10

Cake and sponges

10.1 What is the flour-batter method of cakemaking?

The flour-batter method of cakemaking is based on two separate stages of air incorporation which are later combined before mixing is completed. It involves splitting the flour into two portions, the first to be creamed with the fats and the second portion retained to be mixed into the batter at a later stage. At the same time as the flour and fat are being mixed, the eggs and sugar are whisked together using a second machine to form a foam (as when making sponge cakes).

Typically the fats are creamed with an equal weight (or slightly less) of flour until a creamy mixture is obtained. About 400 g flour to 450 g fat (14 oz flour to 1 lb fat) is recommended. The egg is whisked with its own weight of sugar. This whisking need not be as thorough as for sponge cakes and aeration should not go too far or the cakes will be too light. About five or six minutes on second or fast speed with a planetary mixer is usually adequate. There is a greater possibility of getting a batter too light when using this method than when making cakes by the sugar-batter method (see 10.2) as in the latter case the presence of fat when the eggs are beaten in will prevent too much air being incorporated into the batter.

When the egg/sugar foam is ready it is added to the flour and fat batter while the machine is running at a moderate speed. The foam may be added in small portions – usually in four or five parts, each portion being beaten in before the next portion is added. Alternatively it may be run in as a continuous stream. When both batters are mixed any remaining flour can be mixed in, either by hand or at the slowest machine speed.

For fruited cakes the fruit is added when the flour is almost mixed in. Any minor ingredients such as essences or colours should be added to the fat and flour while beating. If milk is added then this should be done at the time of adding the second portion of flour. Where the weight of sugar is greater than the weight of eggs, the extra sugar should be dissolved in the milk along with colours and salt (if used). This gives a better distribution of the colour throughout the cake batter.

If glycerine is used in flour-batter cakes, this may be added either to the sponge or to the flour batter, usually the latter before the two are mixed together. When milk powder is used instead of liquid milk, the necessary quantity of powder is added along with the second portion of flour, while the necessary amount of moisture in the form of water is added and the batter is mixed as before.

This method enables the eggs to be added far more quickly and with far less possibility for curdling of the batter. In the sugar-batter method adding the eggs too quickly can result in curdling (see 10.15). Another advantage of this method is that by semi-foaming the eggs with the sugar, a more even texture is imparted to the cake. Since most of the flour has been creamed with the fats, there is relatively little of it to be amalgamated at the critical moment in cakemaking after all the eggs are in and so the potential for toughening of the batter by overworking is reduced.

10.2 What is the sugar-batter method of cakemaking?

With this cakemaking method a batter is formed based on an emulsion of oil in water with air bubbles trapped in the fat phase. The other ingredients are dissolved or dispersed in the water phase.

The fats and sugar are creamed together until the mixture is light. Usually this takes about 10 minutes but does depend on the temperature and creaming qualities of the fat and the type of mixer used. Most commercial bakers mix the batter to a fixed specific gravity (see 13.4). The liquid egg is then added in four or five portions over a period of five to seven minutes with creaming of the mixture between additions to prevent the batter curdling. Egg, and the other ingredients, should be at the correct temperature (21 ºC/70 ºF is considered optimum) as this will also assist in avoiding curdling of the batter. Curdling (see 10.15) arises as a result of the breakdown of the emulsion when the fat separates out from the aqueous phase.

Once all the eggs have been creamed in, the batter should have a smooth, velvety look and texture. Flavouring can then be added followed by sifted flour and other powders and any additional milk or water. These are gently mixed into the batter. Any fruit should be added when clearing the batter (i.e. the last stages of mixing to ensure that there are no unmixed ingredients remaining). It is not advisable to mix the fruit with the flour as some flour may stick to the fruit and could cause the formation of larger holes in the baked cake.

It is important in all cakemaking processes to have correct temperatures and mixing conditions to ensure consistent product quality.

10.3 When making fruit cakes we find that the fruit settles to the bottom of the cake after baking. Why is this and what can we do about it?

The settling or sinking of fruit in cakes is connected with the viscosity and density of the batter during the early stages of baking. If the initial viscosity decrease during baking is too great, the fruit, being of higher density than the batter, will sink while the latter is still in a semi-liquid state – rather like a stone would sink in water. The denser or the larger the pieces of fruit, e.g. cherries, the greater their potential for sinking.

To prevent the fruit, whether it be cherries, sultanas or other particulate materials, e.g. chocolate chips, from sinking, the batter viscosity in the early stages of baking must be increased. There are various ways in which this problem can be overcome, such as recipe changes, using high-protein cake flour, the additions of hydrocolloids such as cellulose gums, decreasing the batter pH or processing changes, e.g. by adjusting baking conditions.

In high ratio recipes the batters are always more fluid than traditional types of batters by the end of mixing. However, the use of chlorinated or heat-treated flours will give a more viscous batter than untreated flours during baking. In such fruit cakes it is common to add tartaric acid or some other acid in excess of that found in baking powder. Lowering the batter pH is probably the most effective remedy to the problem since the extra acidity increases the contribution to batter viscosity of the proteins present in the flour, egg and other raw materials. The levels of addition are small, typically 0.2 to 0.3% tartaric acid based on flour weight is added.

Another remedy involves ensuring that the batter does not remain in a fluid state for too long. In some cases baking at a slightly higher temperature reduces the time that the batter viscosity is at its lowest. Reducing the baking powder, particularly for larger units or slab cakes, will reduce the batter aeration during the slower baking conditions normally required for these large sizes of cake and so keeps the batter more viscous for longer periods.

Eggs also have an effect on the viscosity of the batter. The addition of too much egg can cause the batter density to become too low. Generally frozen egg once thawed is a more viscous product than freshly broken shell egg. The addition of too much raising agent can have the same effect on lowering batter density.

The fruit itself should not escape scrutiny. Washed but not properly dried fruit will have a tendency to sink. The extra water associated with the fruit will cause the batter to be less viscous and add to the potential for the fruit to sink. In more traditional cakemaking the dried fruit can be dressed with the recipe flour (not extra flour) in order to coat the fruit and help prevent its downward movement by providing a ‘granular’ coating. The mixture should be added at the end of mixing after the flour has been added to the batter.

Older recipe books show that bakers have added a small quantity of ground almonds to the mixing. During baking this will have sufficient binding and swelling effect to counteract the force of gravity acting on the fruit. However, this can add to the costs of the recipe and may cause other problems, e.g. in the safety of the product when marketing for people with nut allergies. Additions of other starches, e.g. cornflour, should be avoided because they have different gelatinisation characteristics from wheat starch and may lower batter viscosity at the critical moment during baking.

Another cause of sinking fruit is using too weak a flour, that is one with a low protein content. Most flour suppliers will have a slightly higher protein flour (typically around 11–12%) which can be used for fruit cakemaking. If you are making lower-ratio cakes then you can use a good-quality bread flour.

10.4 Can we freeze cake batters and what happens to them during storage?

Cake batters can be frozen successfully and frozen cake batters may be purchased in order to give customers choice without incurring the wastage that might occur with scratch production where demand is less predictable. For those purchasing frozen cake batters the advantages include:

- no storage or handling of raw materials (apart from that for product decoration);
- no ingredient weighing or mixing on site;
- specialist centralised production improves the chances of optimal product quality;
- improved ability to meet peak demands for a variety of cake products.

Cake batters can be frozen and stored for up to about two or three months before any substantial quality losses are encountered. Cake batters do not freeze until temperatures between −12 and −20 ºC (11 and 6 ºF). The temperature will vary depending upon the level of dissolved salts and sugars because their presence depresses the freezing point of the free water in the batter (Cauvain and Young, 2000). The high sugar concentration in most dried fruits will further depress the freezing temperature of fruit cake batters. The time taken to freeze the batter will be shorter at lower air temperatures and higher air velocities in the freezer.

Care should be taken not to expose the frozen batter to temperatures above its freezing point between production, distribution and storage since unplanned thawing can lead to deformation of the batter in the container.

