2

Flours

2.1 What effects will variations in flour protein content have on baked product quality? How is the property measured?

The protein content of flour is probably the single most important property of wheat flour. Perhaps more correctly we should refer to wheat proteins since there is more than one type of protein present. The scheme established by Osborne (1907) is most commonly used for the groups of proteins in wheat, which comprise:

- albumins, soluble in distilled water;
- globulins, soluble in dilute salt solutions;
- prolamines, soluble in 70% aqueous ethanol;
- glutelins, soluble in dilute acid.

The two most important groups for bread and fermented goods are the prolamines and the glutelins. They contain the gluten-forming proteins that give wheat flour its almost unique ability to form a dough capable of retaining gas and increasing in volume under the influence of heat and carbon dioxide gas released by yeast fermentation. The properties of wheat gluten were recognised as long ago as 1729 (Bailey, 1941).

Gliadin and glutentin are the two wheat protein components that give wheat gluten its special properties. These can best be appreciated by making a dough of flour and water and hand kneading it under running water. As time proceeds a milky-white liquid is washed out: this is the starch and other insoluble components. Eventually all that is left is a grey, light brown mass with an extensible but also an elastic character. This is the gluten and its gas retention properties can be shown by placing the mass of gluten in the oven and watching it swell. The quantity of gluten that can be extracted varies with the protein content of the flour.

Bread and other fermented product volumes are directly related to the quantity of protein present: the higher the protein content of the flour, the greater the product volume. This positive relationship has been reported by a large number of observers for many different breadmaking processes and products (e.g. Cauvain *et al*., 1985). Thus in answer to the question, variation in protein content will result in potential variations in bread and fermented product volume. They will also affect the lift obtained with laminated products but will have no significant effect on the volume of other baked products, though variations in protein content may affect other product attributes, e.g. eating quality in cakes.

Protein absorbs water, 1.3 g of water for each 1 g protein (Stauffer, 1998), and so variations in protein also affect flour water absorption.

Wheat proteins contain nitrogen, and protein measurement methods are based on that basic measurement. For many years the standard 'wet chemistry' method was the Kjeldahl (AACC Method 46-10, 1995). The method involves the acid digestion of the flour using sulphuric acid in the presence of a catalyst. The Kjeldahl nitrogen value so determined is converted to protein using a factor; for wheat this involves multiplying by 5.7. More recently Kjeldahl protein determination has been replaced by the Dumas method based on combustion in the presence of oxygen (AACC Method 46-30, 1995).

Flour protein is also commonly measured using near infrared reflectance (NIR) technology (CCFRA, 1991). This provides a fast and simple to use method which can also be applied to on-line processes in the flour mill. However, it should be noted that NIR protein is calibrated against an accepted 'chemical' method since it does not represent a fundamental measurement of protein.

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2.2 There are many references to protein and gluten quality in the technical literature: how important are these properties for bread and other baked products?

As discussed in the previous question flour protein content is probably the most important of all flour analyses because of its relationship with gluten quantity. In gluten washing experiments with different flours not only do we observe different quantities of gluten but for the same gluten mass from two different flours we may observe that the rheological character (i.e. the way it stretches and deforms) of the gluten varies.

The variations in gluten ‘quality’ from different flours are important in many aspects of baking. In particular they directly affect the way in which flours will behave when subjected to the stresses and strains of processing. The key qualities that we need to consider are:

- resistance to deformation;
- elasticity;
- extensibility;
- stickiness.

Gluten has all of these properties and is described as a viscoelastic material; that is, its behaviour can be described by considering both viscous and elastic properties.

In the production of bread and fermented goods we are seeking to preserve the gas bubble structure that has been created during mixing and to obtain a considerable degree of expansion during proving and baking. We therefore seek to have a gluten which has low resistance to deformation, minimal elasticity and maximum extensibility. Bread and other fermented doughs generally only experience problems with stickiness when they are subjected to shear, e.g. as in moulding.

