Biscuit, cracker and cookie recipes for the food industry

Duncan Manley

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Preface

This book is for technologists and managers. During my many years working in the biscuit industry internationally I have frequently been asked for suggestions and help in the matter of new products. I am somewhat dismayed that the thought processes of planning, questioning and trying to understand mechanisms are all too shallow in most development departments.

With much practical experience of biscuit making I have enjoyed the opportunities to give advice and training to the newer workers in my chosen industry. My book *Technology of Biscuits, Crackers and Cookies* was produced to summarise the technology as I had found it difficult to learn the subject when I joined the industry. Later, I ran a very successful series of teaching seminars, the Cambridge Biscuit Seminars, for seven years and these were attended by delegates from 109 companies in 42 countries. Then in 1998 I produced a series of six Manuals as support for teaching biscuit factory operators. The principal purpose of this book is to provide stimuli for product development and improvement.

Development activity is essential for all companies but it is potentially very expensive. The cheapest and most effective part of development is the thinking and the planning. I strongly recommend that much time is given at the outset of a project to thinking about aims and planning daily activities for all involved. As the project proceeds assess progress frequently and modify the plan accordingly. Think laterally, critically and creatively. Constantly ask:

'What happens if . . . ?'
'Why did this happen (or not happen)?'
'Can this be done quicker or better?'

Creativity and progress are not only about knowledge, but the information given here will hopefully help in the thinking and experimentation which are so much a part of successful development.

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Introduction

1.1 How to use this book

This book is written for the biscuit product developer. It is intended as an aid in the task of creating and perfecting a biscuit product. It is hoped that technologists will find the recipes useful when considering new products, as will production managers and senior executives who should compare the recipes detailed here with their current production to see if improvements and cost reductions are possible. In fact, product *improvement* is not only a lot quicker and cheaper than starting from scratch but should be an essential periodic operation in all companies. Each product should be reviewed at least once per year for there is always a better way of doing something!

The last known book of this type was published as a second volume, *Recipes and Formulations*, to W H Smith's *Biscuits, Crackers and Cookies* in 1972.[1] There was little specific information about ingredient qualities, dough piece forming and baking and although useful it was difficult to find one's way around the book. In any case, the volume is long since out of print. There have been a few other publications where biscuit recipes are included with cake and bread recipes. This book limits itself to biscuits, crackers and cookies and to a few other products that are made on typical biscuit plant.

In order to make a biscuit one needs both experience of biscuit technology and an inquiring mind. One also needs some ingredient materials and equipment to mix a dough, form a dough piece of the desired shape and size and an oven to bake it.

The author's book *Technology of Biscuits, Crackers and Cookies* (3rd edition)[2] is a comprehensive account of biscuit technology including ingredients, processes and management techniques. There is a complete chapter on Product Development including accounts of recommended facilities, assessment techniques and the drawing up of product specifications. The present book is not intended to replace that text but to complement it in terms of recipes and suggestions on how adjustments to a biscuit's properties can be achieved.

The term **recipe** is used here to mean a list of ingredients and directions for making something. To avoid confusion the word formulation, which usually implies information expressed in systematic terms, will not be used.

After 34 years of technical and development involvement in biscuit making the author has developed a number of new products and also has become privy to very many recipes from manufacturers worldwide. In most cases these recipes have been given to him in confidence so they cannot be reproduced here in recognisable form. In most companies product developers have some sort of fixed notion that armed with an accurate recipe they can immediately reproduce a famous biscuit. Unfortunately, this is rarely the case. There are several reasons, for instance:

- Ingredients, particularly flour, vary from place to place and from time to time.
- The mixing technique may have a significant effect on the dough quality.
- The forming and baking conditions can result in deviations, some producing a better and some a worse biscuit.

The biscuit recipe and some clues on the processing techniques can be a very great help in the development of a particular biscuit product. However, armed with this information it is unlikely that a developer will be truly successful unless he or she adds critical observation and draws on experience. Thus, like other forms of education which are knowledge based one has to add some skill of one's own if biscuit development is to succeed. Understanding why things happen is essential in the development process and it was to encourage this form of thinking that the author wrote a series of Manuals[3] for those involved in biscuit manufacturing. These Manuals are six in number and are detailed in the references. They are designed principally for factory operatives who should learn not only what happens but also why it does so in the successive operations involved in making biscuits. With knowledge they should be able to maintain process control and take correct action when something changes resulting in biscuits not looking or tasting right. The product developer will also benefit from studying these Manuals.

