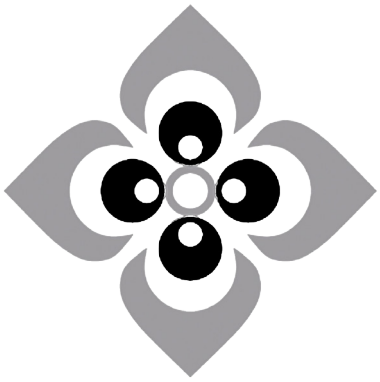

Consortium for Educational Communication

Module
on

Baking: Principle and Classification of baked foods

By

Dr. Sushma Appaiah. M. Sc., Ph.D

Founder & CEO, Giggles of Livez (Golz)

Nutrition Councellor

Roopanagar, Mysuru-570026

Karnataka, India

Text

Introduction to baking

Baking is one of the oldest occupations of the human race. Since early prehistoric human beings made the transition from nomadic hunters to settled gatherers and farmers baking has been practiced. Today the profession of baking has grown as artisan of sourdough breads and assembling elegant pastries and desserts, which began thousands of years ago with the gathering of wild grass seeds and the grinding of those seeds between stones. Baking as an industry has spread its wings throughout the world with great challenges and rapidly growth. Thousands of skilled people are needed every year in this field and the demand is increasing at enormous rate.

Principles of Baking

Let us learn the factors which controls the principle of baking. They are

i)Mixing and Gluten development

Mixing of doughs and batters is a complex process. It involves more than just blending the ingredients together. To control the mixing processes or methods that apply to the baking, it is essential to understand the reactions that take place during mixing.

There are three phases of mixing in the production of doughs and batters:

1. Blending the ingredients.
2. Forming the dough.
3. Developing the dough.

These phases overlap one another. Products contain different ingredients in various proportions based on the requirements.

ii) Air Cells:

Air cells are necessary part of the leavening process. They consist of open spaces surrounded by elastic cell walls made primarily of proteins such as gluten or egg albumin. All the air cells that enable leavening are formed during mixing. Air cells begin forming as soon as the mixing process starts. Thus, length of mixing determines the final texture of the item.

iii) Hydration:

Hydration is the process of absorbing water. The ingredients in baked goods absorb or react with water in different ways.

Starch is the largest component in any baking. During baking, the heat causes the hydrated starch to gelatinize. Without hydration during mixing, gelatinization cannot happen. Proteins are mostly insoluble in water, but they bind with water molecules during mixing. Yeast requires water to become active and to release carbon dioxide gas for leavening. Salt, sugar and chemical leaveners such as baking powder have no effect on baked items in their dry form. They must be dissolved in water to carry out their many functions.

iv Gluten Development

Flour is mostly starch, but, it is the gluten-forming proteins, not the starch, that concerns the baker most. Gluten proteins are needed to give structure to baked goods. Bakers must be able to control the gluten. Glutenin and gliadin are two proteins found in wheat flour. During mixing, these two protein combine with water and forms gluten. Wheat flours are classified as strong or weak, depending on their protein content. Strong flours come from hard wheat and have a high protein content. Weak flours come from soft wheat and have a low protein content. Thus, strong flours are used for breads and weak flours for cakes. **Table 1** depicts the protein content of different types of flour.

v) Fat and Other Tenderizers:

Fat used in baking is called shortening because it shortens gluten strands. Thus, fats are tenderizers. Any baked product with high fat content and little gluten development, is said to be short e.g crumbly cookie or pastry. Sugar is another tenderizer that inhibits gluten development. Sugar being hygroscopic, attracts and binds to water. Water

which gets hydrated with sugar becomes unavailable to hydrate gluten. For this reason, a special mixing method is used for some sweet doughs, in which the gluten is developed in a separate step, before the sugar is added.

vi) Water:

The condition of the water used in bread doughs, specifically hardness and pH, also affects gluten. Water hardness refers to the mineral content of the water, especially its calcium content. Water with a high mineral content is called hard. The minerals in hard water strengthen gluten, making the dough too elastic and hard to work. Too soft water makes the dough too slack and sticky. Treated water or dough conditioners can be used to counteract these effects. The strongest gluten development takes place with a slightly acid pH of 5 to 6.