The sheeting of doughs as for the production of laminated products, pastries, crackers and biscuits also requires that we have an extensible but not elastic gluten. However, since recipe water levels in such products are lower than used in breadmaking the gluten tends to have a more elastic nature. To overcome this it is common to use resting periods during processing to allow the gluten to become softer and less elastic. It is not so easy to use resting periods with fermented products because of gas production by the yeast.

In batter-type products, such as cakes, gluten quality is considerably less important, mainly because it cannot form in the initial mixing stages because the low viscosity of the system makes the transfer of sufficient energy and therefore gluten development difficult.

2.3 I have seen that there are several different methods to assess flour protein quality. Which one gives the most meaningful results?

There are indeed many ways to assess the quality of protein present in flour. Since they are all related to some aspect of baking performance they will all give meaningful results but because they all have a different basis for assessment then it can be very difficult to compare data from one test to another. The other common problem encountered is that almost without exception the methods are not based on the same formulation, mixing or processing conditions that are now in common use in baking. Indeed the basis of many of the flour quality tests originate from the days when breadmaking using bulk fermentation was the norm. Today, no-time doughmaking processes dominate and so this means that the outputs from flour quality tests need a degree of 'expert' interpretation in order to obtain the most meaningful results. Over a period of time experts can readily extrapolate from protein quality data to end product quality and so comparison between flours can be readily achieved.

Some of the protein quality tests commonly used are given below:

Farinograph

This test is based on mixing a flour and water dough under prescribed conditions. It is commonly used in the determination of flour water absorption. Evaluation of the mixing curve can supply data on protein quality using the parameters dough development time, dough stability and degree of softening.

Extensograph

In this test a flour–water–salt dough is mixed using the Farinograph. The resultant dough is moulded and rested under prescribed conditions. After resting, the dough pieces are stretched over two set pins by a moving hook. The test mimics the stretching of the dough in a craft baker's hands. The resistance to extension and extensibility to the point of the dough snapping are measured. The piece may be re-moulded, rested again and re-tested.

Alveograph/Consistograph

In the Alveograph test the water level added to the flour is fixed and after mixing the dough is extruded and shaped. After a resting period the dough is clamped over a metal ring and inflated by air pressure. The resistance of the dough to expansion and the point of rupture are recorded. Typically a curve is produced, the area of which is related to flour strength. The weakness of the Alveograph was the fixed dough water content which has now been replaced with an optimised water level in the Consistograph test but otherwise the procedure is similar.

Roberts/Dobraszczyk dough inflation

This device can be fitted to standard texture analysis machines. The dough is prepared under standard conditions and air pressure is used to inflate a bubble to the point of rupture. There are some similarities to the Consistograph.

Fundamental dough rheology measurements

A number of devices and methods are based on small-scale deformation of dough between two oscillating plates. The data can be related to fundamental rheological measurements but because dough is viscoelastic and deformation forces are so low, the relationship between such measurements and dough behaviour remains as tenuous as with other tests.

Large-scale deformation testing

A number of tests have been developed by workers seeking to mimic the behaviour of dough under normal bakery conditions more closely. The tests tend to be product (e.g. Telloke, 1991) or project specific (e.g. Cauvain *et al*., 1992) and not in common use as standard methods.

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2.4 We have been using a flour 'fortified' with dry gluten for breadmaking. The bread is satisfactory when made on a high-speed mixer but less so when we use a low-speed mixer. What is 'dry gluten' and can you explain why we get different results when we change mixers?

Dry gluten is obtained by washing out the starch from a wheat flour dough (McDermott, 1986). The rubbery mass left is known as gluten which is then carefully dried using controlled procedures which are designed to retain the maximum 'vitality' of the gluten, i.e. its ability to form gluten after hydration and dough mixing. Typically the protein content of the dry gluten will be in the region of 70–75% dry matter. Dry gluten absorbs about 1.5 times its own weight of water when it is used in breadmaking. The addition of dry gluten may be used to boost the level of the natural flour protein to improve the gas retention properties of the dough. It may be added to the flour in the mill or it may be added as a dry ingredient in the bakery. Dry gluten does not usually require pre-hydration before dough mixing.