The developer should also remember that the appearance of the product is extremely important, not only at the assessment stage but also to the consumer. Therefore it is not good enough to have a biscuit tasting good! Biscuits are somewhat unique as foods as they rarely form part of a meal (except for those that are eaten with such items as cheese) but are usually taken as snacks at any time of the day. The design of a biscuit must take into account several factors, not least how and when the consumer will be handling and eating it. The new product (or the changed product) must add value, either value for the manufacturer or for the consumer, hopefully both! Manley[2] calls the product developer a Food Designer and as de Bono[4] says 'Design is at best a risky process but without design there is no progress'.

It is helpful to classify the different types of biscuits. There are several ways of doing this but the form of the dough, by way of enrichment with fat and sugar, and how the dough is formed into dough pieces for baking are two principal ways of classification. These approaches are made in this book with the aim of giving it a logical structure. The recipes, charts and reviews are drawn from a database of over 600 recipes, the vast majority of which relate to commercially produced products over the past 30 years. They may not have been optimised but they do serve to reflect very clearly manufacturers' practice.

There are aspects like the taste and texture of biscuits that are difficult to define concisely in words. The levels of some ingredients like salt and syrups are important for taste and the levels of aerating chemicals and baking condition significantly affect the textures. By reviewing a very large number of recipes for related types it has been possible to come up with averages and ranges of usage levels for certain ingredients which might be useful for developers as starting points for their work. These values should be taken as guides for experimentation rather than suggestions.

The aim to copy faithfully a competitor's biscuit product is not recommended: it is one of the most difficult development tasks. It is impossible to reproduce conditions completely in another place and on other equipment. It is possible to *aim* for particular eating properties and, in addition to the experience of the developer, some detective work is often useful. For example, it is becoming necessary to display ingredient lists and analytical information on food packs and the technologist can use this to guide him in the recipe that was used. Ingredients should be listed in descending order of magnitude and analytical data is usually calculated according to a given procedure rather than as a result of basic chemical tests. In Appendix 3 examples are given of how analytical data is calculated using computer spreadsheets. By setting up such spreadsheets and playing 'what happens if' games the computer can be used to tune the recipe quantities to arrive at quantities of such items as fat, sugar, and protein displayed on competitors' biscuit packs.

Thus the recipes given in this book, together with other processing information, are designed to speed the developer in the task of making the product that is required in terms of looks, shape and size and eating qualities. Provocation is a good thing in the process of creativity: hopefully the range of ingredients used or the quantities suggested will cause the Food Designer to think about what he or she is trying and guide them towards the desired goal. Good luck!

1.2 Names of biscuit products

The word 'biscuit' is unfortunately not consistently defined and that is why so many texts on the subject of this manufacturing technology appear under the cumbersome title of biscuits, crackers and cookies. 'Biscuits' is the original British word used to include small baked products (usually of flat shape) based on wheat flour with various inclusions of fat, sugar and other ingredients: it therefore includes crackers and the more luxurious product called cookies. They all have low moisture content and, if packed so as to protect them from atmospheric moisture, have a long shelf-life.

The principal confusion comes from the American use of the word 'biscuit' to refer to semi-moist short shelf-life morning goods, like scones, that have little or no sugar. The Americans are also specific with the use of the terms 'crackers' and 'cookies' and they do not have a generic word to cover all these types of baked products. The situation in languages other than English is no doubt also beset with problems of group names. For the purpose of this book the word 'biscuit' will be used in the generic sense so covers crackers and cookies but not the American morning product.

Biscuits may be known by traditional local names such as Rich Tea, Bourbon, and Cream Cracker or by brand names, for instance, Hobnobs, Wagon Wheels, and Kit Kat. These names do not have much bearing on their ingredients, for example, cream crackers have no cream in them, custard creams have no custard or dairy cream and digestives are unlikely to be of particular help to those with stomach problems. In fact in the USA 'digestive' is not permitted as a cookie name and wheatmeal or some other name should be used to avoid suggesting a medical connection!

Biscuits are manufactured in most countries of the world and although Britain led the industrialisation of biscuits and also popularised biscuits at least through her former colonies, it is not very helpful to give a recipe a name that means nothing to a developer on the other side of the world. To aid in understanding the type of biscuits in question, marks are shown on separate enrichment classification charts for each of the recipes given.

1.3 Dos and don'ts in recipe development

Dos:

- Be systematic and plan work before starting. Set out overall aims for a project and head each trial record with an aim that can be assessed when the product is measured or tasted. If an aim is not achieved with a trial, think about the problem and make a note of the reason that *you* feel was responsible.
- Vary only one or two things at a time. There are very many variables involved in biscuit making. They include such items as quality and quantity of ingredients, temperature, dough making procedures, dough piece size and weight, and baking conditions.

