

16.2 Leavening Agents

In the preparation of baking products, the dough and batter are to be leavened. (Leavening is increasing the area of a dough or batter by creating or occluding in them small bubbles of gas, mainly carbon dioxide (produced by yeast or chemical agents), air or water vapour. Vapour is formed from water during baking of all doughs and batters. Air is incorporated by beating the viscous batter.)

16.2.1 Air

Air is a leavening agent present in all batters and doughs. To some extent all baked products—yeast breads, quick breads, cakes and biscuits—depend on air leavening. Air is responsible for only a small portion of the total increase in volume of the finished product but is important, because the effectiveness of water vapour as a leavening agent depends on the presence of air in the batter and dough. Even the effectiveness of carbon dioxide in leavening depends upon the distribution of air, as carbon dioxide does not form new gas cells in the batter or dough but diffuses into and expands the existing air cells. Air incorporated through the mixing of the dough ingredients expands when the mix is warmed in the oven and causes an increase in the volume of the baked product.)

(The amount of air contained in batters depends upon the extent of mixing of batters, the viscosity of the batter, the volume of ingredients, and the length of time elapsing before baking. Generally, increased mixing encases more air in a product.) However, when egg-white foams are folded into batter, there should be minimum mixing as, on excessive mixing, egg-foam becomes less elastic (subsec 27.7.1) and causes loss of air with a reduction in volume. When extensive creaming of fat and sugar is employed as in the preparation of cakes, a fat-sugar-air foam is formed making tiny air pockets. The air in such a foam contributes a small but highly significant leavening action.

It is difficult to enclose air in the more viscous mixtures than in the less viscous mixtures. Since temperature affects viscosity, the mixes are to be worked at temperatures enabling the maximum trapping of air. (The proportion of ingredients also influences the viscosity of a batter) or dough. (An extremely fluid mixture with a high proportion of liquid is incapable of holding a large amount of air.) Some ingredients influence the amount of air held in batters and doughs. For example, mixes containing egg-white have more air than those with egg-yolk or whole egg. (There is loss of some air when batters are stored for some time prior to the preparation of the product.) Hence, it is desirable to bake a product as soon as possible after preparing a batter.

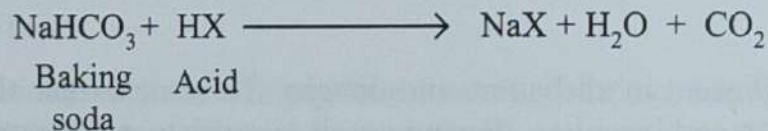
16.2.2 Steam

Steam, like air, is an ever present leavening agent. Even a small amount of water in a batter or dough causes an appreciable leavening action as water expands (1,600 times) when converted to steam during baking. Steam alone cannot leaven a mixture. Its action must be combined with that of air and/or carbon dioxide.)

16.2.3 Chemical Leavening Agents

The principal means of leavening flour mixes is by carbon dioxide, which is generated by the action of chemical leaveners or by the action of micro-organisms on sugars. The most important chemical agent used in leavening is baking powder. Baking soda and acid ingredients, and sometimes ammonium carbonate, are also used as leavening agents.

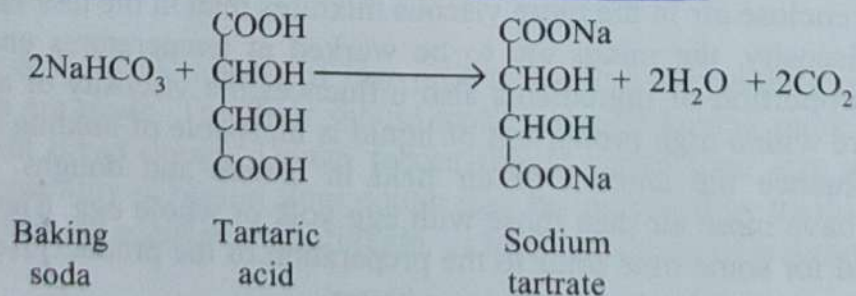
(Baking powder consists of sodium bicarbonate (soda) and an acid component, which may be single or in combination with another acid. The baking powders are named after the acid ingredient used in the powder, as tartrate powder, phosphate powder and combination powder. The acid component reacts with soda when the powder is moistened; this happens when leavening agents are added to batters and doughs, releasing carbon dioxide according to the following reaction:)