The input of energy during dough mixing is an essential part of the development of a gluten structure capable of retaining gas during baking. Different mixers impart different levels of energy to the dough for a given mixing time and so are more or less effective at developing a gluten structure. High-speed mixers impart higher energy levels to the dough during mixing than low-speed mixers. This difference remains true even when the dough mixing time with low-speed mixers is lengthened. This is because the low speed of mixing results in a low rate of energy transfer.

Gluten development, as manifested by improved gas retention, is known to be linked with the rate of energy input to the dough with faster rates of energy input improving dough gas retention for many flours (Cauvain, 1998). This effect is especially true for gluten-fortified flours and it appears that mixers at low speeds are less able to make full use of dry gluten additions. However, the full reasons for the difference are not completely understood.

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2.5 What is the Falling Number of a flour and how is it measured? What values should we specify for our flour miller?

The Falling Number of a flour is related to the level of cereal α-amylase which is present. The production of cereal α-amylase is encouraged within the wheat grains if their moisture content is sufficiently high in the last few weeks before harvesting. Such conditions are most likely to happen if the period concerned is particularly wet.

The full name for the test is the Hagberg Falling Number test and it was originally developed in Sweden. It takes its name from the basis of the test. A flour–water suspension is heated within a tube held in a boiling water bath. The mixture is stirred for 60 s to ensure uniformity of the mixture. At the end of the stirring period the stirrer is brought to a predetermined point at the top of the tube, released and the time taken for the stirrer to fall through the mixture to a lower fixed point in the test tube is measured. The time taken for the stirrer to fall down the tube is known as the Falling Number.

The test is based on the action of the cereal α-amylase on the starch present in the flour. The temperature in the test is designed to give maximum enzymic activity in the flour–water mixture and quickly changes according to the level of cereal α-amylase present; the higher the cereal α-amylase level, the quicker the flour–water paste thins, the faster the stirrer falls and therefore the lower the Falling Number.

The higher the cereal α-amylase level, the greater the formation of dextrins during breadmaking and so the more likely that there could be problems with bread slicing. In bulk fermentation high cereal α-amylase levels will lead to dough softening.

The Falling Number includes the 60 s stirring time so that the lowest theoretical number is 60. In practice Falling Numbers over 250 are suitable for most breadmaking processes. As well as having too much cereal α-amylase activity it is possible to have too little and Falling Numbers above 350 indicate that the flour should be supplemented with a form of amylase (see 4.5). We suggest you specify that your Falling Number lies between 250 and 280, though the actual level you require will be specific to your products and processes.

2.6 What is damaged starch in flour? How is it damaged and how is it measured? What is its importance in baking?

Starch granules in flour have a flattened, roughly spherical shape which is sometimes described as lenticular. They range in size from about 10 to 50 μm. Each starch granule has a surface or skin.

Within the developing wheat grains the starch granules are embedded in a protein matrix in the endosperm. During the flour milling process the endosperm is fragmented by the action of the milling's rolls or stones. Some of the starch granules are exposed to high pressures during the milling process and their surfaces may be become mechanically ruptured or damaged. The damage to starch granules typically occurs during the reduction (smooth rolls) stage of roller milling. Here the gaps and speed differentials between the rolls may be adjusted to give more or less starch damage according to the requirements for the final flour.

Damaged starch is susceptible to attack by α-amylase (see 4.4) and this action provides the basis for the different methods that have been and continue to be used for the measurement of the damaged starch level in flours. A long-standing method based on the enzymic hydrolysis of starch was that devised by Farrand (1964) and for many years the level of damaged starch in flours was referred to in Farrand Units (FU). More recently the most important methods of measuring damaged starch are:

- the Megazyme method based on a two-stage enzymic assay (Gibson *et al*., 1992);
- the AACC method (Donelson and Yamazaki, 1968; AACC, 1995) based on digestion of the damaged starch by fungal α-amylase with the value expressed as a percentage.