The tenderness of a baked item can be adjusted by adding either an acid, such as fruit juice, to lower the pH beyond the 5 to 6 range or adding an alkali, such as baking soda, to raise the pH above this range.

Stages in baking process

The changes to a dough or batter as it bakes are basically the same in all baked products, from breads to cookies and cakes. It is essential to learn about them to control the final quality. The stages in the baking process are as follows

i. *Melting of fats:*

Solid fats mixed into a dough or batter trap air, water, and some leavening gases. When the fats melt, these gases are released and water turns to steam, which contribute to leavening.

Different fats have different melting points, but most fats used in baking melt between 32° and 55°C. Early release of gases in baking are more likely to escape as structure isn't set enough to hold them.

ii. *Formation and Expansion of Gases:*

The gases primarily responsible for leavening baked goods are carbon dioxide, which is released by the action of yeast and by baking

powder or baking soda; air, which is incorporated into doughs and batters during mixing; and steam, which is formed during baking. Some gases – such as carbon dioxide in proofed bread dough and air in sponge cake batters – are already present in the dough. As they are heated, the gases expand and leaven the product.

Production and expansion of gases starts immediately at the beginning of baking. Yeast are killed at 60°C and stops producing carbon dioxide. However, production of steam continues throughout the baking process. As the gases are formed and expand, they are trapped in a stretchable network formed by the proteins in the dough. These proteins are primarily gluten and sometimes egg protein.

iii. Destruction of Yeast and Other Microorganisms:

In addition to yeast, doughs may contain other organisms, including bacteria and molds. Most of these, including yeast, die when the interior temperature of the item reaches about 60°C. Although some microorganisms may survive to a slightly higher temperature. When yeast dies, fermentation stops and no more carbon dioxide gas is released.

iv. Coagulation of Proteins:

Gluten and egg proteins are the proteins primarily responsible for the structure of most baked goods. They provide this structure only when they are heated enough to coagulate, or become firm. This process begins slowly at 60° to 70°C. Gradually they form a solid structure.

While this process is going on, gases continues to expand and the protein strands continues to stretch. Finally, when coagulation is complete, the air cells can no longer expand and the product stops rising. Much of the water that are bonded with the protein during mixing is released and either evaporates or is absorbed by starch. Once the protein structure has completely coagulated, the baked item is able to hold its shape.

The exact temperatures at which coagulation begins and is completed depends on several factors, including the other ingredients that are present. Sugars and fats, especially, affect the coagulation temperature of protein. Most proteins, however, are completely coagulated by the time they reach 85°C.

v. Gelatinization of Starches:

Starch molecules are packed into tiny, hard granules. These granules attract and bind to water during mixing. As they are heated during baking, the water is absorbed into the granules, which swell greatly in size.

Depending on how much water is present in the dough or batter, all the starch does not gelatinizes, because not enough water may be available. In dry products such as cookies and pie dough, a lot of the starch remains ungelatinized. In products made from a batter with a high water content, such as some cakes, a larger percentage of the starch gelatinizes.

vi. Escape of Water Vapor and Other gases:

Throughout the baking process, some of the water turns to steam and escapes into the air. If this takes place before the proteins coagulate, it contributes to leavening. Another result of the loss of moisture is the beginning of crust formation. As moisture is lost the surface becomes harder. Loss of moisture continues even after the product is removed from the oven, as it cools.

A measurable amount of moisture is lost during baking. If a baked product of a specific weight is required, allowance must be made for moisture loss when scaling the dough. The percentage of weight loss varies greatly, depending on such factors as proportion of surface area to volume, baking time, and whether the item is baked in a pan or directly on the oven heath.

vii. Crust Formation and browning:

A crust is formed as water evaporates from the surface and leaves it dry. Browning cannot occur until the surface temperature rises to about 150°C, and this cannot happen until the surface dries. Browning begins before the interior of the item is completely baked and continues for the rest of the baking period.

