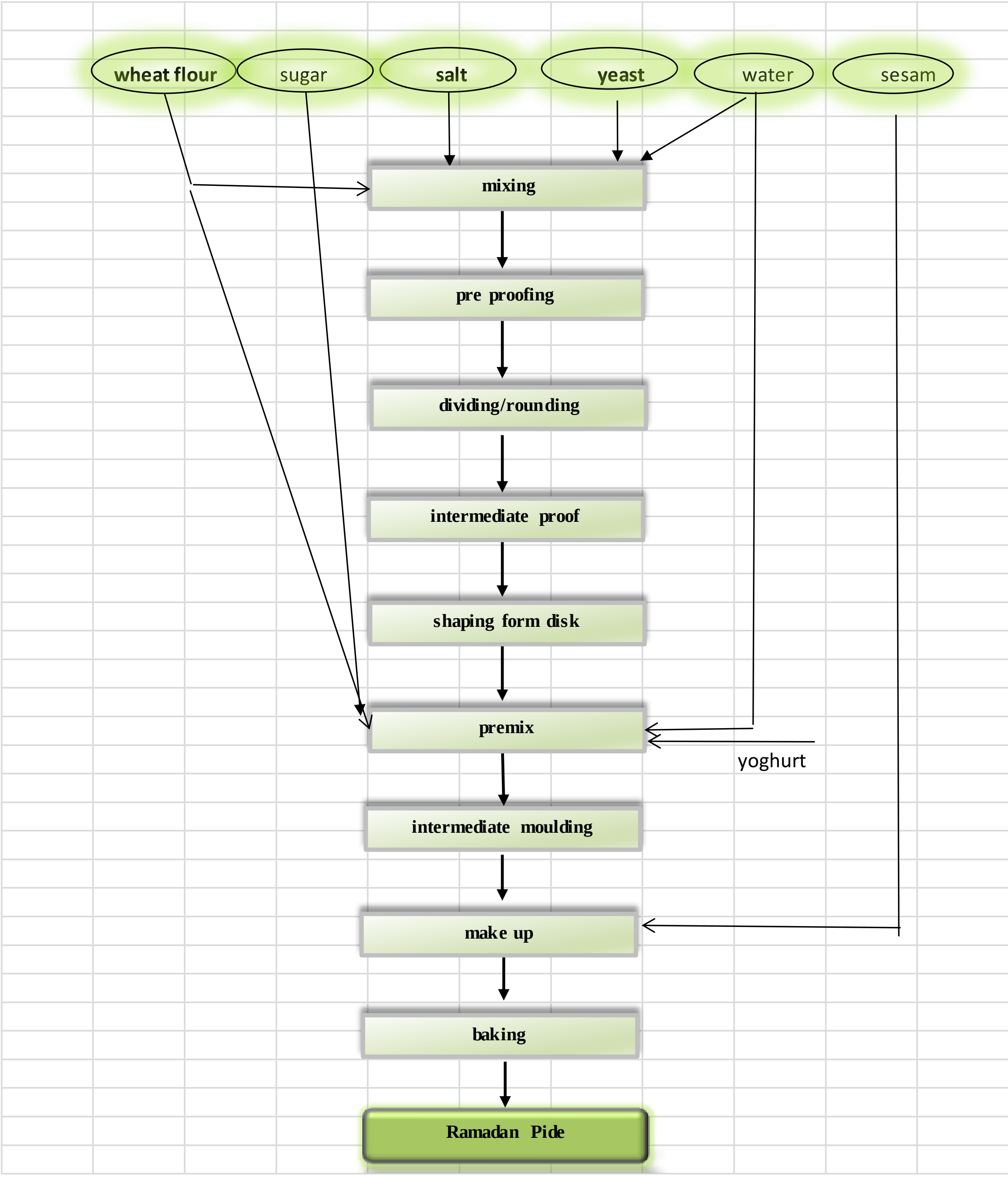

Figure 29. The technological scheme for Ramadan pide bread

Chapter 9

Let’s analyze our work – evaluation of bakery products

The activities of control and quality assurance plays a key role in bread making technology, being part of the general quality system (fig.30) - it starts with all ingredients control, the monitoring of the technological flow parameters and sequence, and the correct evaluation of the final product.