The importance of damaged starch is mainly for breadmaking. Damaged starch absorbs twice its own weight of water in contrast with undamaged starch which only absorbs around 40% of its weight. This high water-absorbing capacity means that the damaged starch may account for about 16% of the total flour water absorption, a value similar to that for the protein itself (Stauffer, 1998). The contribution that damaged starch makes to flour water absorption has made it an essential element of flour specifications.

The upper limits for starch damage are not well defined or understood. The link between damaged starch and α-amylase activity is an important one since excessive amylase activity leads to dextrin formation and the release of water into the dough which, in turn, causes softening. Breadmaking processes employing periods of bulk fermentation are more likely to experience such problems than most no-time systems.

Very high levels of starch damage may lead to loss of bread quality, including a more open (larger average size) cell structure and greying of the crumb colour. Farrand (1964) observed such quality losses and related the starch damage and flour protein levels. His premise that the damaged starch level should not exceed protein^2 divided by 6 is no longer relevant but the principle that the higher the flour protein, the higher the starch damage that can be accommodated remains a relevant 'rule of thumb'.

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2.7 We find that we often have to adjust the water level we add to our flours in order to achieve a standard dough consistency. What are the factors that cause the water absorption capacity of flour to vary?

The water absorption capacity of a flour depends on a number of different flour properties, including the following:

- The flour moisture content – the lower the moisture content, the higher the water absorption.
- The flour protein content – the higher the protein content, the higher the water absorption.
- The level of added dry gluten in the flour – dry gluten absorbs about 1.5 times its own weight of water so that if it has been used to supplement the protein level in the flour the water absorption may be somewhat higher than expected from indigenous protein levels.
- The flour damaged starch level – the higher the level of damaged starch, the higher the water absorption (see 2.6).
- The flour pentosan level – the higher the pentosan level, the higher the water absorption.
- The bran content – the higher the bran content, the higher the water absorption. This is one reason why more water must be added to wholemeal flours than to white flours.

In addition the level of enzymic activity in the flour may affect the apparent flour water absorption because of softening that may occur, especially during any periods that the dough stands in bulk.

A number of workers have studied the factors that may affect flour water absorption (Farrand, 1964) and several have derived equations to predict water absorption from measured flour properties (e.g. Cauvain *et al.*, 1985).

Other reasons why the added water level may vary include the following:

- Variations in partial vacuum levels in the Chorleywood Bread Process (CBP); lower mixer headspace pressures result in doughs that are 'drier' to the touch.
- Variations in dough final temperature since the viscosity of dough increases when the temperature goes down.

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2.8 Why is flour particle size important in cakemaking?

White flour that is used in cakemaking is composed mainly of endosperm fragments that have been separated from the surrounding bran during the milling process. The maximum particle size is fixed by the screen sizes in the plansifters in the mill but typically falls around 150 μm. If we were to examine a straight run white flour we would find some fragments of the original protein matrix (less than 15 μm), some starch granules freed from the protein matrix (up to 45 μm), with the remainder being endosperm fragments of varying sizes.

In cakemaking the wheat starch plays a significant role in forming the cake structure as it controls the batter viscosity during heating and helps retain the expanding gases, carbon dioxide (from the baking powder), air (trapped during mixing) and steam (from the added water). This is particularly true for the so-called high ratio flours which may undergo further treatment with heat or chlorine gas in order to enhance their cakemaking properties.

Many of the key processes in cakemaking depend on the surface activity of many materials and so increasing the surface area of the available starch becomes important in aiding stability of the batter. The separation of the starch granules from the protein matrix can be readily achieved by re-grinding and/or air classification. The aim of re-grinding is to free the starch granules from the surrounding protein and lower the maximum particle size of the flour, typically to less than 90 μm.

