BAKING 101

Mixing and Techniques – Part I

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Many bakers consider mixing the most important step in baking. As seen before in a precedent article (Newsletter Volume 6 Issue 3), all steps of the baking process are connected and all of them are important. However, knowing that mixing is the first mandatory step to produce bread, a lot of attention must be given to this stage of the baking process.

Numerous functional and crucial dough characteristics, such as consistency, gluten development, and dough temperature will be determined during mixing. The goal of this two-part article will be to present in a very detailed way what is really happening when we mix dough. More precisely, the following topics will be covered:

- Steps to follow in order to successfully mix a dough to the dough-
- What is happening during the mixing of the dough
- Precautions to take when mixing extra ingredients Into the dough
- Different mixing techniques -and their applications
- How to determine mixing time
- Factors affecting mixing time
- What technique to choose in a production environment

STEPS TO FOLLOW IN ORDER TO SUCCESSFULLY MIX A DOUGH

Mixing is a procedure that could be divided in four important steps. If all those steps are carefully achieved, the result will be properly mixed dough and a very consistent final product.

① *Preparation before mixing*

This first step might sound very simple, but it is definitely an important one. Before mixing, it is important to scale all the ingredients precisely. I know that sometimes baking is not considered a very precise science, unfortunately, but having all the ingredients scaled properly will insure a well-balanced formula and at the same time a very consistent end product.

The second important thing is to calculate the water temperature. As seen in the preceding article by Marsha de Angelis (*Bread Lines* Volume 10 lssue 1), water temperature will depend on a lot of factors including temperature of the bakery, temperature of the preferment, mixing time, etc. Taking all of these variables into consideration, the baker must define the adequate water temperature to use in order to get the desired dough temperature at the end of the mixing. This desired dough temperature could be different depending on the type of bread produced. In general, it is between 73°F and 78°F. Next, and once again this might seem very logical, it is necessary to make sure that the mixer bowl and hook are clean. It only takes a few seconds to clean scraps of dried dough still stuck to the bowl. If they are left there, they might not dissolve properly into the next dough and will be found, hard as a rock, in the final product to the probable disappointment of the customer.

The last thing is to try to put the flour first in the bowl and then add the other liquids and water. The idea is to avoid changing the weight of the flour. In general, formulas are designed using baker's percent where all the ingredients are based on the total weight of the flour. For example, if the water is added first, then the flour, and the baker realizes that the dough is too soft, more flour will have to be added. But, all the other ingredients were calculated on the original weight of the flour, not including the added flour- The result will be an imbalance in the formula if the quantity of added flour is fairly large.

A special note related to dough mixed in vertical mixer or mixer without a bowl-reverse option: if flour is placed first in the bowl, it might be possible that some of it will get stuck in the bottom without being incorporated into the dough. One way to prevent this problem is to add half of the water first, then all of the flour and the rest of the water, until the dough consistency is achieved.

② *Ingredient Incorporation*

When the ingredients are scaled and water temperature determined, flour and water are placed in the bowl. The mixer is then turned on in first speed. During the next three to four minutes flour and water will be combined together by the mechanical action of the mixer's dough hook. During this time, the baker must watch the consistency of the dough carefully. If more water is needed, this is the best time to add it to the dough.

If preferments are used, they should be incorporated into the dough at this stage. Depending on the type of preferment (high or low hydration), the consistency of the dough might be changed, and some water adjustments might be necessary.

When the consistency is achieved, two options are possible. One is to continue mixing and incorporate the other ingredients of the dough like yeast and then salt, or the baker "autolyses" the dough.

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The autolyse is a process, developed by Professor Raymond Calvel, when the flour and water are allowed to rest foi'a minimum of fifteen to twenty minutes. During this time two important reactions will happen in the dough. The first one is a better hydration of the proteins of the flour, leading to a better gluten quality. The second one is a natural action of the protease, an enzyme naturally present in the flour. When allowed enough time to work, the proteases of the flour will react on the protein and degrade some of the gluten bonds. As a result, the dough will become more extensible and its machinability will be improved.

No salt is used in the autolyse. Its natural action of slowing down the chemical reaction would also slow down the action of the proteases of the flour.

No yeast is added at this time. Yeast generates fermentation, fermentation generates acidity and acidity increases the strength of the dough.

And, in general, autolyse is done to increase dough extensibility, therefore decreasing the strength of the dough.

After the autolyse, yeast and salt are added to the dough.

Notes:
When using Dried Instant Yeast, it is better to incorporate the yeast with the flour for one minute at the beginning of the mixing time. Because of their low water content, cells of Dried Instant Yeast will need more time to re-hydrate. A late incorporation could result in yeast not completely dissolved into the dough and a fermentation activity affected.