- Only offer for tasting or other assessment samples of trials that you think are good or interesting. It is very confusing for others to be as intimately involved in development work as you, the developer.
- Give each trial an identifying reference and record all details of what was done and the results. Record even those trials that are failures. It will be useful to design a trial record form so that spaces or boxes prompt what to record and save a lot of extra writing.
- Save samples and label these carefully. Biscuits rapidly absorb moisture from the atmosphere and become softer and less pleasant to eat. Seal samples in adequate bags or boxes as soon as they are cool after baking. (Label the bottoms of boxes not the lids in case they become misplaced after opening!)
- Use only qualities of ingredients that will be available for use in the factory.

Don'ts:

- Do not expect rapid success. You will probably have to do many trials to perfect a product.
- Do not rush. A few careful trials are worth many rushed and careless ones.
- Do not make do with poor equipment. The scales for weighing should allow you to measure to 3 significant figures.
- Do not make the size of the trial too small. There should be enough samples for several people to be able to see and taste your work when it is good.
- Do not be worried about wasting ingredients. The cost of these is small compared with your time and the benefits to the company when you have succeeded.

REMEMBER: There is always a better way of doing something, search for it and try to do it. Achievement satisfies everyone!

A glossary of ingredient terms may be found in Appendix 1.

References

[1] SMITH, W H (1972) *Biscuits, Crackers and Cookies, Volume 2. Recipes and Formulations.* Applied Science Publishers, London.

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

[3] MANLEY, D J R (1998) *Biscuit, Cookie and Cracker Manufacturing Manuals, 1. Ingredients 2. Biscuit Doughs 3. Biscuit dough piece forming 4. Baking and cooling of biscuits 5. Secondary processing in biscuit manufacturing 6. Biscuit packaging and storage.* Woodhead Publishing, Cambridge.

[4] DE BONO, E (1999) *New Thinking for the New Millennium.* Penguin Books Ltd, London.

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:

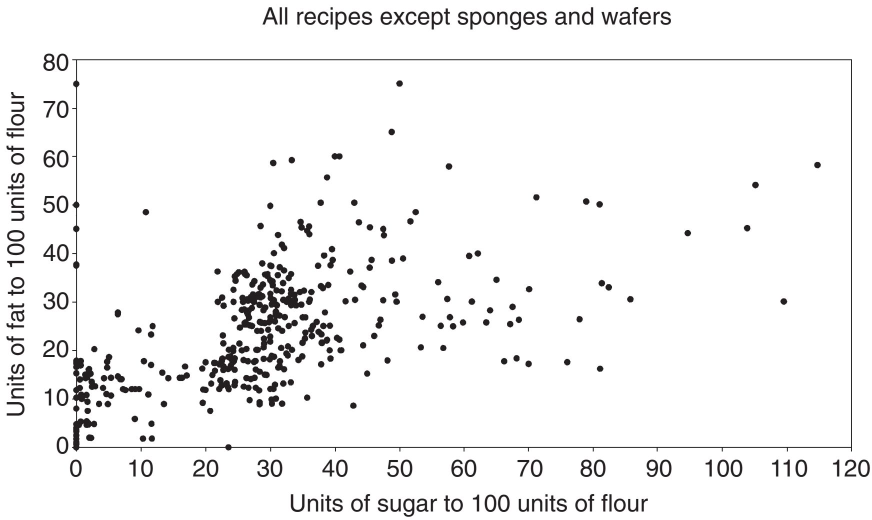
- Name, e.g. biscuits, crackers and cookies, which is basically on the texture and hardness.
- Method of forming of the dough and dough piece, e.g. fermented, developed, laminated, cut (simple or embossed), moulded, extruded, deposited, wire cut, coextruded.
- The enrichment of the recipe with fat and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