Air classification enables fractionation of the flour into components with narrow particle size ranges using air currents. Two or three fractions may be separated using this milling technique. Typically the cut-off points in the air classifiers are set to deliver fractions as follows:

- Less than 15 μm, comprising fragments of free wedge protein and small starch granules. The protein content will be very high, typically more than 20%.
- Between 15 and 45 μm, comprising mainly starch granules and smaller fragments of endosperm. The protein content will be low, typically around 8%.
- Greater than 45 μm, comprising the large fragments of endosperm. The protein content is usually close to that of the base flour, typically around 10%.

Cauvain and Muir (1974) provided a comprehensive study of the effects of changing the particle size of cakeflours and show that treated flours without particle size reduction yielded cakes that collapsed during baking and had a dense cell structure (Fig. 4). Progressive reduction of the maximum particle size decreased the degree of collapse in the cake. They considered that the maximum particle size for cakeflours should be 90 μm. They also showed that the application of heat treatment or chlorination to the flour could be carried out before or after particle size reduction, which emphasises the importance of flour particle size in cakemaking. Cauvain and Hodge (1977) showed that a

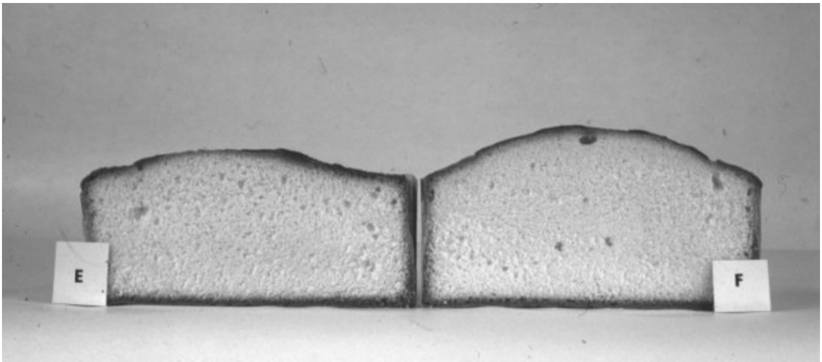

Fig. 4 Effect of flour particle size on cake quality.

significant proportion of larger particles in cakeflours could also be responsible for collapse in sponge cakes.

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2.9 What is heat-treated flour and how can it be used?

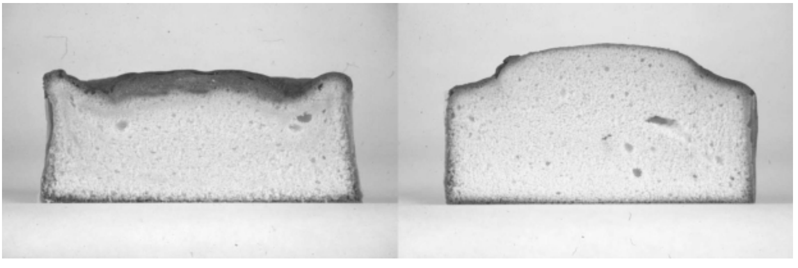
The modification of wheat to produce heat-treated flour or the direct heat treatment of flour may be used to achieve a number of different changes in the final flour properties. We can broadly classify the type of heat treatment as wet (steam) or dry.

Steam treatment of wheat is commonly used to inactivate the enzymes present so that the subsequent flour may be used as a thickening agent, for example in the production of soups. Without inactivation any cereal α-amylase that is present would act on the damaged starch and the subsequent release of water would cause thinning of the soup.

Steam treatment of both wheat and flour may be used to induce a degree of gelatinisation in wheat flour which helps with its potential function as a thickening agent. Steam treatment may also have a small reducing effect on the numbers of viable microorganisms present in the flour but the treatment is usually insufficient to sterilise the material.

