11

Biscuits

11.1 What is 'vol' and what is its function in biscuit doughs?

Vol is a baker's term that is applied to ammonium carbonate. It is used as an aerating agent and does not require the addition of an acid in order to evolve carbon dioxide. It also differs from other aerating agents in that it evolves almost no gas in the cold and decomposes under the influence of heat to yield three gases: ammonia, carbon dioxide and water vapour (steam).

The evolution of ammonia restricts the use of vol. Ammonia is readily soluble in the liquid phase and will remain in the product if sufficient water remains after baking. This is the case with cakes where the use of vol will leave an unpleasant ammonia taste and smell. In biscuits, however, the degree of heat input required to drive off almost all of the water ensures that the majority of the ammonia is also driven off so that the effect on taste and flavour is not detectable.

There are a number of reasons why vol has been used in the baking industry:

- The volume yield of gases is considerable for a given weight of material.
- The complete decomposition and the absence of an aerating acid means that there are no salts left in the product that may yield unacceptable flavours.
- The minimal release of gas in the cold permits the mixing of large batches of dough and extended processing times without significant change in paste density or loss of aeration before baking.

11.2 From time to time we have noticed a white discoloration on the surface of our all-butter shortbread. Why does this occur?

The discoloration that you have observed is the phenomenon commonly referred to as ‘fat bloom’. It is the formation of small crystals of fat on the surface of the biscuit and occurs mainly as the result of temperature cycling during storage, that is periods of warmth and cold such as may occur in unheated locations subject to the effects of ambient temperature fluctuation.

Fat crystals may exist in a number of different forms (see 3.1). Since their size may be as small as 5 μm only agglomerates of fat crystals can be seen with the naked eye. The formation of crystal agglomerates is encouraged by rapid cooling, such as might be experienced when the products are quickly chilled after baking. Similar conditions may occur if a warm product is placed into a chilled environment. A similar problem may be seen with chocolates that have become too warm in periods of hot weather and then placed in a refrigerator to cool.

To minimise the problem you should examine your cooling technique and try to cool more slowly, or eliminate forced air cooling. Also consider whether you can pack in a warmer environment. You should record the typical storage temperature history of the product, looking for any fluctuating periods of warmth and cold and eliminate, or at least minimise, these.

If none of these considerations is relevant you might tackle the problem by introducing a small portion (say about 5%) of a low melting point butterfat fraction or oil into the product. This will help to reduce the tendency for the fat to recrystallise.

11.3 We produce biscuits containing powdered fructose which we cream with the fat and sucrose before adding the other ingredients. Recently we have seen the appearance of brown spots on the product. What causes this effect?

The most likely cause of your problem is associated with the creaming of the fat and the sugars. It is likely that some of the fructose that you are adding has become so coated with fat that it cannot dissolve in the limited amount of water that is available in the biscuit dough. This leads to excessive browning during baking.

To avoid the problem you could dissolve the powdered fructose in the dough water before mixing. Or you could change to a fructose syrup, remembering to re-balance the sugar solids and water content of the recipe.

Similar brown or dark spots may arise if you are using very large crystals of sucrose which do not dissolve completely and lead to the problem sometimes described as ‘sugar burn’.

Dark spots may also originate from undissolved aerating acids in the mix. For example, acid calcium phosphate is sparingly soluble and can hydrolyse on the surface of baked goods to give free phosphoric acid. The acid can carbonise carbohydrates during baking, giving rise to dark spots where the phosphate is concentrated. Often the problem is alleviated by changing to a finer form of the acid concerned so that there is better dispersion. Should the dark spots still form they are usually too small to be detected by eye.

11.4 Our chocolate-coated wafer biscuits are prone to cracking. Why does this happen and how can we avoid the problem?

The most likely cause of your problem is the absorption of water by the wafer and its subsequent expansion. We suggest that you look closely at the quality of your enrobing practices because any uncoated areas or even pin-prick holes in the coating provide access points for water from the atmosphere.

The moisture content of wafers is very low in order that they will have a crisp eating quality. The ERH of the wafer is also very low and much lower than the relative humidity of most atmospheric conditions. This means that the natural driving force is for water from the atmosphere to condense on exposed wafer surfaces where it will be absorbed and diffuse through the sheet. As the moisture level rises the wafer will begin to expand and exert so much pressure on the inelastic chocolate coating that the latter will split. Barron (1977) showed that for each 1% increase in moisture, wafer sheets expanded by between 0.33 and 0.42% of the original dimension.

The time taken for the cracks to become manifest will vary according to the completeness of the coating and the initial wafer moisture content. The relative humidity of the surrounding atmosphere will also affect the rate of wafer expansion: the higher the relative humidity, the greater the relative humidity differential and the faster the transfer of moisture. One way to limit this effect is to ensure that the wrapping of the final product is tight and so has a minimum volume of air around the product.

Reference

BARRON, L.F. (1977) The expansion of wafer and its relation to the cracking of chocolate and 'bakers' chocolate' coatings. *Journal of Food Technology*, **12**, 73–84.

11.5 We are experiencing intermittent problems with gluten formation in our wafer batter. What causes this problem?

Gluten development is undesirable in wafer batters because it can lead to blockages in pipes or nozzles of batter distribution systems. This can lead to uneven distribution of batter on the plates and the incomplete formation of wafer sheets.