Some loss of volume will occur with cakes produced from batters that have been deep frozen and stored at −20 ºC or below for six months (Screen, 1988). This loss of volume will be progressive with increasing storage time. A long storage time will also lead to a firmer and less tender crumb in the baked product. However, with care, the product should still have acceptable volume, crumb texture and taste when baked. The crust of the cake may have a marbled appearance owing to the batter drying out during storage, causing localised excess sugar at the surface of the cake.

The frozen batters should be removed from the deep freeze and can either be given a short defrosting period, or baked immediately from frozen. The defrosting method has no significant effect on cake quality though a slight surface discoloration may occur when product is baked from frozen but this may not be a disadvantage if the cake is to be decorated. Baking conditions should be as normal but if baking from frozen, a longer baking time may be required.

References

CAUVAIN, S.P. and YOUNG, L.S. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science, Oxford, UK.

SCREEN, A.E. (1988) Producing frozen cake batters. *FMBRA Bulletin No. 3*, CCFRA, Chipping Campden, UK, pp. 126–132.

10.5 When we add fresh fruits such as blackcurrants to our cake batters we sometimes find that they fail to keep their colour during baking and often discolour the batter adjacent to the fruit. Can you offer an explanation and a solution to the problem?

This problem occurs because the natural colouring agents in the blackcurrants and many other fruits (see 12.29) are pH-sensitive. This means that they will change colour as the pH changes. For example, anthocyanin, a major colouring component of blackcurrants and other red fruits, will change in colour from red to pink to violet as the pH progressively increases. Blue and violet colours are most likely to occur when the pH is 7.0 or above. To overcome the problem try making the batter slightly more acidic by adding up to 0.6% tartaric acid based on flour weight. This should maintain the basic colour of the fruit without adversely affecting other cake qualities.

The leaking of the colour into the surrounding batter comes from damage to the fruit skins during mixing and depositing. This is difficult to avoid but you should keep the handling of fruit in the batter to a minimum. You may try the addition of frozen fruits as this may help to avoid rupturing the fruit skin. Blueberries have a tougher skin and so are less sensitive to mechanical handling than blackcurrants. However, they are just as sensitive to pH changes.

10.6 Why do cakes go mouldy?

Mould growth is the visible sign that the product has been contaminated with mould spores in an environment suitable for their growth. Such spores can be present in the batter but are effectively killed in the baking process. However, as there are many spores in the atmosphere it is likely that spores settle upon cake surfaces during the cooling and packing processes and if the conditions are favourable they will grow, thus spoiling the product.

The moulds that grow on cakes need water and oxygen to thrive. Ingredients in the cake can 'lock up' water so that it is no longer available for use by the moulds. A measure of the amount of water held by the ingredients is the equilibrium relative humidity, ERH. This is sometimes referred to as the 'water activity'. ERH is measured on a scale of 0 to 100%, water activity on a scale 0 to 1.0. The higher the ERH, the greater the potential for mould growth will be. Cake products usually have an ERH in the range 75–85%. The ERH of a product is different from its moisture content and while the moisture content is a good indicator of the product's eating characteristics, it is the ERH that governs mould growth.

The rate at which the moulds grow is also dependent on the temperature of storage and the level of contamination. In general terms the higher the storage temperature (up to around 33 ºC), the faster the mould growth. For example, with an ERH of 86%, the cake would have a mould-free shelf-life of about 10 days for a storage temperature of 21 ºC (70 ºF) and of about 7 days if stored at 27 ºC (80 ºF).

It is possible to measure the ERH of a cake product. Representative samples of the product are carefully prepared and can be measured using a water activity meter. Alternatively the product ERH can be calculated from recipe ingredient and baking data. There is software, ERH CALC™ (CCFRA, 1999), which can be used to calculate the ERH of the product from its ingredient data and moisture loss during baking, cooling and storage. It can then be used to determine the mould-free shelf-life of the cake. Such software is invaluable to product development teams in assessing the 'use by' date required by retailers.

Some ingredients have the ability to hold on to water better than others. For example, salt and glycerine are very effective and additions can prevent some of the water in the recipe from being used by the moulds. Increasing sugar content or reducing water content can also extend shelf-life provided the eating characteristics desired are still maintained.

It is important to provide the product post-baking with as clean an atmosphere as possible to reduce the potential for spore contamination. The following suggestions may reduce such contamination:

- After de-tinning allow products to cool without removing any lining paper. All surfaces in contact with the cake should be clean, dry and free from flour dust. Preferably cooling should not take place in the bakery but in a temperature-controlled area.

- If the product is to be cut or decorated ensure that all utensils used are clean and dry and wrap immediately after further processing.
- Store the product in a cool place before dispatch.

Reference

CCFRA (1999) ERH CALC™, CCFRA, Chipping Campden, UK, www.campden.co.uk.

Further reading

CAUVAIN, S.P. and YOUNG, L.S. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science, Oxford, UK.

CAUVAIN, S.P. and SEILER, D.A.L. (1992) Equilibrium relative humidity and the shelf-life of cakes. *FMBRA Report No. 150*, CCFRA, Chipping Campden, UK.

10.7 In the light of the previous question, why do heavily fruited cakes go mouldy more slowly?

Vine fruits used in heavily fruited products, such as Christmas cakes, Christmas puddings and Dundee cake, have natural mould-inhibiting properties. This is partly as a result of the high natural sugars present in the fruit and this property lowers the ERH of the product and so extends the shelf-life. Also there are traces of natural preservatives in the fruit skins that, while not changing the batter ERH, will improve the product mould-free shelf-life.

Care must be taken, however, with products such as these that the cake or pudding is cooled properly before packing in order to ensure that there is no localised condensation on the surface. Localised condensation provides areas high in moisture and, while the overall ERH of the product may be adequate to ensure the desired mould-free shelf-life, on these localised areas the relative humidity and moisture content can be high enough to allow mould growth at a faster rate.

In Christmas pudding production, the steaming process actually adds moisture to the product rather than removes it as in conventional baking. An allowance must be made for this extra moisture in the final product when determining its ERH and desired shelf-life. Usually Christmas puddings have an ERH below 80% and a moisture content between 25 and 28%. On storage the space in the container above the pudding can become saturated (owing to the evaporation of moisture from the product). If storage conditions fluctuate grossly then moisture can condense and fall onto the product surface either by spot condensation on the packaging film or on the sides of the container. The local atmosphere then becomes favourable to mould growth. If the pudding basins are not adequately filled with the pudding mixture, water enters while they are still boiling and remains to a much greater extent than if the basins/containers had been well filled and tightly sealed before boiling. When the puddings are boiling the water must not be allowed to cease boiling since if the temperature falls, the puddings are inclined to contract, and water might enter between the container and the outside of the pudding. After steaming the puddings should be cooled with the top surfaces exposed to permit drying out without risk of condensation and allowed to dry for 24–48 hours before packing.

Further reading

CAUVAIN, S.P. and YOUNG, L.S. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science Ltd, Oxford, UK.

10.8 Why are we getting mould between our cakes and the board on which they sit?

Mould spores are always present in a bakery, particularly where there may be poor hygiene or an excess of flour dust. Moulds in flour dust are destroyed during baking. The board itself may not be the source of contamination though this cannot be discounted. The cake may have picked up the mould spores post-baking, for example, from a surface in the bakery on which there was flour dust. If the spores are picked up and the cake is subsequently iced they are sealed by placing the cake on the board. The humid conditions created in those circumstances provide the appropriate conditions for the mould spores to germinate.

This problem only occurs with cakes of high ERH. Usually there is a certain amount of air trapped between the board and the cake and if the relative humidity of the localised trapped air is below 75%, mould growth will not take place despite contamination. This can be achieved by painting the base of the cake with a concentrated sugar solution (thus lowering the RH) before putting it on the base board – the basis of the tradition of painting on a fruit purée onto the surface of cakes. A practical, low-cost solution is to raise a fondant to boiling point and paint it over the base of the cake. The syrup is largely absorbed and helps to act as an adhesive.

Eventually moisture migration will take place between the cake crust and crumb, and the whole cake will come into equilibrium. The desired localised reduction in ERH near the base is maintained for a long time to prevent mould growth. Similarly the top surface of a sponge, which may have become contaminated from mould spores in the atmosphere and which is subsequently iced, can exhibit mould growth of this nature.