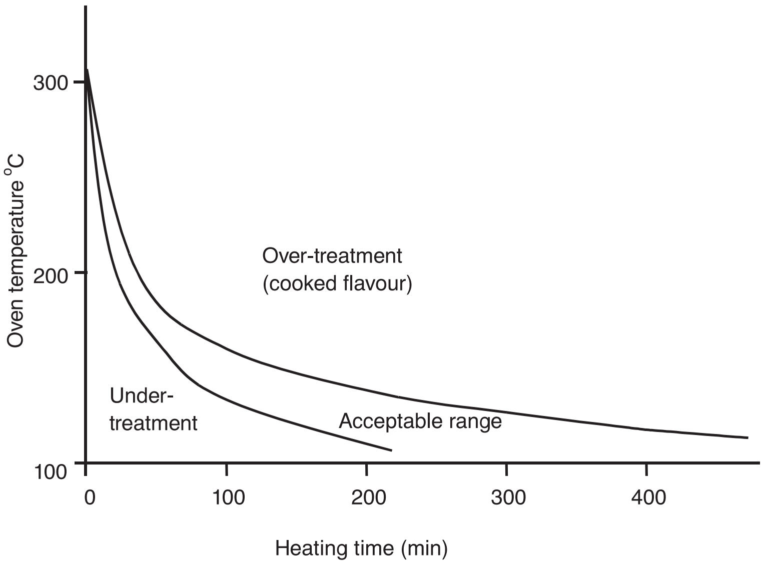
Dry heat treatment of wheat and flour has a long history. In the earlier years of the 20th century it was used to modify the extensibility of gluten from some wheat varieties (Kent-Jones, 1926) but such uses are no longer in common practice. The main application of dry heat treatment to wheat and flour is in the preparation of high ratio cakeflours as an alternative to chlorination (see 2.10). A number of patents were developed that established the necessary heating conditions required to achieve the necessary modification of flour properties (Doe and Russo, 1968; Cauvain *et al.*, 1976). The cakes illustrated in Fig. 5(a) use an untreated flour (left) and a flour from a heat-treated semolina (right), while the graph (Fig. 5(b)) shows the effect of the relationship between oven (heat) temperature and heating time (Cauvain *et al.*, 1976). Treatment temperatures normally exceed 100 °C, rising to around 140 °C as the treatment temperature increases the residence time required to achieve the modification decreases from several hours to a few minutes.

The mechanism of the improving effect from dry heat treatment is not clear but is likely to be associated with some modification of the surface properties of the starch present in the final flour. At the end of the treatment process the flour



(a)

Fig. 5 Effect of flour heat treatment on cake quality.



(b)

Fig. 5 Continued.

is very dry and it is clear that the loss of moisture is associated with achievement of the necessary changes in the flour (Cauvain *et al.*, 1979), but the low moisture content of the flour is not part of the mechanism of improvement. When the dry flour is rehydrated considerable heat is given off – known as heat of hydration – and unless compensatory steps are taken, this may lead to undesirable increases in cake batter temperatures and premature release of carbon dioxide gas.

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2.10 What is chlorinated flour and how is it used?

The treatment of flour with chlorine gas was first identified in the 1920s and was used for the modification of the cakemaking properties of flours for many years in the UK, the USA, Australia, New Zealand, South Africa and many other countries. The use of chlorination for cake flour treatment was withdrawn from the UK in 2000 (The Miscellaneous Food Additive (Amendment) Regulations, 1999). It remains permitted in many other countries.

Chlorine treatment of flour permits the raising of recipe sugar and liquid levels to make the so-called high-ratio cake (i.e. a recipe in which the added sugar and water levels both exceed the flour weight). The principal benefit of the high-ratio cake recipe is that product moisture levels can be increased without adversely affecting the mould-free shelf-life of the product. The higher moisture level confers a more tender eating quality to the final product. If the flour has not been chlorinated and used with a high-ratio recipe then the cake structure will collapse, with loss of crumb structure, the formation of dense, dark coloured streaks and the product eating quality becomes pasty (Fig. 6).