Figure 30. Relationship between the quality system, quality assurance and quality control

Small and medium sized bakery all over the world increasingly has to consider the production of good quality products as essential to their survival. Consumers and buyers are becoming more aware of the importance of safe, high quality products. Large companies that can afford advertising space on the radio, television or in the press emphasize the quality of their goods, often in a very subtle way. This quality image is given by stating for example "our foods are made only from high quality ingredients." The quality image could be promoted through packaging etc. In the case of exporters, the standards are becoming more and stricter.

In order to improve and control product quality it is essential to fully understand the meaning of the term quality. A common definition is "achieving agreed customer expectations or specifications". In other words, the customer defines the quality criteria needed in a product. To meet this standard the manufacturer puts in a Quality Control System to ensure that the product meets these criteria on a routine basis.

There is a lot of analysis to perform, from different points of view: physical, chemical, microbiological, nutritional and sensorial.

Physical-chemical determination: humidity, acidity, water activity.

Rheological determination: alveograph, farinograph – the strength and power of flour.
Microbiological determination: the presence of molds and bacteria.
Nutritional evaluation: the nutritional value provided by the macronutrients proteins, lipids, carbohydrates and by micronutrients – vitamins, calcium, magnesium, iron, and other components - as fiber, antioxidants.
Sensorial analysis: appearance, taste, flavor, smell, texture - all the attributes we can perceive with our senses.

Controlling quality may be achieved by:

- inspection of raw materials to ensure that no poor quality ingredients are used
- carrying out checks on the process to ensure that the weights of the ingredients and temperature and time of baking are correct
- inspecting the final product to ensure that no poor quality loaves are sent to the consumer.

9.1. Pay attention from the beginning – raw materials control

The quality control begins with the raw materials – it is important to remove any problem that could rise from the unsatisfactory characteristics of flour, yeast, fats, sugars, and so on.
Some of the main parameters to be followed also all the flow along are:

- humidity is an important feature to be tracked for any technological stage for raw materials, intermediate products (dough in bulk or pieces if dough) , semi-finished products, finished products, having an important role in conservation, maintaining products characteristics during the shelf life; there are direct (determine the water content of the product) and indirect methods (determine the dry substance);
- acidity is due to acidic organic compounds present in the tested product and could be water-soluble and fat-soluble compounds; acidity is determined by titration;

For flour supplementary determinations could be: the ash content, the granulosity degree, the color, the temperature, etc. For the flour behavior during mixing, fermentation, the determination of enzyme activity is important: α - amylase (falling number index) β - amylase, lipase, phospholipase, maltose index, proteolytic activity, as well as oxidoreducting enzymes (lipoxygenase, ascorbatoxidase, peroxidase, tyrosinase, catalase). In order to have a better control on the ingredients, it is better to determine the presence of some additives in flour, such as bleaching agents: chlorine, bromate, peroxides, and nitrogen oxide.

For compressed yeast besides sensory analysis, physical and chemical analysis is performed: moisture, acidity, identification of flour, starch and foreign materials; the growth power of yeast – is the main feature that shows the capacity of leavening in dough.

Water - the hardness of the water used is very important. Therefore medium hard water - is considered optimal because the mineral salts contained have an effect of strengthening the gluten and also serve as a yeast feed; very hard water is undesirable because it has the effect of slowing fermentation, meanwhile soft water tends to exert a softening effect on gluten and results in a sticky dough.

9.2. Monitoring the technological flow – phases control

For every step of the technological flow, there are specific parameters to be monitored:

- mixing – temperature of ingredients, time and speed of mixer, final temperature
- bulk fermentation: time, temperature, acidity
- dough mixing: time and speed, temperature
- resting: time, ambient temperature and humidity
- final mixing: time and speed, final temperature
- dividing: pieces weight, time
- dough piece proving: time, temperature and humidity of chamber (fig. 31)
- baking: time, temperature
- cooling: time, temperature

Figure 31. Monitoring parameter temperature – for dough piece and bread

9.3. Think as a consumer does – final products control

Besides the physical, chemical, microbiological determinations, the analysis of the bread from the consumer point of view are very important, because they are buying the product based on the impressions the product inducts through consumers senses. Therefore the appearance, texture, color, taste, smell of bread has to be evaluate from the consumer point of view. We could perform a sensory analysis or we could measure these parameters. Modern methods provide us a lot of data regarding the color, the volume and internal structure of the bread, by scanning the products with high-resolution imaging, HD combined with controlled lighting. Some examples in these regard are: colorimeter (fig. 32), device for volume of loaf determination (fig. 33) and internal structure analyze (fig. 34).