Browning occurs when chemical changes happens to starches, sugars, and proteins, referred as caramalization. Caramelization involves only the browning of sugars. A similar process, called the Maillard reaction, causes most of the crust browning of baked goods. This a process which, occurs

when proteins and sugars together are subjected to high heat. Maillard browning also occurs on the surface of meats and other high-protein foods.

The chemical changes caused by caramelization and Maillard browning contribute to the flavor and appearance of the baked item. Milk, sugar, and egg, when included in doughs and batters, increase browning.

Post Baking stages

Many of the processes continue after the baked item is removed from the oven, while some of these processes reverse. This period is explained in two stages, i.e cooling and staling. Staling begins immediately, and cooling is only the first part of this process.

Cooling:

Moisture continues to escape after the item is removed from the oven. At the same time, cooling begins, which causes the gases to contract. If the protein structure is completely set, the product may shrink slightly but hold its shape. If the product is underbaked, however, the contraction of gases may cause it to collapse.

When baked goods are removed from the oven, the surface is dried than the interior crumb. During cooling, the moisture content tries to equalize throughout the item, as a result, crisp crusts gradually become softer. Proteins continue to solidify and bind to one another during cooling. Many products are fragile when they are still hot, but cooling makes them firm enough to handle. It is best to handle or cut baked goods only when cooled. Melted fats resolidifies and this process makes the texture firmer.

Starches continue to gelatinize while the interior is still hot. Also, starch molecules bind with each other and become more solid as the product cools. This process is called starch retrogradation and is responsible for staling.

Staling:

Staling is the change in texture and aroma of baked goods, due to a change of structure and a loss of moisture by the starch granules. Stable baked goods lose their fresh-baked aroma and are firmer, drier, and more

crumbly than fresh products. Prevention of staling is a major concern of the baker, because most baked goods lose quality rapidly.

As indicated, starch retrogradation begins as soon as the item begins to cool. As starch molecules bind with each other, the starch forces out moisture and becomes harder and drier.

Starch retrogradation is more rapid at refrigerator temperatures than at room temperature, but it nearly stops at freezer temperatures. Chemical staling, if it is not too great, can be partially reversed by heating. Breads, muffins, and coffee cakes, for example, are frequently refreshed by placing them briefly in an oven.

Loss of crispness is also a problem with low-moisture products such as cookies and pie crusts. The problem is usually solved by proper storage in air-tight wraps or containers to protect the products from moisture in the air.

In addition to refreshing baked goods in the oven, three main techniques are used to slow staling:

1. *Protecting the product from air:* Two examples of protecting baked goods are wrapping bread in plastic and covering cakes with icing, especially icing that is thick and rich in fat.

   Hard-crusted breads, which stale rapidly, should not be wrapped, or the crusts will quickly become soft and leathery. These bread products should always be served very fresh.

2. *Adding moisture retainers to the formula:* Fats and sugars are good moisture retainers, so products high in these ingredients keep best.

   Some of the best French bread has no fat at all, hence, it must be served within hours of baking or it will begin to stale. For longer keeping, bakers often add a very small amount of fat and sugar to the formula.

3. *Freezing:* Baked goods frozen before they become stale maintain quality for longer periods. For best results, freeze soon after baking in a blast freezer at -40°C, and maintain at or below -18°C, until ready to thaw. Breads should be served quickly after thawing.

   Refrigeration, on the other hand, increases the staling. Only baked goods that could become health hazards, such as those with cream fillings, are refrigerated.

Classification of Baked Product:

General classification of baked food is depicted in **fig 1,** based on type of the dough mix.

Cookies:

Cookies are one of the best known quick snack products. Cookies are often referred to as small sweet cakes. They are characterized by a formula high in sugar and shortening and low in water. Similar products in our country are called biscuits. To learn more on cookies, viewers can refer chapter on cookies, under Paper – 4, Science and technology of grains and cereals (1st year).