Chlorine treatment of flour is achieved by mixing and blending the gas through the flour. Typical levels of treatment lie between 1200 and 2500 ppm chlorine based on flour weight. The higher levels are commonly used to treat flour intended for the manufacture of fruited cakes. The gaseous treatment has a number of effects on flour quality but only a small proportion of the gas used actually confers the beneficial effects to the flour. In summary the chlorine gas is used as follows:

- Around 50% of the level used is absorbed by the flour lipids (typically around 2% of the flour mass) but appears to play no significant part in the improving action.
- Around 25% denatures the flour proteins (i.e. prevents the formation of gluten) but plays no major role in the cake-improving effect.
- The remaining 25% or so reacts with the starch granules and this is the main cake-improving effect. It appears that the chlorine reacts with the proteins associated with the starch granules and makes them more hydrophobic. There is also evidence that chlorine treatment increases the exudation of amylose

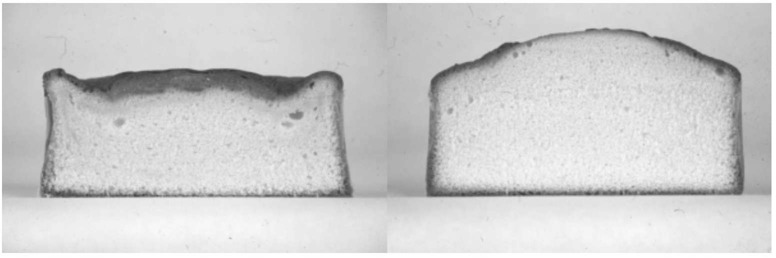

Fig. 6 Effect of chlorination on cake quality.

from within the starch granules (Telloke, 1986) but that there is no change in the gelatinisation temperature of the starch (Cauvain *et al*., 1977).

- The action of chlorine is to bleach the flour pigments so that a whiter flour and brighter product crumb colour result.
- The flour pH is lowered and commonly used as a crude measure of the level of chlorination achieved. More accurate assessment of the level of chlorine treatment requires the use of a chloride meter.

In the UK and elsewhere the heat treatment of flours for cake making has replaced chlorination (see 2.9).

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2.11 We have two supplies of wholemeal (wholewheat) flour: one is described as 'stoneground' and the other comes from a roller mill. Why is the bread we obtain from the stoneground flour often smaller in volume?

The fundamental difference between roller-milled and stoneground wholemeal flours is related to the size distribution of the particles that form the flour. These particles come from the bran, germ and endosperm components of the wheat grain. Overall roller-milled wholemeal flours tend to have a greater proportion of endosperm released as white flour compared with stoneground flours.

While stoneground flours may be milled to coarser or finer average particle sizes it is difficult to provide flours in which the particle size distributions of the bran and endosperm (white flour components) differ. In bread baking the particle size of the bran can have an important effect on bread quality, with larger bran particles being less deleterious to bread volume than fine ones (Cauvain, 1987). Collins and Hook (1991) studied the effects of the particle size distribution of roller-milled and stoneground wholemeal flours on bread quality and found that loaf volume increased with increasing fineness of the endosperm particles.

Thus there may be more than one reason why you are experiencing the loss of volume with the stoneground and so you should measure the particle size distribution of the flour concerned. While coarser bran particles are desirable, coarser endosperm particles are not.

In order to overcome the loss of product volume with the stoneground flour you may wish to consider using a high-protein flour or making adjustments to your formulation or improver level if you use one.

References

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2.12 Some wholemeal flour we have had in stock for a while has passed its use-by date. Can we still use it?

The quality of all flours changes with storage time; in some cases the changes may be advantageous and in others detrimental. Wholemeal flour has a higher lipid content than white flours and is more prone to problems associated with rancidity. The low moisture content and water activity of wholemeal flour will ensure that microbial spoilage is unlikely to occur. There is a potential for rancidity from enzyme-catalysed changes in the flour oil and this is a key factor in limiting its shelf-life. The other point to consider is the potential for insect infestation. We recommend that you do not use the wholemeal flour in question and try to implement more strict control on your flour stocks to avoid a similar problem in future.

