2
Classification of biscuits

2.1 Introduction

Scientists and technologists love to classify things but unfortunately they find that products or articles based on natural products tend to form groups that overlap, thus confounding neat definitions. Biscuits are no exception! The problem even arises in any attempt to define the word 'biscuit'. It is generally recognised that these products are cereal based and baked to a moisture content of less than 5%. The cereal component is variously enriched with two major ingredients, fat and sugar, but thereafter the possible composition is almost endless. Some problems come in defining the boundaries between biscuits and cakes, or between biscuits and sugar confectionery. One may reasonably consider that boundaries are unimportant: this might well be true until the authorities decide that different packaging declarations, different weights or different taxation conditions apply to one group and not to another.

Groupings of biscuits have been made in various ways based on:

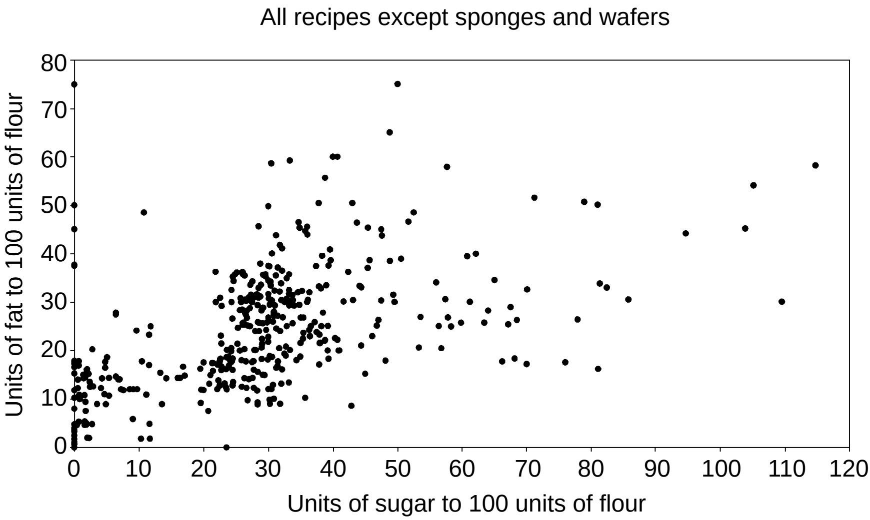
- Name, e.g. biscuits, crackers and cookies, which is basically on the texture and hardness.
- Method of forming of the dough and dough piece, e.g. fermented, developed, laminated, cut (simple or embossed), moulded, extruded, deposited, wire cut, coextruded.
- The enrichment of the recipe with fat and sugar.

Another classification may be used to describe the secondary processing that the baked biscuit has undergone. Examples are:

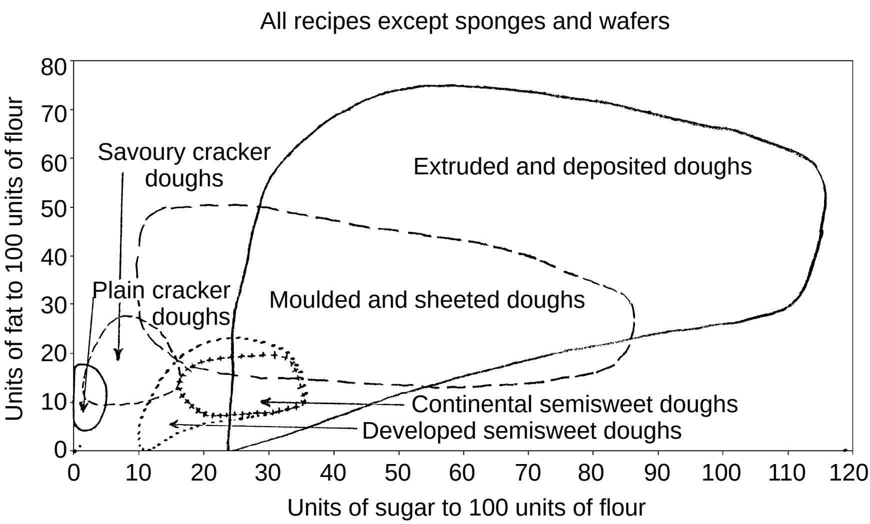
- Cream sandwiched.
- Chocolate coated.

- Moulded in chocolate.
- Iced (half coated with a sugary slurry that has been dried).
- Added jam or mallow (or both).

The result is that the same English adjectives have come to be used in different contexts for different biscuits. Rather than trying to untangle or describe these groupings it is felt best to emphasise that there is overlap and to show, with the aid of figures, how various common types of biscuits are classified relative to one another based on enrichment and the amount of water thereby needed to form a dough.