Gluten formation depends on three main factors: the presence of protein in the flour, the hydration of that protein from the addition of water and the input of energy during mixing. In batter systems the ratio of water to flour solids is usually high enough to lower batter viscosity to such an extent that gluten formation should not occur (Cauvain and Young, 2000). However, wafer batters are often pumped and recirculated through holding tanks to prevent separation of the solids while they are standing and this may cause shear in a number of areas of the pipework. Shear leads to work and subsequently gluten formation.

Since the recirculation of wafer batters is a practical expedient then the ingredient specification or batter formulation will have to be changed to alleviate the problem. Lowering the overall protein content of the flour used is the most obvious way of reducing the potential for gluten formation. This may be achieved by using weaker or softer milling wheats. Alternatively you could use a low-protein, starch-rich fraction from an air-classified flour. Typically this would equate to particles in the range 15 to 40 μm.

Alternatively you could replace a portion of your standard flour with a heat-treated flour. Heat treatment denatures the protein and restricts its gluten-forming potential (see 2.9) but will affect water absorption, and an increase in the water addition will be necessary in order to maintain a standard batter viscosity. Another way to reduce gluten formation would be to replace a portion of the standard flour with wheat or some other suitable starch.

Lowering the protein content of the flour used in your batters may have an adverse effect on the wafer strength, making them more fragile and so more prone to physical damage.

Reference

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

11.6 A batch of our biscuits containing oatmeal has developed a 'soapy' after-taste which makes them unpalatable. Why is this?

The soapy taste that you observe is almost certainly the result of lipase enzyme activity in either the dough before baking or in the baked product during storage. Oats are prone to this problem because of the high level of lipase enzyme activity which is naturally present. Lipase splits fats into fatty acids which react with the sodium bicarbonate to yield the soapy flavour. The most common way of avoiding this problem is to use only oat products in which the lipase activity has been eliminated. This is achieved by steaming the oats and you should specify this to your supplier. Steaming should not have any adverse effects on the functionality of the oats, which is limited in biscuit making.

You should also examine your dough mixing and processing to ensure that there has been no incorporation of scraps of old dough or dough that have become heavily contaminated with microorganisms, which also have the potential for considerable lipase activity.

As commented above the lipase activity can have a microbial origin and so could also come from post-baking contamination. In normal circumstances the water activity of an oatmeal biscuit is too low to support microbial activity because of its low moisture content. However, if there has been any condensation on the surface of the biscuit then the water activity might have become high enough to initiate the necessary microbial activity. You should consider whether there have been any opportunities for warming and cooling that may lead to condensation in the pack.

Oat-based products may also develop off-odours and bitter tastes because of oxidative rancidity. In this case the low water activity in the product encourages the problem, along with exposure to light and traces of certain metals, e.g. iron and copper. Oxidative rancidity is normally a lengthy process, taking many weeks or months to become manifest. The inclusion of a suitable anti-oxidant in the fat is usually helpful in avoiding this problem.

11.7 How do biscuits and crackers get broken during storage, even if they are not disturbed?

The problem you describe is the one commonly referred to as 'checking' and is related to the distribution of moisture in the baked biscuit or cracker. It was first studied and the reasons for the problem reported by Dunn and Bailey (1928).

After leaving the oven the moisture remaining in biscuits and crackers is unevenly distributed. In particular, the edges and upper and lower surfaces have a much lower moisture content than the centre. During storage the moisture migrates from the higher moisture content centre to the drier areas in order to achieve equilibrium. This movement of moisture sets up a series of stresses and strains in the product which, because the product is inflexible, can be of sufficient force to crack the surface. In some severe cases the biscuit may completely break into a number of smaller pieces. The cracks develop along weaknesses in the product structure, many of which are microscopic in size.

The best means of avoiding this problem is to ensure a minimum of moisture gradient in the baked product. This commonly means baking at lower temperatures for longer times. Alternatively you can introduce immediate post-baking drying using radio-frequency or microwave heating. Ideally the moisture differential between surface and centre should be less than 1% and average biscuit moisture contents in the order of 2–3%.

It is possible for biscuits to absorb moisture from the atmosphere but this usually leads to softening of the biscuit rather than checking.

Reference

DUNN, J.A. and BAILEY, C.H. (1928) Factors affecting checking in biscuits. *Cereal Chemistry*, **5**, 395–430.

11.8 We are making a ginger crunch cookie. Why do we experience variations in size?

Variations in biscuit size often come from variations in flow during baking. The three main ingredients that control flow are sugar, ammonium bicarbonate and flour protein level.

If you want to increase flow then you can:

- increase sugar or glucose syrup level;
- increase ammonium bicarbonate (vol) level;
- use a flour with a higher protein content.

If you wish to decrease flow then you should use lower levels of the above ingredients.

Since you are experiencing variations in flow then you should check the weights of the three key ingredients to make sure that they are being delivered consistently. If there is no problem with the weights being delivered then you should look at the flour qualities.

11.9 When making ginger nuts we find that we do not always get the degree of cracking that we would like. Why is this?

The cracks that form on ginger nuts are mostly related to the level and balance of sugar types being used. You should try increasing the level of coarse sugar or reducing the level of fine sugar in the recipe.

The oven humidity can also affect crack formation and an increase may be of some help, especially if you can introduce the humidity into the first section of a multi-section oven,

The products may exhibit poor cracking because they are flowing too much (see 11.8).