It is very difficult to eliminate contamination of this type, but it can be reduced by placing the cakes on a clean dust-free surface and covering them with, for example, greaseproof paper prior to packing. The boards should be stored in a dry place and protected from contamination by dust.

Further reading

CAUVAIN, S.P. and YOUNG L.S. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science Ltd, Oxford, UK.

10.9 We are experiencing mould growth on the surface of our iced Christmas cakes. This is the first time we have had this problem. Why has it happened?

Christmas and celebration cakes need to be stored with care to avoid mould growth on their surface. This mould growth is caused by localised areas of high moisture on the surface of the iced cake. These localised high-moisture areas can often form because of the presence of undissolved sugar crystals in the icing which makes it hygroscopic. If cakes are stored in a container before they are completely cool, condensation can fall from the surfaces of the container or wrapping material onto the cake, forming an area of high moisture. Such areas are good breeding grounds for mould.

A good way to avoid this problem is to cool the cakes completely and then to wrap them in greaseproof paper before placing them in tins with a few holes for ventilation. The tins should then be stored in a cool, dry place. The cakes should not lose too much moisture during storage because the average ERH will be low and so limit evaporative losses. See also 10.8 and 10.25.

10.10 We are experiencing a ‘musty’, off-odour developing in our cakes, even though we store them in a deep freeze. Why?

Because of their high sugar content cakes are susceptible to picking up both moisture and odours from the surrounding atmosphere. Care should be taken to keep the areas and surfaces of all containers clean and free from other materials that might impart odours into the atmosphere. In the case of a deep freeze, it is important that any stagnant water accumulating in the drip tray near the evaporator is regularly flushed out with clean water. Such stagnant water provides a breeding ground for moulds and bacteria which can produce odours that are readily absorbed by the cakes.

10.11 When we take our cup cakes from the oven we find that the paper cases they were baked in fall off. How do we avoid this problem?

The tendency for cakes to shrink when baked is the most usual cause of paper cases becoming detached. The shrinkage generally results from the recipe having too high a liquid level. On cooling, the pressure of the steam formed and maintained within the cake while in the oven is reduced and the cake shrinks under normal atmospheric pressure. Because the cases are rigid, they hold their shape and the result is that the cake shrinks away from the case.

This same problem is sometimes found in pound cakes baked in hoops or paper bands. The steam within the cake cannot readily escape from the sides as it does from the surface and so the cake remains softer here. Underbaking or sweating during cooling can also contribute to the fault. Sometimes these cakes have an uncooked core near the bottom.

The remedy is to reduce the liquids in the recipe or by increasing the proportions of baking powder and sugars.

10.12 Why do our Genoese cake sheets tend to lack volume and have cores in the crumb?

Poor volume seen with very close grain and the development of seams or cores in the crumb suggests inadequate chemical aeration in the batter. It may be that the sodium bicarbonate was omitted or the wrong balance of raising agents was used. Check that sodium bicarbonate is included when weighing the other ingredients. Often preparing a composite baking powder for general use or purchasing a ready-made baking powder will avoid any errors in preparation. To improve the general quality of the Genoese sheet we suggest, as a trial, you increase the proportion of aerating agents to determine the level best suited to your recipe.

Genoese sheets sometimes have an uneven surface giving problems with uniform volume. This unevenness can be the result of poor mixing and scraping down of the batter. We suggest the following procedure on adding the eggs should be followed:

1. Add half of the eggs over 1 minute. Scrape down.
2. Add remaining eggs over 1 minute. Scrape down.
3. Mix for a further 3 minutes.

All mixing should be done on slow speed. Make sure that, on scraping down, that the job is done properly.

Have a look at your mixer and examine the gap between the beater and the bottom of the bowl. This should be as small as possible to avoid areas of undermixed batter that may then find their way into the sheet when deposited. If you think that the gap is too large you may need to replace your beater or even your mixing bowl.

10.13 Sometimes our Madeira cake has a poor (coarse) texture. How can we improve it?

Madeira cakes are characterised by their uniform and fine texture (cell structure). If the texture is coarse, the addition of a suitable emulsifier can help rectify the problem. The emulsifier will help to reduce the overall size of the gas bubbles incorporated into the batter and improve their stability during baking. A number of emulsifier preparations are available. They come in gel and powdered forms; we suggest that you consult your ingredients' supplier.

The powdered form is used in the formulation of dry cake mixes. A proportion of such emulsifiers consists of a carrier, usually skimmed milk powder. If this is the case then you should make allowance by reducing the level of milk powder in the recipe otherwise the cake may be too brown because of the Maillard reaction and the lactose in the milk powder. You should have no such problems if you use a gel emulsifier but you will need to adjust the recipe water addition to compensate for the inclusion of some water in the gel.

A suitable usage level for powdered emulsifier would be between 5 and 10% of flour weight; you should reduce the milk powder level by about half of your normal level of addition in your recipe to avoid the potential for darkening. In the case of a gel emulsifier around 2.5% flour weight should be suitable.

10.14 Our small Madeira cakes often shrink excessively during cooling. How can we avoid this?

All cakes shrink a little on cooling. However, excessive shrinking on cooling occurs because the intact gas cells in the texture contract. During baking the gas cells forming the foam in the batter expand as they are filled with the steam and gas produced by the raising agents. Because of the high quantity of sugars in the batter the gelatinisation temperature of the cell wall material is delayed and the structure does not 'set' until the temperature reaches the high 80s °C. The flexibility of the cell wall material allows the cells to expand until they burst or perforate, converting the foam to a sponge structure and allowing the gases to permeate throughout the cake. This all happens at a microscopic level. If this setting does not take place, even though the cake is considered baked because it has achieved the necessary appearance and colour, then on cooling the pressure inside each cell falls and under the weight of the cake and atmospheric pressure the cells shrink. This causes the whole cake to shrink.

This problem can be remedied as follows:

- Give the tins a substantial jolt as they leave the oven, causing the cells to 'burst' and the pressures to equalise. This can be achieved by allowing the pans to drop from one conveyor to another near the start of the cooling process.
- Increase the level of baking powder in the recipe, or change to a slower acting powder. This should help to break down the cell walls as the cake sets during baking, so leaving the minimum number of intact cells in the crumb.

10.15 Why do cake batters made by the sugar-batter method sometimes have a curdled appearance? Does this affect final cake quality?

Curdled batters are usually the fault of carelessness or haste during preparation of the ingredients or mixing. If all the ingredients in the batter are at a similar temperature they will amalgamate to form a thick, smooth cream. However, if the eggs are added too quickly, causing the butter or fat particles to separate from the water in the mixture, breaking down the emulsion, the mixture will become curdled. It will also happen if the butter or margarine, which contain water as well as fat, is used in a hard rather than a soft condition and then well creamed with the sugar to a whitened, smooth cream before any eggs are added. This problem may well be evident in the case of rich recipes, e.g. Madeiras containing a great percentage of eggs, particularly if the eggs are watery or if poor-quality frozen eggs are used.

Care should be taken to get the batter and eggs at a suitable temperature and the eggs should be added slowly. Each portion of egg should be adequately beaten in before the next quantity is added.

Batter can be prevented from curdling by:

- ensuring all ingredients are at the correct mixing temperature, typically 20–22 °C (70° F);
- adding a small quantity of flour at the first signs of curdling;
- using a high-ratio shortening containing an emulsifier.

If the recipe includes a high ratio of sugar and liquid to flour, it is essential that a high-ratio shortening, or an emulsifier in conjunction with plain shortening, is used.

Generally curdling will not significantly affect the final cake quality, provided the recipe is properly balanced. This is because any water that separates out during curdling is later reabsorbed when the flour is added.

10.16 We are experiencing seepage of jam in our frozen fresh cream gateaux when they are thawed. Can we avoid this?

Seepage of this nature is caused by the formation of surface water through syneresis within the cream and jam as a result of the crystallisation or aggregation of polymers. It is commonly found with products that undergo freezing and then thawing. Surface water forms because of the breakdown of the cream foam and subsequent release of water. In the case of jam seepage, the jam is basically a coloured sugar solution containing fruit and the colour is unlikely to be held fast. Once a coloured solution has formed it can diffuse into the cream.