2.1 Relationship of sugar and fat enrichment in biscuit recipes.



2.2 Delimitation of areas for different groups of biscuits based on enrichment of the recipes.

2.2 Classification based on enrichment of the recipe

As technologists it is useful to be able to categorise biscuits from their external and internal appearance as this helps in deciding the likely recipe and means for forming and baking. In order to do this one must firstly look critically at the surfaces, particularly the edges and the base, to identify whether, for example, the dough piece was cut, moulded or extruded. The method of forming is limited by the enrichment of the formulation. The pattern on the base is formed during baking. Doughs rich in fat and sugar bear much stronger impressions from a baking wire than less enriched doughs where the gluten has been developed during mixing. Internal investigations will reveal a laminar structure in many biscuits with a developed gluten and a more crumbly and more irregularly open structure in doughs with higher fat and sugar. Figure 2.1 displays about 500 recipes in terms of their relative contents of flour, fat and sugar. Figure 2.2 shows how the recipe areas of the major types of biscuits are distributed on the enrichment graph.

It is necessary to explain how Fig. 2.1 was constructed and upon what basis calculations have been made.

In all cases, recipes are of biscuits which have been commercially produced within the last 30 years. The recipes are of doughs mixed before various late additions have been made such as garnishing sugars, salt dusting or egg washes. They are not therefore a representation of *baked* biscuit composition but of basic mixed doughs.

Each recipe has been adjusted to be relative to 100 units of flour including other cereal/starchy products such as corn starch, vital wheat gluten, malt flour, and oatmeal.

The sugar level is on a dry basis and it is assumed that liquid sugar has 67% solids, malt extract syrups and glucose syrups 80% solids and invert syrups 70% solids, as is shown in Appendix 1, Glossary of ingredient terms.

The fat values are on pure fat so margarines and butters are only 85% fat. The fat values of fresh and dried full cream milks have been included even though they are usually of insignificant amounts. Also, the fat content of fresh cheese and cheese powder, although not common ingredients, has been added to the total fat.

In other biscuit texts, reference is often made to the 'percentage' of fat or sugar in a dough. Sometimes this means the amount relative to 100 parts of flour, as has been used here, but more correctly it should be relative to the total dough weight, plus or minus added water. There are reasons for choosing either system but it is felt that to use units relative to 100 units of flour (cereal content) without the word 'percentage' is best and this system is used throughout the book. Basing recipes on 100 units of cereal materials means that changes can be made to individual ingredients, such as sugar, water or an aerating chemical, without having to recalculate all the others to get true percentage values.

Values used are all relative and are not confused by difficult traditional units like sacks of flour, barrels of fat, parts per million, ounces, pounds, gallons, pints or fluid ounces. There is a growing acceptance of the metric system for weighing and it is thus easy to convert the values shown into kilograms or grams to create a mix of the desired size. As fats have specific gravities of less than 1.0 and syrups specific gravities greater than 1.0 it is desirable to **weigh** all ingredients if possible but if metering is by volume the influence of density on the weight of material taken should be fully understood. For those who use imperial units of weight, temperature, volume and length there are conversion tables in Appendix 2.

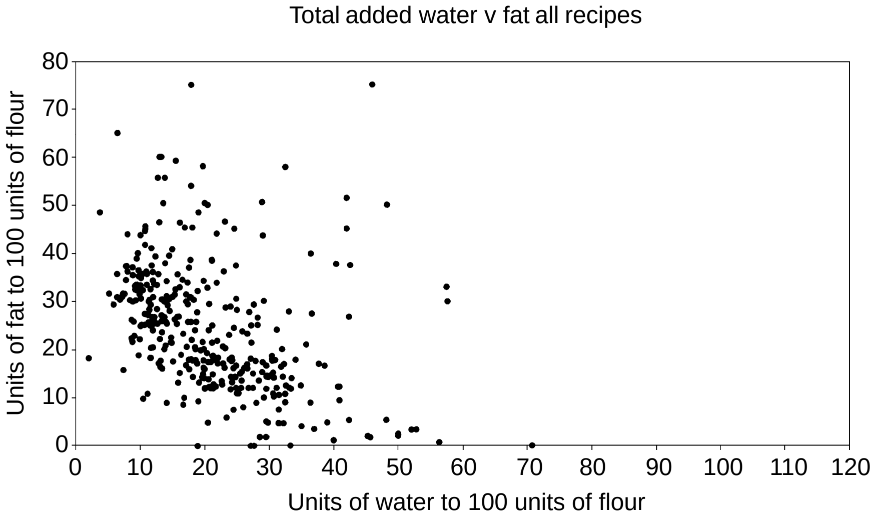
It is not surprising to see, in Fig. 2.1, that as the fat level increases, the sugar level tends to rise too. In any search for a completely new type of biscuit it is best to stay within the broad limits that have been tried because there is probably a good reason for the blank areas on the chart or for the limits of boundaries shown for particular types. One of these may be the need for a balanced recipe. It is found, for example, that a certain level of fat demands a minimum level of sugar to produce an acceptable texture.