The same principle could be applied for an autolyse. Because mixing time is reduced when an autolyse is done, it is better to incorporate the Dry Instant Yeast just before the autolyse. The time they will get dissolve into the dough, the autolyse time will be almost over and the fermentation of the dough still minimum.

When using liquid preferments like poolish or liquid levain, their incorporation must happen at the beginning of the mixing process, even if an autolyse is done. Their low yeast content won't really affect the strength of the dough. Stiffer preferment with more yeast, like pre-fermented dough, should be incorporated after the autolyse time.

Technically speaking, when no autolyse is made, flour, water, yeast and salt could be incorporated at the beginning of the mixing. Despite the common belief that salt will kill the yeast, no change would happen in the dough or bread characteristics. The salt and yeast will be in contact in the dough for the next 4 to 6 hours after mixing, so if something would happen, it would have plenty of time to happen.

However, in order to have better control over the ingredient incorporation and to make sure that no ingredients have been forgotten, it is better to follow a standard procedure in regards to the addition of ingredients into the dough. For example, if the baker always adds yeast, then the salt, before going into second speed, there is less chance of error or better odds of noticing a mistake.

③ *Dough development*
When all the ingredients are well incorporated and the dough consistency has been achieved, the baker will go to the next step: dough development.

This step, depending on the desired dough development, could be done in first speed or second speed.

The mixing time depends on the desired gluten development. A long mixing time in second speed is used for well-developed dough, and a short mixing time in first speed is used for under-developed dough. More precise guidelines will be presented later in the article.

The gluten structure development depends also on the characteristics that we are looking for in the final product. This will also be discussed later.

④ *After mixing*
Because fermentation activity is dependent on the temperature of the dough, it is important for the baker to check if the desired dough temperature has been obtained or not. If the temperature is good, then the baker can follow his regular baking process. If the temperature of the dough is too cold or too warm, the first fermentation time will need to be adjusted: longer for cooler dough temperature, shorter for warmer dough temperature. The difference in temperature would have to be taken into consideration for troubleshooting the next batch of dough (increase or decrease of the water temperature).

A common mistake in many bakeries is to continue mixing if the temperature of the dough is too cold. For sure this process will warm up the dough due to the extra friction, but this extra mixing time will also continue to develop the gluten of the dough. As an end result we might get the desired dough temperature, but the dough is likely to be over-developed. So, adjusting the first fermentation time is a much safer and advised procedure.

Good precision and some attention during all of these steps should lead to the dough being properly mixed. Let's discuss now what istechnically happening during the formation of the dough.

Two main types of changes are happening during the mixing of the dough: the physical changes and the chemical changes.

PHYSICAL CHANGES HAPPENING DURING FORMATION OF THE DOUGH

As soon as flour and water are in contact, the water will hydrate the flour components. The two main components of the flour are the starch and the protein.

Two main, types of starch are found in the flour, the native starch and the damaged starch. The native starch absorbs water on the outside of the particle only, damaged starch absorbs close to its own weight in water.

Both starches will play the role of filling agent in a dough system.

Proteins, depending on their quality can absorb 200% to 250% of their weight in water. These proteins will inflate, and when inflated will have the natural property of being attracted to each other and will form chains of proteins called the gluten of the dough.

Once the gluten has been formed, the mechanical movement of the dough hook will work the gluten into an organized structure. If one looks carefully at the mixer's hook working in dough, two distinct movements can be observed. The first part of the movement stretches the chains of gluten and the second part folds the chains of gluten over onto themselves.

After a period of mixing, the chains of gluten become longer and longer, finer and finer, and more and more overlapped. This creates the three-dimensional gluten structure of the dough.

A long mix will generate a gluten structure that is well developed, and a shorter mix will generate a gluten structure that is under-developed. A mixing time that is too long will stretch the gluten chains to the point where they will break. This is what we call over-mixing the dough.

Due to the overlapping and better organization of the gluten chains, the structure of the gluten will get stronger. A noticeable change in the rheology of the dough can be observed. The dough is becoming less extensible, more elastic and able to trap gas. Visco-elastic properties are developed, or more simply the dough increases in strength and gas retention.

Note related to mixing time in first speed
Starch will absorb water faster than protein. Protein hydration is a little slower. To insure a good gluten quality, it is necessary to mix in first speed for at least five or even six minutes for a larger batch. If we switch the mixer too early to second speed, we might start to organize gluten that is barely created and therefore penalize the gluten development of the dough.