The problem is sometimes encountered where frozen products are partially thawed and then refrozen as might be experienced with refrigerated transport. This temperature cycling impairs cream stability and as a consequence the jam spreads out. If the temperature cycling in transport reaches above −5 ºC (23 ºF) then seepage is more likely to occur. We would not expect to see such temperature changes in a well-managed and monitored distribution chain, except for some boxes on the outside of stacks or pallets. The cardboard sealed box and the air between it and the gateau does present a reasonable barrier to heat transfer. Also a stack of frozen gateaux should behave as a reasonable cold sink.

The solution to the problem is to avoid periods of intermediate defrosting. Where such periods do occur, the temperature the gateaux reach should be kept as low as possible.

Further reading

CAUVAIN, S. and YOUNG, L. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science Ltd, Oxford, UK, pp. 136–138.

ROBB, J. (1986) Control of seepage from non-dairy confectionery fillings. *FMBRA Bulletin No. 5*, CCFRA, Chipping Campden, UK, pp. 187–199.

10.17 What are the causes of the small, white speckles we sometimes see on the crust of our cakes?

White speckles on the crust of cakes are most commonly due to sugar that has recrystallised. They are sometimes referred to as ‘sugar spots’. Sugar spotting on the crust of cakes is caused by the recrystallisation of sugars that were previously in solution in the batter. During the baking process, the reduction of moisture content particularly near the surface of the cake can result in the sugar coming out of solution and forming the spots on the surface.

Any changes in recipe resulting in a reduction of moisture content or excessive sugar, thereby increasing the ratio of sugar to water, may give rise to sugar spot formation. For example, the change from butter or other fat containing a proportion of water to a white fat containing no water can be enough to precipitate the problem. Similar results may occur if any water-containing ingredients are replaced by forms containing no water.

Other factors that might cause sugar spotting on cakes include the following:

- Increased granularity of sugar, which may prevent it dissolving properly at the batter stage. As a precaution, the sugar can be dissolved in the water added to the batch before mixing. This is easily done when using a flour batter or blending mixing method. When a sugar-batter mixing method is employed, sugar in excess of the weight of fat may be dissolved in the liquid portion before addition. With all-in mixing methods pre-dissolution of coarse sugar is essential to avoid this problem.
- Baking at a lower than normal temperature or baking in an oven with too low humidity may prove detrimental.
- Allowing the deposited batter to stand for too long a period in the bakery atmosphere before baking may cause surface drying and subsequent sugar spotting. If using a travelling oven, a much shorter standing time is required because of the hot air passing over the cakes at the entrance to the oven. In such ovens the problem can be overcome by applying, by hand or automatically an ‘atomised’ spray of water over the cakes while they are on the oven sole and as they pass into the oven.
- In Madeira cakes where a ring of batter (a sugar ring) may have overflowed the wrapper and become loose, a slight reduction in scaling weight or increasing the height of the paper band used would help to prevent overflowing and hence the localised sugar spotting.

10.18 Why are we getting an orange discoloration of the crumb of our fruit cakes?

Fruits, for example cherries, used in cakes may contain permitted colouring dyes. Many such colours are soluble at different pHs (usually above pH 4.0). When the discoloration occurs in the crumb surrounding the cherries it is caused by the colour from the fruit ‘bleeding’ into the crumb.

If the cherries are added at a later stage in mixing, the discoloration will be far less pronounced. If they are washed and drained before use and introduced at a late stage then the bleeding should cease.

In summary:

- Use good quality fruit in your products. Preferably use whole, unbroken fruit.
- Where the problem occurs wash the fruit with water slightly acidified by citric acid and drain thoroughly.
- Check with your supplier which dyes (and their solubility level) are used in the fruit so that the problem can be avoided.

See also 10.5

10.19 Our sultana cakes are collapsing. What can we do to remedy this problem?

Sultana cakes can tend to shrink or sink slightly at the top. This is sometimes accompanied by a slightly open crumb cell structure (grain). This is caused when the batter has been over-aerated during mixing, thus making the specific density of the batter too high to support the denser fruit, particularly nearer the centre.

This may be countered by increasing the amount of liquid in the recipe, if the flour content is adequate, or by reducing either the sugar content or the amount of aerating agent. The first and last of these actions usually brings about an improvement. It is also preferable to have the egg content slightly higher than the total fat content as egg adds strength to the cake structure. Where milk is replacing eggs, a simple method for calculating the baking powder requirement is to assume that 560 ml (1 pint) milk requires 28 g (1 oz) baking powder. See also 10.3.

10.20 We are we getting large holes in the crumb of our fruited slab cake?

Large and unsightly holes in fruit cake can be caused by any of the following reasons:

- If damp fruit is used, localised steam is formed around the fruit during baking, especially near the centre of the individual berries where it is less able to escape quickly. The top of the cake becomes baked and so the localised steam is trapped and it produces holes in the crumb as the pressure builds up. All fruit should be thoroughly dried after washing to remedy this problem.
- In spreading Genoese and large fruit slabs, air may be entrapped during depositing or, while spreading batter by hand or with a wet palate knife, part of it may be folded over, again entrapping air and so causing holes.
- Low carbon dioxide levels, either because there is too little baking powder or because the baking powder has reacted too quickly.
- Occasionally over-mixing of the batter, especially when adding the fruit, can cause the problem. In this case the holes may run vertically or at an angle rather than horizontally.

See also 10.29.

10.21 Why do cakes sometimes sink in the middle?

Many of the faults that occur in cakemaking are a result of the ingredients in the recipe not being 'balanced' for the type, size and shape being made. This balancing of ingredient ratios is important to ensure the correct aeration and structure for the baked product. Whether the collapse occurs during baking or after baking is an important clue as to why the problem is occurring.

In the case of the sunken top the following ingredient effects are relevant:

- The sugar level may be too high. The late gelatinisation of the starch means that the transition from foam to sponge does not occur before the end of baking (see 10.30).
- The fat level may be too high.
- The baking powder level may be too high.

You may need to rebalance your recipe to eliminate this problem.

There are other reasons why a cake might sink in the middle. If a cake is removed from the oven before it is thoroughly baked it will drop in its centre. The centre of a cake is the last portion to bake so that if the product is removed from its source of heat when it is still fluid the crust will be unsupported and the cake sinks.

If the cakes are knocked or moved about while they are baking and before they have become properly set there could be a premature release of gases which can cause the cakes to sink in the centre (Fig. 28).

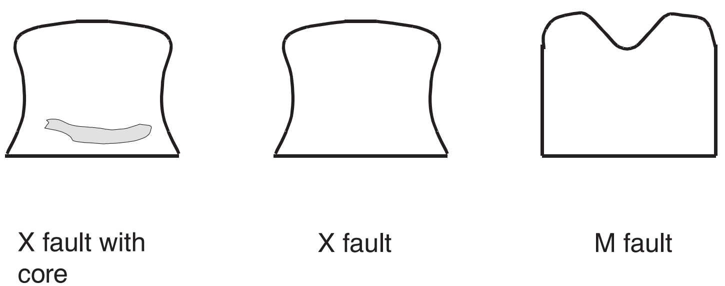

Fig. 28 Collapse in cakes.

10.22 Our fruited cakes are fine to eat soon after production but tend to become drier eating after a few days. Why?

Fruited cakes are a multicomponent product comprising two phases: the cake crumb and the dried fruit. Even though the two components are in intimate contact from mixing through to baked product, equilibration of moisture does not necessarily occur. In many cases after baking there is a significant difference in cake crumb and fruit particle moisture content with the dried fruit continuing to absorb moisture from the cake crumb. Experimental data (Cauvain and Young, 2000) has shown that up to four days may be required for equilibrium to be achieved. This lack of moisture equilibrium is most likely to be the reason for the dry eating cake crumb that you are observing.

One way to overcome your problem is to raise the moisture content of your fruit by washing and draining it before use (see Fig. 29). However, note that this will raise the overall moisture content of the cake and may decrease its mould-free shelf-life.