The greatest fundamental difference between all the biscuit group areas shown is in the existence or otherwise of a three dimensional structure of gluten that imparts extensibility and cohesiveness to a dough. A point comes where, due to the shortening action of fat, the softening action of sugars or the mechanical interference of crystalline sucrose, cohesive gluten is not developed so the dough becomes 'short'. There is a big difference in the way that short doughs can or must be handled and formed compared with those with extensible gluten. By and large, dough pieces formed from short doughs do not shrink after formation and then increase in outline during baking (a phenomenon described as spread) whereas those with extensible and cohesive gluten tend to shrink (mostly in their length) after cutting and during baking. By subtleties of processing it is possible to confuse the distinctions which are recipe related described above. Thus we return to the basic problem of precise classification mentioned before.

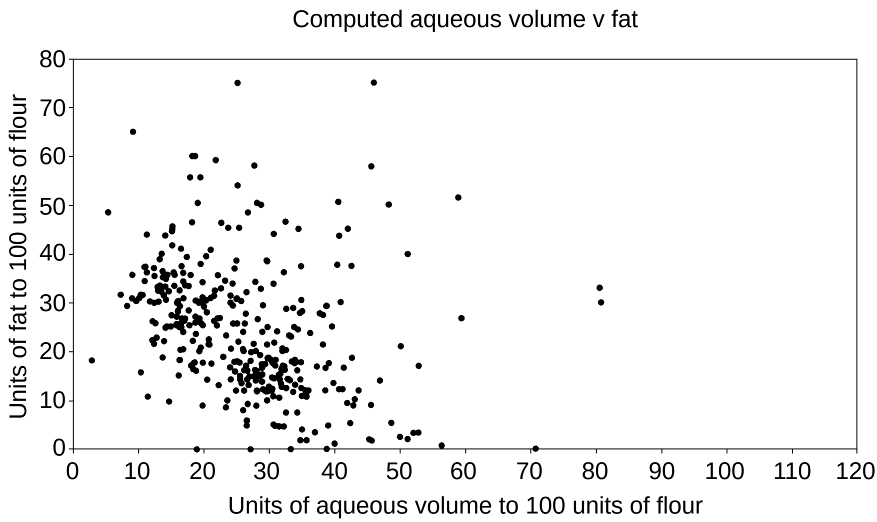
Sections of the enrichment graph as shown in Fig. 2.2 will be used as the basis for recipes detailed in later chapters.

Superimposed on this pattern of types, which is based on enrichment of recipes with fat and sugar, come other aspects which tend to make the biscuits more interesting or exotic. Thus layering of fat in a low sugar dough gives puff biscuits. Layering of fruit between an extensible dough gives sandwiches such as Garibaldi biscuits. Moulding of short dough around a fruit paste gives fig rolls. Coextruding two dissimilar doughs or coextrusion involving a fruit, nut or chocolate centre gives biscuits with distinct dichotomy of textures and flavours. Decoration of the dough piece surfaces with such ingredients as salt, sugar, nuts and egg wash improves appearance and flavour.

After baking, the biscuits may be fat sprayed (mostly savoury types), sandwiched with sweet or savoury fat creams or marshmallow, or variously enrobed with chocolate, chocolate substitutes or water icings. Descriptions of these types and processes are included in subsequent sections.



2.3 Relationship of water to fat in biscuit doughs.



2.4 Relationship of aqueous phase to fat in biscuit doughs.

Sponge drop products occupy an intermediate place between biscuits and cakes. If the sponge is moist when packed, as that in Jaffa Cakes, it is technically a cake even if it has been made on biscuit equipment, but if it is dry like that in ladyfingers perhaps it is a biscuit!

Wafer biscuits represent a special type of baked product because they are formed between a pair of hot plates and not on a baking band or wire as are most other types. The recipe is simpler, low in enrichment with fat and sugar, and is mixed to a fluid pumpable batter. Most wafers are rather uninteresting to eat on their own but they form useful, rigid carriers for other more flavoursome mixtures such as sugar cream, caramel toffee and marshmallow. Wafer batters with higher levels of sugar can be rolled after baking and before cooling. After cooling they are harder and much more palatable to eat than the other flat sheet wafer types.