CHEMICAL CHANGES HAPPENING DURING FORMATION OF THE DOUGH

When water is introduced in the mix, it will start all the chemical reactions naturally happening in a dough system. The two main ones are fermentation activity and enzyme activity. It is interesting to know for the baker, that depending on the quantity of water, the rate of these reactions will be affected. For exam pie, wet dough will generate faster fermentation activity, and, in order to be able to keep a good control on his process, the baker will have to reduce the level of yeast in the formula.

Another important chemical change happening during mixing time is the oxidation of the dough. This reaction is due to the air naturally incorporated in the dough during mixing. The air contains oxygen, which will have some effects in the dough.

To a certain point, the effect of the oxygen will be positive. The oxygen will chemically react with the molecules of protein to form better gluten bounds. This will naturally reinforce the gluten structure and the tolerance of the dough.

Too much oxygen (long mixing time), will negatively affect some flour components called carotenoid pigments. The pigments are natural components of the kernel of wheat and are responsible for the creamy color of the flour and some aroma production. Too much oxygen will deteriorate these pigments and automatically lead to a final product with a white crumb color and a bland flavor.

Despite the negative effect of too much, oxygen, some air is still necessary. During mixing, micro cells of air will be introduced into the dough system. These micro cells will play an important role |star in the baking process by forming the core of the crumb structure during fermentation, the gas produced by the yeast will accumulate in these micro cells and form the "alveoles" of the crumb.

Note related to the oxidation
To slow down the negative effect of the oxidation, one specific property of the salt can be used. Salt has a natural property of slowing down all the chemical reactions (this is why we used to use it to increase the shelf life of foods - cured meats or salted fish). By incorporating the salt into the dough at the beginning of the mixing time (while the mixer is still in first speed), the oxidation process will naturally, be slowed down.

On the other hand, if the baker wants to achieve a very white crumb structure, the incorporation of the salt must be delayed. As a side effect, flavor will also be penalized.

INCORPORATION OF OTHER INGREDIENTS INTO A DOUGH SYSTEM

It will be difficult to discuss every ingredient that is added to the dough in every bakery, but some observations about the main ones could be helpful.

1 *Incorporation of fat*
A smaller percentage (2 to 4%) of solid fat, like butter or margarine, could be incorporated at the beginning of the mixing time with flour and water.

A larger percentage (5 to 15%) of solid fat should be incorporated when the dough is at 50% of development (in general in the middle of the second speed time). An earlier incorporation (at the beginning of the mixing time) would delay the development of the gluten and increases the mixing time. The fat would "lubricate" the chains of proteins, delaying the bounding of the gluten.

More than 15% solid fat should be incorporated when the gluten is almost fully developed. This will insure a strong dough structure able to support this massive incorporation of fat.

Liquid fats, like oil, are in general part of the hydration of the flour and should be incorporated into the dough at the beginning of the mixing time. If a large quantity of oil is used, it is also possible to incorporate it after the full gluten development (very slowly in first speed).

2 *Incorporation of sugar*
A small amount of sugar (up to 12%) can be incorporated into the dough at the beginning of the mixing time.

Higher levels should be incorporated in several steps. Sugar being a hydroscopic ingredient, it will have the tendency to absorb a lot of water. If too much sugar is introduced to the dough at once, it might take some water away from the protein, disorganizing the whole gluten structure.

When levels of sugar are very high (20 to 30%), some bakers use the same technique as for high level of butter: sugar is left out of the dough and incorporated when the gluten is well developed.

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3 *Incorporation of eggs*

Eggs should be incorporated at the beginning of the mixing, as they will play a major role in the hydration of the flour. It is recommended, even though some formulas call for only eggs to hydrate the flour, to always add some water. Eggs don't have the same flour hydration characteristics compared to water. To insure a good gluten quality, at least 10% of water (in addition to the eggs) is necessary. The final product will have a lighter and moister crumb texture.

4 *Incorporation of dry ingredients*

Ingredients like malt or milk powder can be incorporated at the beginning of the mixing time with flour and water.

Incorporation of solid ingredients like nuts, dry fruits, chocolate chips... Any chunky ingredients that won't dissolve into the dough must be incorporated at the end of the mixing time. Once the gluten has been properly developed, the mixer is turned back in first speed and the ingredients are, added to the dough. The dough is mixed until the ingredients are well distributed into the dough.

This gentle incorporation will have two positive effects for the dough and the bread. First, the ingredients will stay intact into the dough (the action of the hook in first speed in very gentle and won't crush the added ingredients). Then, incorporating those ingredients in a gentle way will reduce damage to the gluten structure. If second speed was used, the ingredients would react - like razor blades into the dough and cut all the gluten bonds that were formed during the mixing.

This was a general description of the mixing process. The next step is to understand how a thorough knowledge of mixing can be used. We will address this topic in the next issue.