There are several ways off preventing crumbling with fruit cakes:

- Use flour of medium strength (10–11% protein) instead of high-ratio cake flour.
- The proportion of fat used should be less than the egg content by approximately 10% (based on flour as 100%).
- Where the ratio of sugar to liquid is high, the cake crumb tends to be more fragile. For a fruit cake this ratio should be lower than 115% flour weight.

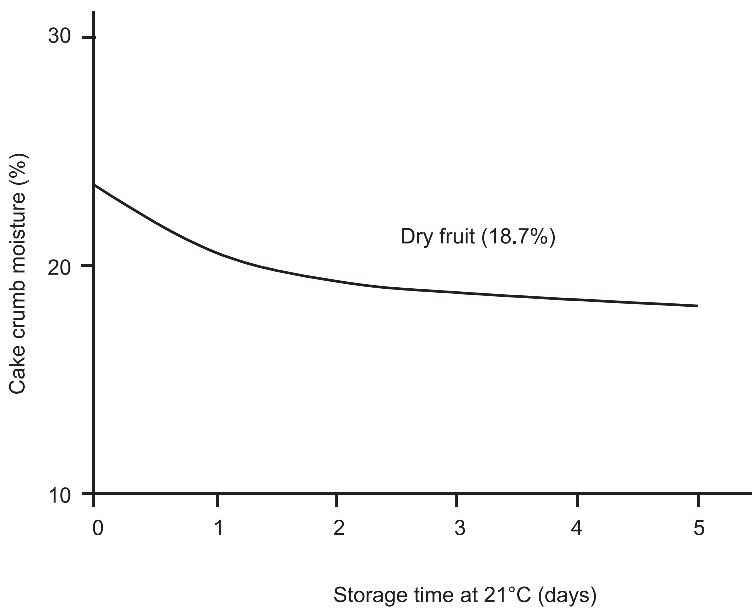

Fig. 29 Effect of fruit on cake moisture during storage.

- When the proportion of egg in the total liquid is low, the cake structure is weak and has a tendency to crumble on cutting. Egg should make up about 50% of the total liquids to prevent this.
- Emulsifier should be kept to a minimum.
- Avoid high levels of raising agents as these can increase crumb fragility.
- Wash fruit and dry well before use. Dusty or unclean fruit may produce a ‘drag’ effect during cutting.
- Mixing must be controlled to ensure constant batter aeration and emulsification. Under-mixing and also over-aeration of batters can cause a crumbly end-product.
- Batter depositing and baking should not be delayed after mixing.

Reference

CAUVAIN, S.P. and YOUNG, L.S. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science Ltd, Oxford, UK.

10.23 Our cake quality varies when we change from one type of oven to another, even when the ovens register the same temperature. Why?

Ovens, even those of the same make and model, vary in their ability to deliver heat to the product. The temperature setting indicated on dials or displays are indications of the actual air temperature rather than a measure of the heat available for baking.

During baking heat is transferred to the product in one of three ways:

- Convection, the transfer of heat in fluids, achieved by the colder fluid carrying away heat from a hotter surface which sets up convection currents.
- Conduction, the passage of heat through a medium, from hot to cool regions, the heat being passed on from molecule to molecule, e.g. hot pan to cooler bread dough.
- Radiation, the transfer of heat from hot surfaces without the need for a transferring medium, e.g. the heat we receive from the sun.

Ovens used in bakeries use all three heat transfer mechanisms though the balance between the three varies with oven type. For example, in a deck oven conducted and radiant heat dominate, while in a rack oven convection and to a lesser extent radiation dominate.

The thermostat fitted to an oven senses and controls the temperature of the oven by calling for more or less heat accordingly. Occasionally this may be at fault and may not be working accurately or may be controlling the temperature at a point that does not coincide with the position of the cakes in the oven. For specific temperature settings in your oven it is advisable to bake the products at several different temperatures to find the ideal settings for your oven. You should try to make sure that the oven has a reasonably similar load for each trial otherwise you will get variable results. Try adjusting temperatures in 5 ºC steps, above and below your current settings, so as to avoid making products that would not be acceptable for sale.

It would be wise to check that a consistent temperature is being delivered for consecutive bakes in case you have a problem with burners or heating elements. You may find that the oven is not fully recovering its heat load between bakes of successive batches. If this is the case you should consult your equipment supplier. On the other hand it may be that the time between bakes is so long that ‘flash’ heat builds up in the oven. This is associated with the radiant heating component in the oven and often leads to burning of the product crust. Since most products are baked to a particular colour and shape, the temptation in these circumstances is to lower the oven temperature for the next bake. You should avoid this if possible. If you are about to use an oven that has been standing empty but heating for a period of time and you suspect there may be problems with flash heat, we suggest that you inject a burst of steam into the chamber. The evaporation of the water will remove some of the excess heat and readily escapes when you open the oven door or damper. If you use the latter remember to close it again when you load the product into the oven otherwise you could end up drying the product out unnecessarily.

Variations in oven humidity can also lead to variability for some products. For example, Swiss rolls benefit from humidity in the oven as the water vapour keeps the crust moist and so aids the rolling process post-baking.

While your problem is associated with cakes you might like to note that the same rules will apply to almost all baked products.

10.24 We are encountering an intermittent fault with our round high-ratio cakes in that a shiny ring with a pitted appearance is seen on the cake surface. What factors are likely to give rise to this fault?

This fault is caused by the batter viscosity being too low during the early stages of baking. As the product is heated the viscosity of the batter helps to trap the gases produced by the raising agents. If the batter is too fluid, i.e. low in viscosity, then the structure, which is not set, allows gases to escape and these burst through the forming crust, leaving behind the pitted surface appearance.

The shine on the ring suggests that the sugar level in the recipe is too high. High levels of sugar delay the gelatinisation of the starch and so the batter is kept fluid for longer.

An increase in viscosity can be achieved in any of the following ways:

- Reduce the water content of the batter.
- Increase the flour-damaged starch. Damaged starch will hold more water, thus making the batter more viscous.
- Extend the mixing time but avoid over-mixing.
- Reduce the recipe sugar level.

10.25 How important is the temperature of cakes at the point of wrapping?

Cakes can be wrapped at either high temperatures or completely cooled. In either case the important point is to ensure that no localised condensation occurs on the surface of the product which might result in mould growth during storage. The equilibrium relative humidity of the product should remain at the level required to achieve the desired mould-free shelf-life (see 10.9).

If a cake requires no filling, coating or other finishing after baking there is no reason why it should not be wrapped direct from the oven at a temperature of about 88–93 ºC (190–200 ºF). Obviously there may be some difficulties involved in wrapping at these high temperatures, such as damage to a fragile product and control of condensation as the product cools. Provided the wrapping material is in reasonably close contact with the product, condensation soon disappears even when a moisture-impermeable film is used.

Materials for wrapping at high temperatures should be chosen with care. Materials such as polythene would be unsuitable, but most grades of cellulose film do not appear adversely affected by hot wrapping.

If products are to be cooled and then wrapped care must be taken during the cooling process. Rapid cooling can be achieved with suitably high air velocities. However, if drying out of the product is to be prevented, the relative humidity in the cooler must be carefully controlled. The relative humidity can be controlled only if the air temperature is closely regulated since relative humidity changes rapidly with a small change in air temperature at a given moisture vapour content.

If refrigeration is used both temperature and relative humidity can be controlled satisfactorily with an air temperature of, say, 16 ºC (60 ºF) and about 80–85% relative humidity. To prevent the product drying out the relative humidity should be close to the equilibrium humidity of the product (typically 80–85% for cakes) so that moisture is not encouraged to move from the product. The high relative humidity in a refrigerated system means that large cooling plates are required to prevent condensation of moisture onto the cooling coils.

Without refrigeration, relative humidity can be controlled using water spray type humidifiers. In this case close control is more difficult especially if the air temperature (around 21 ºC, 70 ºF) is subject to fluctuations.

The moisture loss from flour confectionery products during cooling may be a critical factor in determining their mould-free shelf-life and eating qualities. If controlled cooling conditions are used it is possible that an increase in the moisture content of the product could occur with a resulting reduction in the shelf-life. It is advisable to make careful checks on moisture content when setting up the cooling system and recipes may need adjustment to decrease the ERH of the product.