Crackers:

Cracker is a term used for biscuits of low sugar and fat content, tasting bland or savory. They are usually made from a strong flour and developed dough. They generally contain 100 percent flour, 5-20 percent fat and 0-2 percent sugar. The doughs generally contain low levels of water (20-30 percent). The leavening agent is either water vapour or a chemical leavening. Crackers and crisp breads are used as bread substitutes usually topped with savory foods like cheese, meat preparations and/ or salad items.

Saltine crackers are distinguished by their long fermentation time and their particularly light and flaky texture. They are made by a sponge and dough process as per the formula given in **table 2.**

Biscuits:

This is one processed wheat product which has found acceptability in rural areas in our country. The raw materials for biscuits are flour, sugar and shortening. For protein enriched biscuits, soy flour or peanut flour or protein isolate can be added at 15-25 percent levels to provide 10 percent extra protein. Other ingredients include leavening agents, vitamins, minerals and flavours. Dear viewer's detailed information can be gathered from chapter on Biscuits under Paper -3, Introduction to food technology.

Cakes

Cakes are characterized by high level of sugar in the formula in which starch gelatinizes during baking. Cakes set when and provides baked product in light volume. Further, aspect on cake can be referred from chapter on cake under paper-4.

Pastry:

Pastry is characterized by a high fat and low water proportion, relative to flour, and little or no sugar. As with other short dough products, the objective is to prevent, as far as possible, flour protein from developing gluten and thus making a tough-textured product.

In most pastries, the first step is always the same i.e. rubbing some or all of the fat into the flour. This gives flour particles a waterproof coat. Helping protect them from hydration later. Water can then be added, together with any other ingredients to bind the mixture to a paste. Variations on this main theme are many e.g. Danish pastry, puff pastry, flaked pastry, pie doughs etc. The basic formula for Danish pastry is shown in **table 3**

Wafers:

The wafer is a thin, crisp and light textured product, prepared by very rapid baking, not of a dough, but of a batter consisting of a liquid blend of flour, water and raising agent and sometimes small quantities of other ingredients.

The flour is generally from a white wheat. If the flour is too strong, the wafers are hard and flinty. The mixing of a wafer batter is usually a single-stage process or whisking action rather than the folding and kneading action required for most types of cookie dough. The objective of mixing is to evenly distribute flour particles and other ingredients into water without converting flour protein to gluten in the process. After mixing, batter is pumped to the wafer oven. This machine is different from the oven used for cakes and cookies or crackers. The baking takes about two minutes.

Cooling of a wafer sheet is done carefully so that both sides of the wafer lose their heat evenly. e.**g table 4** gives composition of sugar wafers

Bread:

Flour is the major ingredient of bread and is obtained through the milling process, in which, bran and germ part of the wheat grains are removed as far as possible. This is done to get the flour of desirable composition from baking point of view. The major components of flour are moisture (14 percent), starch (70 percent), protein (11.5 percent), ash (4 percent), sugar (1 percent) and fat (1 percent).

The flour should have color, strength, tolerance, high absorption and uniformity with following characteristics for the production of quality bread. These are explained here briefly.

1. **Colour:** Flour should have a creamy white appearance, without bran fragments. Bleaching of flour contributes towards the control of degree of creaminess.
2. **Strength:** The flour is referred as strong or weak, based on gluten protein (**table 1**)
3. **Tolerance:** The ability of flour to withstand the fermentation process and to produce a satisfactory loaf over a period of time is defined as tolerance.
4. **High Absorption:** This refers to the ability of flour to hold the maximum amount of moisture without additional mixing for full development of dough.

Students can learn more on bread from the chapter 4 on breadmaking under the paper 4

Conclusion

Baking industry has developed enormously in most of the countries. In India also large population depends on bread as staple breakfast item irrespective of culture, region and religion. Commercial baking requires many large and small equipment. The popularity of baked foods has led to many varieties and innovations e.g pizza, pie, pastries', wafers etc. The principle of baking includes many process together like mixing, hydration, gas formation etc. The various stages during baking and also cooling conditions decides the quality, texture and acceptability of the products.