When a large amount of independent information is collected together as a database it is interesting to analyse it to see if relationships and correlations exist that may help in understandings or predictions. For example, it is always a problem to know how much water is needed to make a dough. Figures 2.3 and 2.4 take a global look at the relationship of water in most of the recipes shown in Fig. 2.1. For Fig. 2.3 the total water in a recipe (added water and water contained in syrups, butter, etc. but not in flour and other cereals) is plotted against fat which is the other liquid phase provider in the dough. It will be seen that there is a general relationship that the higher the fat content the lower the water content. Unfortunately, the spread of the results is very large. There are many reasons for the deviations from a precise correlation and some of these are:

- Unknown water absorption values for the flours.
- Variations in, and unmeasured, consistencies of doughs.
- A spread of dough temperatures which affect the consistency and therefore the need for water level adjustment.
- The occasional use of significant levels of biscuit rework material.

When sugar dissolves in water the volume of the liquid increases by 60%. It was therefore thought that by calculating the new effective volume of water as a result of the sugar dissolving in the dough perhaps a better correlation between dough water and fat content could be found. Figure 2.5 shows the ‘water’ level enhanced by the increase in volume due to sugar dissolving. In many recipes there is not enough water to dissolve all the added sugar: this situation has been taken into account before the values for the plots were calculated. The correlation has not improved significantly as a result of this manipulation of the values.

Other aspects reviewed from the recipe database have been the levels of chemicals, particularly sodium bicarbonate, ammonium bicarbonate and salt that have been used in the various types of biscuits. These are summarised where appropriate.

2.3 Classification based on method of dough piece formation

Biscuit doughs are formed into pieces ready for baking in one of four principal ways:

- By sheeting and cutting.
- By moulding with a rotary moulder.
- By extrusion.
- By depositing.

All these processes are described in detail along with the machinery used in the publication *Technology of Biscuits, Crackers and Cookies*[1] but a brief outline will be given here as the relevant techniques are mentioned for each of the recipes given later.

Sheeting involves the continuous compression of a mass of dough into a layer of more or less uniform thickness. On biscuit plant the width of the sheeted dough is normally the same as the general width of the plant, that is, 800, 1000, 1200, 1400, or 1600 mm. This sheet of dough is then passed through a short series of 'gauge' rolls to reduce the thickness. When the thickness is thin enough to form dough pieces the sheet passes under **cutters** which make the pieces. These pieces are separated from the surrounding dough (known as cutter scrap) and pass forward to be placed onto the oven band for baking. The cutter scrap is normally returned to the sheeter and reincorporated with fresh dough as the sheet is formed.

A variation in the sheeting and cutting system is that of **'laminating'**. After a sheet has been formed and reduced somewhat in thickness a special and complicated machine arranges the sheet of dough as a pile of layers which is usually transported away at 90° to the previous direction of travel. The pile of dough layers is subsequently reduced in thickness ready for cutting by passing through a series of gauge rolls. The laminating procedure develops a structure in the dough which is enhanced during baking especially if fat, flour or a mixture of these two is distributed between the layers as they are piled up.

Sheeting and cutting are processes used mostly for hard, developed doughs which exhibit some extensibility. Such doughs are relatively low in fat and sugar. This dough piece forming technique can be used for short doughs but the non-extensibility of short doughs makes it much more difficult to transfer the dough sheet between machines so only one gauge roll after the sheeter and before the cutter is recommended. There are a few advantages of sheeting and cutting over the normal moulding method for making short dough pieces but very few manufacturers now use sheeting and cutting for their short doughs.

Rotary **moulding** is the principal method used for making dough pieces from short dough. It has the great advantage that only one relatively simple machine is needed to convert a mass of dough into dough pieces ready for baking. There is no production of 'cutter scrap' dough, which has to be recycled, but there are significant limitations in the consistencies of dough that can be handled and on dough piece weight adjustment. Rotary moulders are not suitable for very soft doughs or for doughs containing large particles such as nuts, chocolate chips and dried fruit.

Softer doughs and doughs with larger pieces included are **extruded**. Again, only one machine is involved and the extrusions, which of course are determined in outline by the shape and size of the holes in the die plate, may or may not be cut into pieces with a reciprocating wire and then the technique is known as **wire cutting**. Alternatively, the extrusions may form a continuous ribbon or **bar** which can be cut into lengths either before or after baking. The extrusion process also allows **coextrusion**. Usually, this process is limited to places where there are only two materials such as dough surrounding a central extrusion of fruit paste or one dough within another. Other configurations are possible.

A special type of extrusion is known as **depositing**. Here the dough is very soft, usually as a result of a high fat content or because the dough is a egg batter. The extrusions are intermittent through a row of nozzles mounted in a depositor head. The depositor head rises and falls, relative to the accepting surface underneath, and discrete amounts of the dough form as pieces to be baked. The nozzles may rotate or oscillate giving interesting shapes to the deposits formed.

Reference

[1] MANLEY, D J R (2000) *Technology of Biscuits, Crackers and Cookies, 3rd edition*. Woodhead Publishing, Cambridge.