Most of the studies in the long-term storage changes in flour have used white flours. As storage time increases, the breadmaking potential of white flours changes and a progressive loss of volume in the final product is likely. Such changes take place slowly and appear to be associated with changes in the flour lipid composition and in particular with the release of free fatty acids (Bell *et al.*, 1980). The loss of volume may be overcome with the addition of extra fat or some other form of lipid, e.g. emulsifiers (Bell *et al.*, 1976, 1980). The restoration of the breadmaking potential of white flours through the addition of a suitable lipid, e.g. higher levels of breadmaking fat or a suitable emulsifier, could be achieved with white flours even after they had been stored for 48 months (Collins *et al.*, 1992).

Historically, long-term storage of flours has been used to enhance the baking performance of flours. This appears to be in contradiction to the findings described above, but it should noted that there has been a fundamental change in breadmaking processes in the last 100 years with a move from bulk fermentation to no-time dough systems. With the latter breadmaking systems, the role of fat in assisting gas retention is more critical and this may account for the apparent reversal of the storage effects.

The cakemaking qualities of flours are also considered to improve with long-term storage and some natural bleaching appears to occur.

References

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2.13 What are the active components in self-raising flour?

Self-raising flours contain sodium bicarbonate and a suitable food grade acid. When used in baking the bicarbonate and acid react to generate carbon dioxide gas. Self-raising flours are most commonly sold through the retail trade and find greatest use in the domestic market. They may be used in smaller bakeries as an alternative to separate additions of plain flour and baking powder.

The level of added baking powder is usually governed by a form of regulation that specifies the volume of carbon dioxide gas that is evolved at the point of final use. Since there may be a small degree of reaction between the active components and loss of carbon dioxide gas during the relatively long storage periods for such flours, the rates of addition to the fresh flour will be somewhat higher than required by legislation. For example, the UK Bread and Flour Regulations (1996) specifies that self-raising flour should yield not less than 0.4% of available carbon dioxide but commonly rates of addition will deliver around 0.8% when freshly prepared. The latter level equates to 1.56% of the flour weight being sodium bicarbonate.

A number of different food acids may be used in the production of self-raising flour. They include:

- acid calcium phosphate (ACP), monocalcium phosphate (MCP);
- sodium acid pyrophosphate (SAPP);
- sodium aluminium phosphate (SALP);
- cream of tartar, potassium hydrogen tartrate;
- glucono-delta lactone.

Each acid component will be added according to its neutralising power with sodium bicarbonate (Thacker, 1997). The rate at which carbon dioxide gas is released depends on the type of acid being used. Sometimes a mixture of two acids may be used to provide a so-called 'double-acting' baking powder which provides for both early and late carbon dioxide release.

References

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THE BREAD AND FLOUR REGULATIONS (1996) SI 1996/1501, HMSO, London, UK.

2.14 What are 'organic' flours, how do they differ from other flours and what will be the differences to the baked product?

The term 'organic' refers to the manner in which the wheat has been farmed and turned into bread and flour. Organic farming uses more traditional methods of treating the land during the farming cycle and in particular does not use 'artificial' fertilisers and restricts applications of pesticides, insecticides or herbicides. Organic wheats will be segregated and milled separately from other types.

In principle any breadmaking wheat types may be used in the production of organic wheat flour. However, since the farming process relies totally on the application of natural fertilisers there is a tendency for the protein of many wheat varieties to be lower than that which could be obtained with non-organic farming methods. Currently the UK production of organic wheats is too low to sustain the market requirements and much of the wheat is imported. Large quantities of organic wheat come from North America where the fertility of the soil and the larger growing areas have not necessitated the use of the more intensive farming methods seen in the UK.

The lower protein of some organic flours may present a potential problem for the production of bread of similar volume to that typically seen with non-organic flours. The other ingredients that may be added to manufacture organic bread are closely specified and many must also come from organic sources, e.g. dried gluten which could be used to boost bread volume. You should consult the Soil Association or similar body for advice. In the event that you wish to make organic bread you will need to obtain the necessary accreditation from a specified body.

In summary you should not expect organic baked products to be substantially different from non-organic ones. However, you may need to make some adjustments to your formulations in order to maintain product quality.