(source: Konica Minolta)

Figure 32. Rapid device for bakery products color determination

Figure 33. Loaf volume determination (source: www.stablemicrosystems.com)

Figure 34. Bread crumb internal structure determination (source: c-cell.info)

Chapter 10

Innovation and new trends

Bread is universally accepted as a very convenient form of food that is important to all populations having deep roots in history, and is still one of the most consumed and acceptable staple food products in all parts of the world. It is a good source of nutrients, such as macronutrients (carbohydrates, protein, and fat) and micronutrients (minerals and vitamins) that are essential for human health.

At European level, in recent years some trends are in progress:

- understanding clean label demand - clean label means different things to different consumers, the definition isn't quite so clear, some consumers are really zoned in on ingredients, and some are looking for a healthier label around reduced calories, reduced fat. There are other consumers who don't care what's on the label – they are buying based on price. But both ingredient-focused and nutrition-focused consumers are willing to pay more for products with 12 or fewer ingredients, meanwhile taste and convenience remain critical to driving purchasing decisions.
- to reformulate bakery products without partially hydrogenated oils (PHOs); the transition to non-PHO shortenings and oils is made through PHO-free shortening solutions for bakers - palm or high oleic soybean shortenings that function more like partially hydrogenated shortening.
- whole grain consumption has been linked to significant reductions in the risk of heart disease, Type 2 diabetes, digestive cancers and stroke. Studies have shown that eating whole grains may aid in weight management and lowering blood pressure (fig. 35).There are a lot of things that come with the whole grain — minerals, antioxidants, vitamins — that are very easy to promote as being more healthy

Figure 35. Products made of whole grain

- Using vegetal flours to improve nutritional value and texture. Pulses are a low-fat source and have high fiber content and a low glycemic index, and are derived from the hulls of such pulses as peas, lentils and chickpeas. Fruits and pulses flour, when combined with grain products, may improve the overall nutritional content of a food item (fig.36).

Figure 36. Bread with vegetal flour

10.1. Research and development R&D role

Nowadays there is a valuable role for research to push back the frontiers of science and this is a task for the academic community. These will lead to the development of future materials and processes and some will result in new technologies. Other forms of R&D help to better understand, often well known, observations from our daily life, for example, why do our processes work better on some occasions than others? The development of new materials, products, processes and equipment is the lifeblood of many industries; without this we will stagnate. More R&D can be undertaken to protect the health of the consumer and this is often the area of concern of national governments. So R&D represents a diverse range of activities from gene mapping and nanotechnology to process changes and product development. Within this the academic community, research organizations and industry all have valuable roles to play.

During the past years, a large number of scientific studies had been published outlining a direct association between unbalanced diets and rising incidences of chronic health-related issues, including cardiovascular disease, diabetes and obesity. This international debate has launched a rapidly rising, increasing investment in industry for research in products with nutritionally value-added ingredients that promote health and wellness. Mostly, the innovations in bread, bakery and pastry, were designed aiming at for more healthful products by including more whole grains, fiber, prebiotics and probiotics, or antioxidant ingredients. Consumers now, have an increasing interest in food that promotes and maintains energy, enhance satiety, or make consumers feel full after eating. This demand gives bakery industry added opportunities to develop products containing new functional ingredients compliant with these requirements.