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

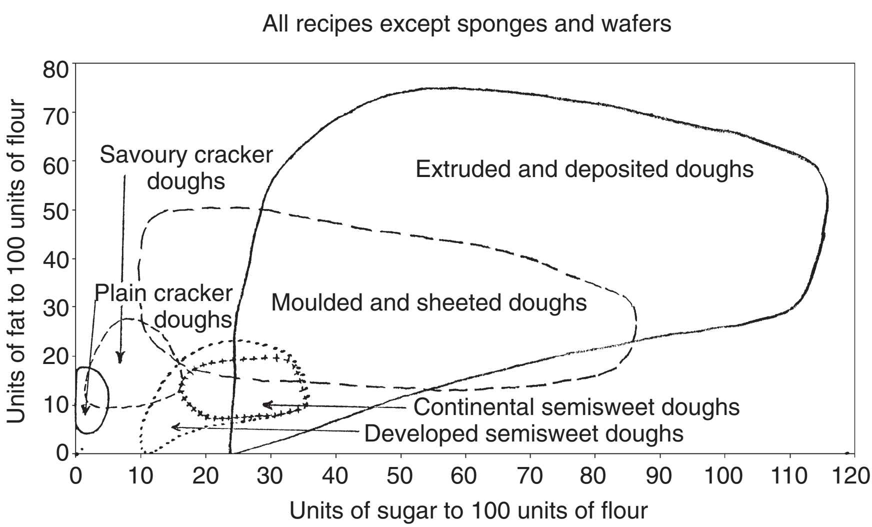
- Cream sandwiched.
- Chocolate coated.

- 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.

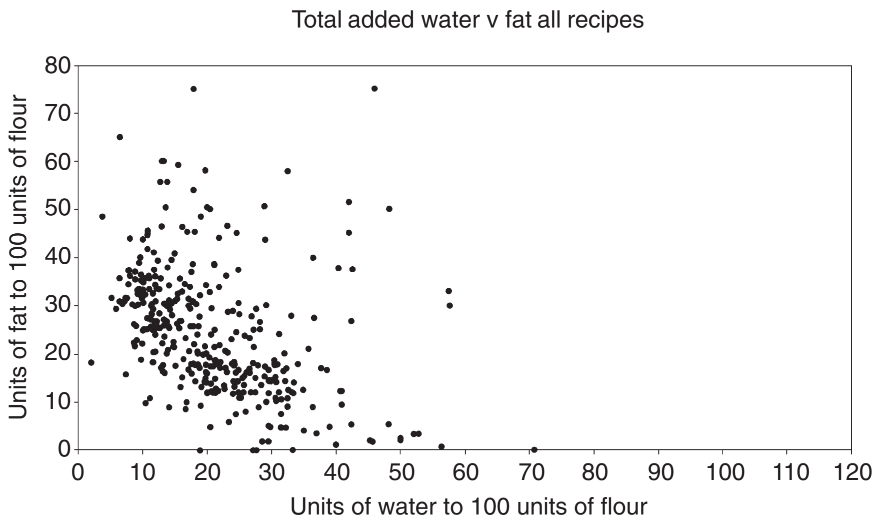
It is not surprising to see, in Fig. 2.1, that as the fat level increases, the sugar level tends to rise too. In any search for a completely new type of biscuit it is best to stay within the broad limits that have been tried because there is probably a good reason for the blank areas on the chart or 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.

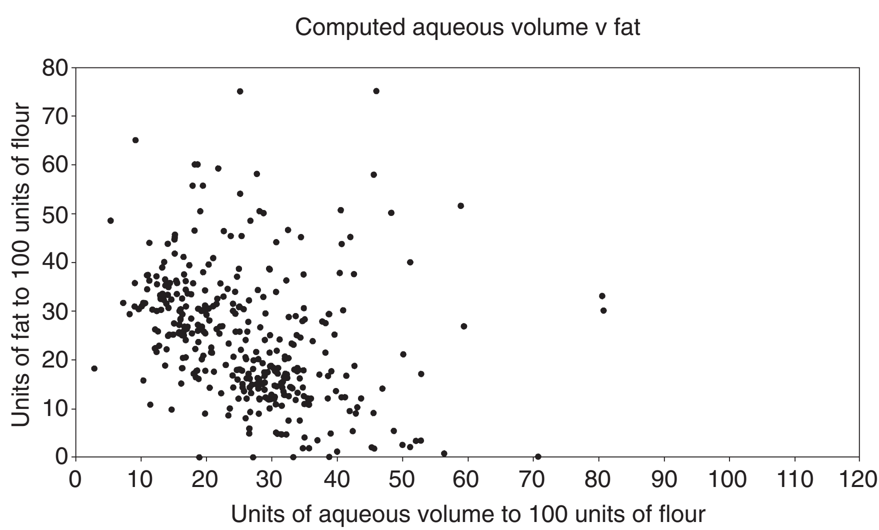
Sections of the enrichment graph as shown in Fig. 2.2 will be used as the basis for recipes detailed in later chapters.

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.