Under controlled cooling conditions, it is important that any air blown over the product is clean and thorough filtering of air drawn from outside is desirable. Cooling times are dependent on the size and thermal conductivity of the product.

It is pointless using high air velocities with large products, where cooling time is controlled mainly by the time taken for heat to be conducted from the centre of the product to the outside.

See also 10.6, 10.8 and 10.9.

Further reading

CAUVAIN, S.P. and YOUNG, L.S. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science Ltd, Oxford, UK.

10.26 We have a shrinkage problem with the parkin cake we produce. How do we eliminate it?

Shrinkage of parkin cake is usually due to an excess of liquid or to an abnormally low proportion of egg. For this type of cake the proportion of liquid should lie between 25 and 60% of the total flour weight (inc. oatmeal) and the egg between 5 and 20% flour weight.

Sample recipe

Ingredient	*Weight (g)*
Flour	500
Oatmeal	500
Baking powder	15
Ground powder	15
Margarine	350
Golden syrup	560
Brown sugar	570
Eggs	200
Milk	375

10.27 What precautions should we take when freezing flour confectionery products?

The greatest benefits to be gained from freezing cakes and other flour confectionery products is a delay in the staling process, provided the products are adequately protected against moisture loss and microbial spoilage.

Before freezing all products should be cooled to ambient temperature (typically 20–25 ºC, 70–77 ºF) in order to maintain the efficiency of the freezing process. The most efficient and economical freezing temperature is −20 ºC (−5 ºF). However, cryogenic freezing systems using liquid nitrogen or carbon dioxide have led to the use of much lower temperatures, −171 ºC (−275 ºF) for liquid nitrogen and −100 ºC (−73 ºF) for liquid carbon dioxide. Fans operating in such equipment aid heat transfer.

It is advisable to use a specially produced moisture-proof film that has increased flexibility and is resistant to cracking. Wrapping the products before freezing will help reduce evaporative losses but does increase the length of time taken for the product to become frozen.

Storage times for frozen products vary but can be many weeks at −20 ºC (−5 ºF). Remember that if products are stacked in frozen storage then the temperature of the product may vary according to its position in the stack and in some cases may be unacceptably high with subsequent defrosting.

The thawing time for frozen confectionery depends on the unit size and thawing conditions available. A 285 g (10 oz) sized plain slab cake can take up to 6 h standing at 21 ºC (70 ºF) before the internal temperature reaches 21 ºC but such a cake would be edible within 4 h. If the same cake was thawed at 38 ºC (100 ºF) an internal temperature of 21 ºC would be reached within 1.75 h. Dry eating products may occur if the thawing rate is too slow because of excessive moisture losses.

Condensation can occur during thawing and depends largely on the thawing temperature, which controls the time during which the surface temperature of the product remains below the dew point of the atmosphere in the packaging. The higher the thawing temperature, the more quickly is the condensation removed and the less likely it is to affect the product.

10.28 We would like to improve the quality of our slab cake. How important is batter temperature in this context?

In order to produce an optimum product the temperature of the ingredients and the resulting batter should be such that it allows thorough amalgamation and good aeration from each of the components. A batter temperature maintained at 21 ± 2 ºC (70 ± 3 ºF) is recommended.

There is little rise in temperature of cake batters during their short mixing times and so there is no need to provide for chilled water or egg. Ingredients that are too cold, e.g. frozen egg and cold milk, cause a tightening of the batter and a partial ‘setting’ of the fats. The latter effect is seen as ‘curdling’ of the batter (see 10.15).

It is also important that the batter temperature does not increase too much so that the fats melt and allow the batter to lose aeration. Higher batter temperatures will also increase the chemical reaction of leavening agents, resulting in a loss of aeration from this source.

By keeping materials at an even temperature, better aeration and a more thorough dispersion and hydration of ingredients will result in a cake with better appearance, volume and texture when baked.

10.29 Why should the whole of the batter for one slab be placed in the tin in one piece rather than bit by bit?

If the batter is placed in stages into the tin, there is a chance that a quantity of air can be trapped between the various deposits and this may result in large, unsightly holes in the slab when it is baked and cut. It is therefore better that the batter deposit is placed in the tin in one piece to ensure an even texture in the baked product.

Similar problems may be encountered filling sponge moulds and here there is also a chance of trapping a bubble of air at the top where the mould is small. One trick used to fill such moulds to avoid entrapping large bubbles is to fill a long funnel and allow the batter to flow slowly into the bottom of the mould.

See also 10.20.

10.30 What happens to the batter when cakes enter the oven and how can you tell when a cake is baked?

Converting a fluid batter to the desired eating characteristics in the end product is the result of getting both the temperature and timings correct during baking. The ‘foam’ structure (discrete cells) of the batter is converted to a ‘sponge’ structure (inter-connected cells) in the baked product. Baking is a process of heat gain and moisture loss.

Even before the cake enters the oven, the condition of the oven is important. Any build-up of ‘flash’ heat should be dissipated so that the cake receives an even bake. Once the cake is in the oven, the heat starts to melt the fats. This first occurs on the outside of the cake and gradually extends to the inner portions. At the same time the air cells begin to expand and if raising agents are present carbon dioxide is released to inflate the cells. This begins slowly at first from the outside and gradually extends to the interior of the batter. The temperature of the cake continues to rise and some of the starch cells are gelatinised while the cake is still in a molten state. The cake continues to rise until the structure is set by the gelatinising starch and the outside of the cake colours to give a cake of the required size and appearance. The continued expansion of the cells along with the gelatinisation of the starch causes the foam cells of the batter to become ruptured to form the inter-connected cells of the final structure.

If the cakes are small and the oven is hot, a skin forms quickly on the top and rapidly colours as the moisture in the vicinity of the surface is converted to steam, leaving the sugary portion of the batter to reach a temperature where the sugars caramelise. Although this skin forms quickly it will not have sufficient strength to prevent the interior of cake expanding (especially where there is a high proportion of baking powder). The pressure eventually exceeds the strength of the top. The top is the weakest portion of the cake as the sides and bottom are often supported by the tin or hoop. The batter forces its way through the forming crust and a rounded or bold head is formed. This is small at first but grows as baking continues. The fluid batter has moisture driven off before it too takes on colour.

In larger cakes the top skin takes longer to form as in these cases the oven is cooler (to allow for a more even bake and to prevent the outside being burnt before the inside is baked). Also the humidity in the oven is higher (e.g. when the oven is full of products), and because larger cakes usually contain a higher proportion of eggs than milk they give up their moisture at a lower rate. Eggs coagulate at the boiling point of water and retain a good deal of the water that would otherwise have been driven off as steam. If the recipe is correctly balanced, the bursting through the centre top is less pronounced.

The temperature at which the structure is set depends on the sucrose concentration in the batter. The higher the sucrose concentration, the higher the gelatinisation temperature and the longer the batter will remain fluid during baking. To test whether a cake is baked the centre surface is lightly pressed. If the surface just springs back it shows that the centre of the batter (the last portion to set) is baked.

If the oven temperature is too low, aeration proceeds as usual but the cake is slower at drying and setting on the outside so that the top skin will be longer in forming. The fluid batter will rise evenly all over the surface and a flat-topped cake will result. Another manifestation of too low a temperature in baking is a discoloured crumb, particularly in the lower portion of the cake, and the cake will also be dry eating. The low temperatures result in the cake taking longer to set but at the same time drying out. As the drying out continues the sucrose concentration in the unset portions of the cake becomes higher and will begin to caramelise. The coloured crust becomes thicker and the longer the cake remains in the oven, the more the discoloration of the crumb extends into the body of the cake. The upper part of the cake has been in contact with the steam inside the oven, and the damp atmosphere will have kept the cake moist and, to some extent, will have prevented the development of excessive dryness. The lower crumb, however, not in contact with the steam, becomes dry and then discoloured.

Deciding the temperature at which to bake one particular kind of cake is complicated. The ingredients, their quality and quantity, and the size of the cake along with the type of results expected all need to be considered. Some ‘rules of thumb’ for deciding on the baking temperature are:

- the greater the difference between the proportion of flour to butter and eggs used, the hotter the oven should be;
- the higher the proportion of fats, the cooler the oven should be;
- the larger the cake, the lower the temperature should be;
- the faster the heat input, the more rapid the moisture loss.