Here are some examples of research studies applied:

- the use of enzymes in baked products – shows ingredient functionality and their role in final product quality. The addition of a maltogenic a/p/za-amylase has been added to bread and cake systems and shown to retard the staling of bread. The action of the enzyme is to modify the starch present by a limited hydrolysis of the starch chains. This reduces the extent of recrystallization of the starch, a property related to firming. Baking studies showed improvements in cake volume and softening of the crumb that gave benefits over 14 days storage at 20°C

- understanding the effects of processing through non-invasive measurement of product changes during proving and baking; significant changes in the structure of bread and cakes occur during proving and baking. These are difficult to study due to the nature of the product and the process environments, therefore the X-ray computed tomography was used to study the internal structures during processing to provide high quality images in which individual bubbles are clearly visible (fig. 37). Processes seen in dough and bread include the effects of proving and molding, oven spring, the formation of the break between the top and side crusts and the formation of the crust.

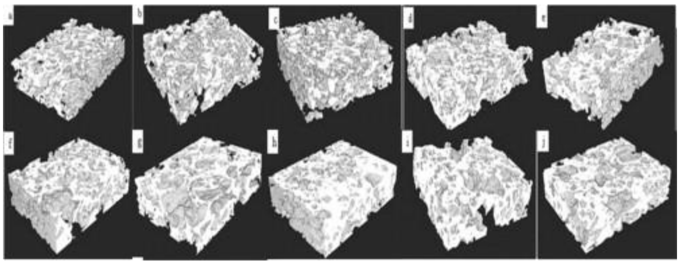

Figure 37. Gluten-free breads with different recipes studied by X-ray micro tomography. (source: https://www.sciencedirect.com/science/article/pii/S0268005X13002804)

- development of objective measurement techniques for baked foods and texture measurement. Texture is an important sensory aspect of many baked goods that affect consumer acceptance and repeat sales. A number of techniques are available to instrumentally measure texture – there are studies that show that the optimal method of measurement differs for different baked goods and the interpretation of the data is critical to correlating sensory and instrumental techniques.

10.2. Consumer's needs and expectations

Tremendous growth in food industry has been largely due to increasing demand for safe, healthy and convenient foods. Nowadays, in order to have a healthy diet, consumer trend implies food products with low chemical preservatives content and high input of vitamins, minerals and dietary fibers. These nutritional and quality characteristics describe frequently consumed food products. Cereal based foods play an important role in the diet and obviously bakery products which hold high nutritive value. The same important role of cereal based products could be seen in various healthy eating pyramids, as example the Mediterranean one (fig. 38).

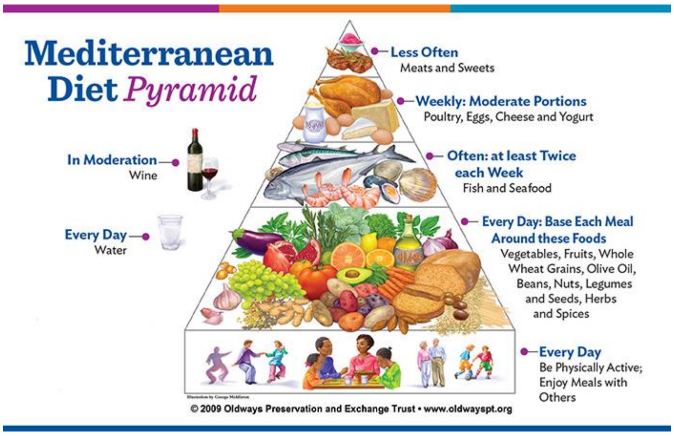

Figure 38.The role of cereal based products in various alimentation patterns

Certain consumer groups – such as parents – have an above-average interest in nutrition. All around the world, they place an even greater value on natural food and drinks than people without children. Their motives are clear: parents want to make sure their children grow up healthily, and also want to serve as role models. Because of this, their shopping behavior is different.

The bread market is changing, and we have seen a major shift in what consumers want - the demands of traditional breads that once drove growth in the industry have been replaced by new products such as cleaner-label, organic, gluten-free and artisanal bread solutions. Indeed, clean-label and nutritional trends may take the shape of high protein, fiber and nutrient content on the shelf. Breads aren't just bookends for sandwiches, and now it is clear that the bread can deliver as much to a meal as the other foods on the plate.

The most significant trends today have to do with organic, non-GMO and all-natural lines of baked goods. Some consumers are turning toward artisan breads, which are usually made with fewer additives and more natural ingredients, while others are looking to reduce certain aspects, such as gluten, salt, sugar, fat and artificial additives.

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