(Baking powder also contains an inert filler, which is commonly corn starch. The starch serves two purposes. It acts as a buffer between soda and the acid and prevents their going into action, when exposed to air, by absorbing moisture. It also helps standardize the powder to release a standard amount of carbon dioxide. Baking powder yields 12–14 per cent of available carbon dioxide.) In order to achieve this, the weight of soda is kept constant (28–30 per cent by weight), while the weight of the acid component is varied according to the amount needed to release the necessary amount of carbon dioxide. To standardize the powder, the difference in weight is corrected by the addition of the filler.

Sometimes powdered and dried egg albumen is added to the baking powders. It dissolves in cold water and increases the viscosity of the dough which helps to hold gas bubbles in the dough, thus increasing the effectiveness of the baking powder.)

(Tartrates are commonly used as the acid component of baking powder in the form of tartaric acid or potassium hydrogen tartrate (cream of tartar). The reaction is:



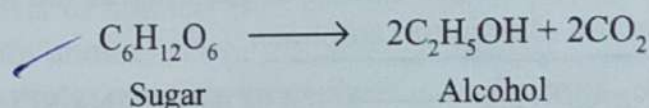
(Tartrates leave virtually tasteless residues but they act as cathartics (purgative) and diuretics. However, these substances are safe in their normal application and usage levels. The disadvantage of use of a tartrate is that it is fast-acting and quickly releases all the gas at room temperature.)

Ammonium bicarbonate is used as a leavening agent in baking biscuits and crackers as they have a large surface-to-mass ratio and ammonia escapes when baked at high temperature.)

16.1.1 Yeast

A biological method of leavening is by yeast fermentation. Yeast is a unicellular micro-organism that reproduces rapidly in the presence of sugars under appropriate conditions of pH (4-6) and temperature (30°C). During the growth and multiplication of yeast, the sugar decomposes into alcohol and carbon dioxide. This change takes place anaerobically and is known as fermentation. There are many strains of yeast that bring about fermentation. The particular strain of yeast used in baked products is *Sacharomyces cerevisiae*.)

A large number of reactions take place leading to the production of the final products and the overall reaction can be represented thus



(The carbon dioxide liberated during fermentation in the flour mixture leavens batters and doughs, and the alcohol produced is driven off during the baking process. Secondary products of fermentation, e.g., acids, carbonyls and esters, may affect the gluten, or impart flavour to the baked product.)

Flour contains about 1.5 per cent sugar on a dry weight basis. (Sucrose is normally added to yeast doughs). Yeast contains a number of enzymes that act upon carbohydrates. Invertase of yeast hydrolyzes sucrose to glucose and fructose, which are fermented. Flour contains ample β -amylase and a small amount of α -amylase. Some maltose is formed in the dough through the action of flour amylases on starch. Maltose is also hydrolyzed by yeast maltase to glucose, which is then fermented. Fermentation of glucose is brought about by a number of enzymes collectively known as zymase.

(Yeast used for leavening is marketed in two forms: compressed yeast and active dry yeast.) Properly selected yeast strains are grown in a medium of molasses containing the necessary nutrients under controlled conditions. When growth ceases, yeast cells are separated by centrifugation, mixed with a small amount of starch, and compressed into cakes. (Compressed yeast has a moisture content of 72 per cent and is the most active form of yeast for bread making, but is unstable at room temperature. It must be stored at 1° to 3°C and even at this temperature it is active only for about five weeks.)

(The active dry yeast is propagated in the same way as compressed yeast using special strains of *S. cerevisiae*. It is then recovered, compressed, extruded and dehydrated at approximately 43°C to about 8 per cent moisture. The dried material is then ground into granular active dry yeast. The shelf life of dry yeast is over two years, if stored at 5°C and six months when held at 32°C.)

(In some cases, leavening is brought about by the combined fermentation of yeast and bacteria. The yeast produces carbon dioxide for leavening and the bacteria produce the acids that impart a distinctive flavour.) Bacteria can themselves also be used for leavening; under controlled conditions, bacteria grow and act on sugar producing carbon dioxide and hydrogen, which, in batter and dough, act as leaveners.

16.3 Fermented Products Based on Yeast