Further reading

CAUVAIN, S.P. and YOUNG, L.S. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science Ltd, Oxford, UK.

10.31 What are the advantages of having the oven filled when baking slab or other cakes?

The advantages of having an oven filled with product come from the humidity and heat transfer. Once cakes are placed in the oven their temperature rises and eventually the moisture in the product reaches boiling point and steam is given off. If the oven is full of product then the volume of steam will be fairly large for a given volume of oven capacity. The humidity in the oven will be high and will act on the surface of the cake, keeping it moist. As each cake is in close proximity to its neighbour, the side crusts will be kept thin and pale in colour. The hardening or drying of the final crusts on the top and sides will be delayed, enabling the cake to reach full growth before it is set.

If the crust has become set before full growth has been achieved, the inside of the cake will burst through the prematurely formed crust and form a break or crack across the slab. In some cases this break may be desired, e.g. in muffins. The atmosphere in the oven is less humid and so the product crust sets and dries before the cake has risen fully.

For slab cakes a break on the surface is not desirable and so aim for a full oven, with the oven door remaining closed for the whole baking period. Where this is not possible, a humid atmosphere should be created in the oven by placing tins of water in the oven with the product.

10.32 Why do we add extra acid to make white cake batters?

If the sodium bicarbonate element of the raising agent is not completely neutralised by the acid component then the excess bicarbonate will cause some degree of caramelisation of the sugars during baking. Indeed this occurs in all cakes but because the crumb of many cakes is tinted yellow either with egg yolks or egg colour the slight degree of discoloration largely passes unnoticed.

In the case of a white cake where no egg yolk is present the slightest discoloration would be noticed. To prevent this therefore, additional acid – cream powder or cream of tartar – is added to make sure that all the bicarbonate of soda is neutralised.

10.33 We have been experiencing problems with collapse of our sponge sandwiches which leaves the product with a depression forming on the top of the cake and an area of coarse cell structure in the crumb. What causes this problem?

The area of coarse cell structure that you have observed in your collapsed sponge cake is often referred to as ‘core’ formation. Sometimes this might be observed in the crumb even though the top of the cake has not collapsed.

The primary cause of your problem is instability of the air bubbles in the batter. When the sponge batter reaches the oven and the gas bubbles begin to expand it is important that they do not coalesce until the right moment in the later part of the baking process. To remain separate from one another the stabilising film must stretch as the air bubbles expand under the influence of heat and because of the carbon dioxide gas that is diffusing into them as the result of the accelerating baking powder reaction. If the stabilising material is not able to stretch sufficiently then it ruptures, allowing adjacent gas bubbles to coalesce and form larger ones – the coarse component of the cell structure. At the same time the displaced stabilising material will join with other materials to form areas devoid of air cells – the thick cell wall material which also looks darker in colour.

While there is only one primary cause there are many contributing factors, including the following:

- The presence of traces of fat or oil in a non-emulsified sponge recipe. Ensure that all traces of fat or oil are removed from the mixing bowl and whisk by using boiling water to wash the utensils.
- Too little emulsifier in an emulsified sponge recipe. Try increasing the level to about 0.75% of the batter weight (see 5.15).
- Too much baking powder in the formulation (see Fig. 30). Reduce the baking powder level and if the cake lacks volume increase the mixing time to lower the batter relative density or increase the emulsifier level.
- Batter relative density too low, especially with low levels of emulsifier. While the batter may be stable at low temperatures it is during the baking that bubble stability is most important.
- The particle size of the flour being too large (Cauvain and Hodge, 1977).

One factor known to contribute to this problem is the presence of ‘anti-foaming’ agents such as silicones. Even levels as low as 2 ppm have been shown to induce core formation in sponge cakes. The effective level depends to some extent on the level of emulsifier present but 5 ppm silicon will destabilise most sponge cake batters. Traces of silicone may come from a number of different sources, including the following:

- Barrier creams used for hands.
- Vegetable oil.
- Sugar.
- Flour, most likely from the wheat.

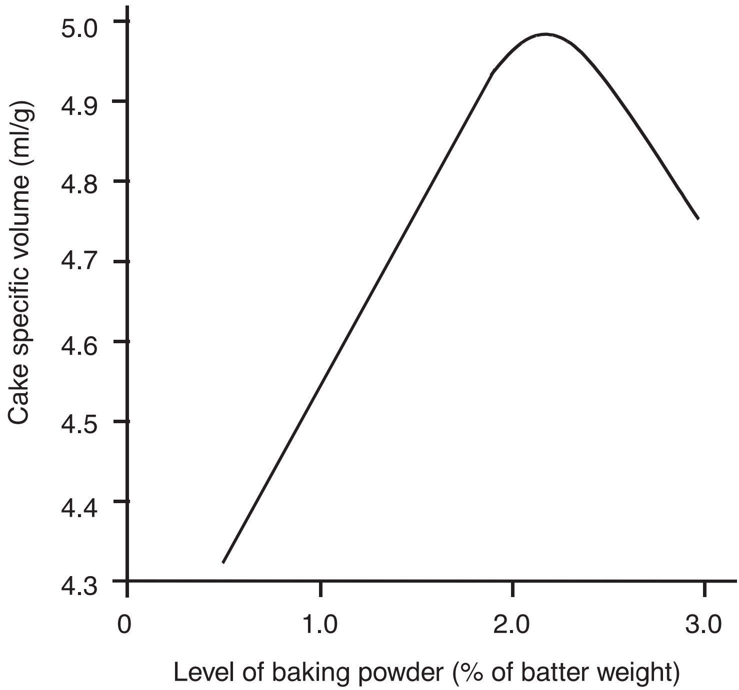

Fig. 30 Effect of baking powder level in sponges.

- Skimmed milk powder.

If you suspect that an ingredient may have become contaminated with silicon you should discuss the problem with your supplier.

Reference

CAUVAIN, S.P. and HODGE, D.G. (1977) Collapse in sponge cakes. *FMBRA Bulletin No. 6*, December, pp. 214–222. CCFRA, Chipping Campden, UK.

Further reading

CAUVAIN, S.P. and CYSTER, J.A. (1996) Sponge cake technology. *CCFRA Review No. 2.* CCFRA, Chipping Campden, UK.

10.34 We are having problems with the bottom crust of our sponge cake products becoming detached after baking. We also notice that the corners of the product become rounded and the texture close. Why do these problems occur?

The problem comes from a lack of carbon dioxide in the formulation either because you are adding too little baking powder or because too much has been lost before the product reached the oven, or you are mixing the batter for too long.

In most cakes, but especially with sponges, getting a fine cell structure and light texture in the baked product requires the evolution of baking powder in the oven to inflate the air bubbles that have been incorporated during mixing. Even though the air bubbles expand under the influence of heat in the oven their degree of expansion is limited by *Charles's Law*, i.e. to $\frac{1}{273}$ of their volume for each 1 kelvin (for practical purposes $1\,K = 1\,^{\circ}C$). The evolution of carbon dioxide provides increases in gas volumes far in excess of that obtained purely from the temperature effect.

As the sponge batter expands during heating its relative density changes and this affects the heat transfer rate into the batter. Batters with high relative densities, i.e. low gas volumes, bake faster than those with low relative densities, because the gases involved act like an insulating material. Thus the more gas that is evolved during baking the slower the heat transfer rate and this leads to a more uniform expansion of the batter.

Steam is also generated during the baking process. This requires that the temperature in the product exceeds 100 °C. The presence of dissolved sugars raises the boiling point of the aqueous phase in sponge (Cauvain and Young, 2000) but the crust still sets fairly early in the baking process. The quantities of steam progressively evolved from the batter as the heat penetrates to the centre build up pressure under the top crust and detach it from the rest of the product. There is also a build up of steam at the angle of the base of the pan and its side, which prevents the batter flowing into that area. The rounding of this area of the product is often referred to as ‘chamfering’.

