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A GUIDE TO THE EFFECTS OF THE MAIN INGREDIENTS USED IN CAKE AND SPONGE RECIPES

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The definition of cake varies in different parts of the world (sometimes called 'fine bakery wares') but most types are characterised by recipes based on wheat flour, sugar and whole eggs and milk or water, commonly with the addition of fat or oil. The level of added liquids is such that a relatively low viscosity 'batter' rather than a dough is formed. Commonly cake batters have to be baked in a mould, pan or tin in order to give form and shape to the final product. There is usually much less processing required for cake batters before baking than for bread doughs.

Modern cakes are characterised by being relatively low density products, typically 0.4–0.7 mlg^{-3}, with a tender-eating, friable crumb and sweet taste. In general, they are intended to have a sweeter taste than bread and other fermented products. Their final moisture contents typically lie in the region of 18 to 28%, lower than that of bread but higher than that of pastries, biscuits and cookies. The organoleptic and mould-free shelf-life of cake products varies according to their formulations.

The formation of a particular cake structure depends to a large degree on the ratio of the main ingredients used in the recipe and the way in which the different ingredients interact with one another in the formation of the initial batter and the heat input during baking. The interactions are complex and sometimes difficult to predict but there are some basic principles which have evolved with time and study which can be used as a basis for constructing cakes recipes and optimising cake quality.

Cakes are made by first forming a complex emulsion and foam which is then processed by being heat set in the oven. As a broad generalization cake batters may be considered as fat, or oil, in water emulsion systems (except those containing no added fat or oil). The aqueous phase in the batter comprises the dissolved sugar and suspended flour particles; the water may come from the liquid egg, milk, any water containing ingredients and the separate addition of water.

Air bubbles are incorporated into the batter during mixing. Several mechanisms (discussed in more detail below) are associated with air incorporation and bubble stabilisation in cake batters. The main ones involve the egg proteins, solid fat (at batter temperature) and emulsifiers such as glycerol mono-stearate (GMS).

There is no significant gluten formation in cake batters and indeed cake making technology commonly exploits positive steps to limit gluten formation. The key structure forming component of cakes is the starch contributed by the wheat flour and the modification of its gelatinisation characteristics through the addition of sugars and high levels of liquids (egg, milk, water) or by some form of flour treatment.

Air Incorporation and Gas Bubble Stability

Air incorporation and gas bubble stability are critical elements in delivering final cake quality as they contribute directly to product volume and cell structure, which in turn influence softness, eating quality and shelf-life. In a similar manner to that seen with fermented products, total aeration is achieved through the incorporation of air during mixing supplemented with the release of carbon dioxide gas, in the case of cakes from baking powder rather than yeast. The incorporation of air during cake batter mixing, unlike bread dough, does not rely on the development of a gluten network and in many respects is more complicated than that of fermented products.

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In a simple cake recipe comprising flour, sugar and whole egg, it is the egg proteins which provide the basic air incorporation and gas bubble stabilising mechanism. As the mixing tool (whisk or beater) is drawn through the batter, small air bubbles are incorporated on the trailing edge. Once in the batter, the egg proteins for a protective film around the air bubbles thereby entrapping them, without this mechanism the air bubbles would gradually rise to the surface of the batter and escape to the surrounding atmosphere. As the batter is warmed during baking the trapped bubbles expand and begin to coalesce (join together) to form larger and larger bubbles which eventually become the cells which are visible in the crumb of the final product.

Fats and oils are common ingredients in cake making which are added to modify the eating qualities of the product. However, in the preparation of the batter low levels of these fats and oils will often displace the egg proteins at the interface of the air bubble and while they may keep the bubbles trapped initially, the batters tend to become unstable as the temperatures rise in the oven and the cakes may lack volume or in some cases may collapse entirely. Increasing the level of added fat will contribute to improved gas bubble stability as the fat takes on the major role in stabilising the gas bubbles. However, it is important to ensure that the appropriate form of fat is used, principally that portion of the fat which will remain 'solid' component at batter preparation temperatures and in the early stages of baking (see below).

An alternative to aiding the incorporation and stability of the air bubbles is through the use of emulsifiers (see below). Emulsifiers can be used at lower levels than fat and also allow the more effective use of liquid oils. The stability of the gas bubbles incorporated into the batter is considerably strained in the early stages of baking in the oven. In part this arises because the bubbles expand as the result of the increased temperature and in part through the release of carbon dioxide gas from the reaction of any baking powder additions (see below) and these are critical times for cake volume and cell structure formation.

Categories of Cakes

Cakes may be classified into six arbitrary categories:

- *Low-fat sponges* containing less than 5% fat.
- *High-fat sponges* containing more than 5% fat.
- *Low-ratio cakes* in which the level of sugar and liquids in the recipe are individually less than the flour weight.
- *High-ratio cakes* in which the level of sugar and liquids in the recipe are individually greater than the flour weight. Commonly the flour used in the manufacture of high ratio cakes will have been subjected to some post -milling treatment (see below).
- *Fruited cakes* which have a proportion of dried vine fruits, fresh fruit, nuts or other particulate materials in the recipe.
- *Chocolate cakes* containing a proportion of cocoa solids (in some cases the term chocolate when applied to cakes may be the subject of legislation or formal guidance – readers are advised to check the position with respect to the markets in which they are selling products).