The rate at which carbon dioxide gas is evolved depends on the rate of reaction between the acid component and the sodium bicarbonate. This can be regulated either by changing the acid type or its particle size. In the latter case larger particles are slower to react.

We suggest that you first investigate the effect of raising the level of the baking powder that you are using. This usually solves the problem. If it persists then you are probably using an acid that is too fast acting and we suggest that you change to a slower one. A rough guide for choosing a suitable acid is:

- fast acting acids – acid calcium phosphate (mono-calcium phosphate), tartaric acid and cream of tartar (potassium hydrogen tartrate).
- slow acting acids – sodium acid pyrophosphate and sodium acid aluminium phosphate.

The baking powder reaction rate can also be controlled by using an acid or sodium bicarbonate with a larger particle size; however, you must ensure that unreacted components are not left behind in the baked product as this can lead to flavour problems.

If you mix the batter for too long then the carbon dioxide gas evolved during the mixing process may escape from the batter rather than diffusing into the air bubbles. Cauvain and Cyster (1996) showed that this could happen even when using an apparently 'slow' acting acid such as sodium acid pyrophosphate.

References

CAUVAIN, S.P. and CYSTER, J.A. (1996) Sponge cake technology. *CCFRA Review No. 2.* CCFRA, Chipping Campden, UK.

CAUVAIN, S.P. and YOUNG, L.S. (2000) *Bakery Food Manufacture and Quality: Water control and effects*, Blackwell Science, Oxford, UK.

10.35 When making sponge drops we find that the last ones to be deposited are not as good as the first ones. Why is this?

Once a batter has been mixed changes in its properties occur with time. The nature of these changes varies according to the manner in which the batter is treated and the length of time that elapses before it is deposited. The main change is related to the stability of the air bubbles in the batter and the evolution of carbon dioxide gas from the baking powder in the formulation.

Once mixing starts, the acid in the baking powder begins to dissolve and react with the sodium bicarbonate present. The rate of the reaction depends on the type and nature of the acid and the temperature of the batter. The reaction proceeds more rapidly at higher temperatures whatever the acid being used. Some time after the baking powder reaction has begun the carbon dioxide gas diffuses into the air bubbles in the batter and they begin to inflate. Some may become so large that they can rise in the batter and escape at its surface. The stabiliser in the batter (e.g. emulsifiers) helps prevent this from occurring.

As the batter standing time before depositing increases, more carbon dioxide is evolved and eventually some of it can escape from the batter. If too much of the carbon dioxide is lost the batter relative density begins to increase, that is the batter becomes less well aerated and the sponge drops in volume. The length of time that has to elapse before this situation is reached depends on the particular baking acid being used but can occur with all acids. The potential for 'de-aeration' of the batter increases if the batter is agitated or subjected to shear. The longer that the batter stands, the greater will be the potential de-aeration effect from any agitation.

We suggest that you examine the length of time that the batter stands and see if this can be shortened. This may require the production of smaller batches mixed more frequently. Avoid excessive agitation of the batter once prepared, e.g. try to minimise the degree of scraping down of hoppers because this incorporates 'old' batter which contains less gas. Alternatively, consider using a slower-acting acid in your baking powder.

10.36 From time to time we experience problems with Swiss rolls cracking on rolling. What causes the problem?

The two most important characteristics of a Swiss roll sheet are that it should have a uniform thickness after baking and should be sufficiently flexible to withstand the rolling process. Control of a number of different recipe and process factors are therefore important if you are to avoid problems with the rolls cracking. We suggest that you look closely at the following aspects.

- The thickness of sheet after baking, since both increases and decreases in thickness may cause cracking. Thinner sheets are particularly prone to cracking. Pay attention to any changes in sheet thickness that may have arisen from changes in batter density, lower or higher, from changes in mixing times or from different levels of air injection in continuous mixers.
- Since baking powder action makes a significant contribution to roll thickness you may wish to examine the level that you use. The rate at which the carbon dioxide is released varies according to the type of acid that is being used and you may wish to check that you are using the same acid each time. There is some release of carbon dioxide gas while the batter stands before depositing and so any significant variation in batter standing time can have an effect on final product volume.
- You should check your deposit weight control to ensure that there are no significant variations. Remember that the deposit weight for a given unit area with Swiss roll batter is low and so even small variations may have a significant effect.
- Avoid unnecessary drying of the roll during baking. This may come from longer baking times, higher baking temperatures or higher air velocities in some types of oven. Variations in batter formulation and aeration will also have an effect on the final roll moisture content. Remember that a thinner deposit will bake to a lower moisture for a given set of baking conditions.

10.37 What causes sponge sandwiches to assume a peaked shape during baking?

There are a number of different reasons why this problem should occur but a particularly common one is associated with the conditions in the oven during baking. Often the condition is caused by too rapid a heat transfer to the batter. In all baked products heat is transferred from the surface to the centre and in the case of round products much of the heat transfer is along the radii from outer edges to centre. In the case of round sponges the surface area is large relative to its thickness so that a small portion of batter in the centre is the last to bake and the considerable expansion forces present exploit the radial effect and force the sponge to peak.

The most obvious sources of too rapid a rate of heat transfer are as follows:

- Too high a baking temperature in the oven. Robb (1987) showed that sponge cake peaking was entirely dependent on baking temperature and independent of baking time. The solution is to lower the baking temperature but you may also have to increase the baking time in order to remove sufficient water from the product.
- Excessive top heat, particularly in deck ovens. The high radiant heat component in such cases acts like too high a baking temperature. In such cases the ‘baking temperature’ may appear to be satisfactory. If you cannot balance the heat components in your oven steaming the chamber before you are ready to bake is a good way of removing excess radiant heat.
- In the case of ovens that bake by forced air convection too high an air velocity can cause the product to peak. Cauvain and Screen (1988) showed that high air velocities in forced convection ovens increased sponge cake peaking even when the temperature was ‘normal’.

Other possible reasons for the problem include the following:

- Over-treatment of the flour, either from excessive chlorine treatment (see 2.10) or excessive heat treatment (see 2.9). In the latter case you might also expect that the flour has a ‘burnt’ odour which may carry through to the product. If you suspect that this may be the cause we suggest you discuss the problem with your flour supplier.
- A lack of carbon dioxide gas because the baking powder level is too low or because the rate of reaction has been too fast and much of the carbon dioxide gas has been lost before the batter reaches the oven.
- Insufficient mixing so that there are too few gas bubble nuclei present in the batter for carbon dioxide inflation.

References

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10.38 How do we convert a plain sponge recipe to a chocolate form?

The use of the term 'chocolate' to describe a cake varies a little around the world and is often regulated in some way. For example, in the UK chocolate can be used as a cake descriptor only if the final product contains not less than 3% dry, non-fat cocoa solids (LAJAC, 1963). This is usually achieved through the addition of cocoa powder and when calculating the level to use in a recipe allowance must be made for variations in moisture (usually around 5%) and fat (commonly between 10 and 20%).

The calculation is quite straightforward, as shown by the following example:

- Cocoa powder contains 5% moisture and 15% fat.
- The required dry, non-fat solids are 3%.
- The mass of cake crumb after baking is 100 kg.

The quantity required is given by $\frac{3 \times 100}{100 - 5 - 15} = 3.75\,\text{kg}$

It is wise to increase the level of added cocoa powder slightly so that any variations in cocoa composition or cake moisture content are taken into account. Thus in the above example the level of cocoa powder could be increased to 4 kg.

The addition of cocoa powder should be considered as 'flour' for the purposes of recipe balance. It is common practice to add extra water along with the cocoa powder (Cauvain and Cyster, 1996). For the example given above the addition of 2 kg extra water would be recommended. Without this extra water addition the batter would be very viscous and may become difficult to process in the normal manner.

Even with the addition of extra water chocolate cakes tend to be more dry eating than the equivalent plain form. It helps to increase added oil or fat levels slightly, or to add glycerol. There may also be some loss of volume in chocolate sponge; this can usually be compensated for by slightly raising the added emulsifier or baking powder levels.

Often chocolate batters may contain an excess of sodium bicarbonate to yield alkaline cake which helps enhance the chocolate colour in the final product.

References

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