3
Dough consistency

3.1 Introduction

Water is added at the mixing stage to nearly all biscuit recipes. It functions as a catalyst because it is almost totally removed during the subsequent baking process. Water hydrates ingredients like flour and, if conditions are right during subsequent mixing, hydrated wheat protein changes into a visco-elastic material known as gluten. This is very important in determining the nature of the dough, how the dough behaves in the forming processes and ultimately the structure in the baked biscuit. Water also allows the solution of some ingredients such as sugar and, in the case of chemicals, permits reactions to take place in the dough.

However, the amount of water that is added is related principally to the consistency of the mixed dough and it is the problem of achieving the correct consistency that is the subject of this section.

3.2 What is dough consistency and why is it important?

Biscuit dough forming machinery (the principal processes have been outlined in section 2.3) has been developed over very many years, basically as the mechanisation of techniques that were originally done by hand. Unlike manual techniques, machines are not able to adapt their treatment of dough according to changes in the consistency. This means that for modern dough-forming processes optimum consistency and a continuous maintenance of this dough consistency are essential if the machinery is to perform reliably. The alternative is that plant operators or feedback sensors must continually adjust the machinery settings to accommodate consistency changes. This is not a satisfactory situation for ideal process control.

Dough consistency is very difficult to define and measure. It is manifest as the softness, stickiness, elasticity and extensibility that can be assessed by manipulating a mass of dough in the hands. This physical condition results from the ingredients of the dough, including the amount of water which has been added, the mixing conditions and the temperature. Generally, the greater the liquid component in the dough and the higher the temperature the softer will be the dough. The liquids are either water (including water in syrups, milk, egg and so forth) and fat. The fats used in biscuit doughs are generally semisolid like butter. Crystals of fat are dispersed in liquid fat (often known as oil when in the liquid state). Fat crystals melt as they are heated so the amount of liquid is a function both of temperature and of type of fat.

During the mixing of the constituents added water becomes distributed in a number of different ways all of which significantly contribute to the nature of the dough:

- It is absorbed into such ingredients as flour and starch. Hydrated wheat protein may be changed into gluten, as was mentioned above, and this gives the dough a cohesive nature. The absorption is time-dependent and coarse particles like oat flakes take longer to hydrate than does powdery flour. The formation of gluten depends firstly on the hydration then on a period of mixing so this is both time- and energy-dependent.
- It dissolves sugars, chemicals and other substances to form solutions. The dissolution of sugars, principally sucrose, effectively increases the volume of the liquid phase by a factor of 0.6 of the weight of sugar and also makes the dough more sticky. The amount of sugar that will dissolve is limited by the saturation of the solution and this is about 67% at ambient temperatures. The solution of the sugar is quicker than the hydration of the flour so a dough at first becomes more sticky and then, as this syrup is involved in the cereal hydration, the stickiness becomes less apparent.

  As the chemicals dissolve, reactions between them and other ingredients become possible and the pH of the dough may change. Generally, higher pH values, as a result of solutions of ammonium bicarbonate and sodium bicarbonate for example, soften gluten and lower the consistency of the dough.
- It contributes to the liquid phase in the mass together with liquid fat. The fat may coat cereal particles in the initial stages of mixing and retard the hydration and the formation of gluten.

Mixing is often a rather crude process involving the blending and working of all the ingredients placed haphazardly together. Furthermore, as mixing proceeds there is a development of heat in the dough which increases reaction speeds and affects consistency. It is therefore difficult to be sure in what order or to what degree of completion the above mechanisms, that involve the incorporation of water, have reached.

The aim of mixing is to produce a dough which is homogeneous and of a consistency suitable for further processing. The problem is that this consistency is not stable. The stickiness may decrease as the hydration process continues and the firmness of the dough increases due to a phenomenon known as thixotropy. In thixotropic materials the consistency is related to the immediate history of that mass. A good example is toothpaste: this is firm as it comes from the tube but rapidly softens as it is moved over the teeth. Another is tomato sauce which is firm in the bottle but becomes much more fluid after the bottle has been shaken! It is very difficult to measure critically the consistency of thixotropic materials because they have to be worked in a prescribed way immediately before the test is made. For this and other reasons instruments used for assessing dough consistency of biscuit doughs with their great variety of ingredients are generally rather unsatisfactory.

3.3 Why should consistencies of dough change?

The main reason why doughs appear different after what was apparently a standard mixing procedure is that the metering of the ingredients was not precise. The most likely problem is that while the metering of flour is accurate, varying inclusions of scrap dough or biscuit recycle materials can give big changes to the consistency.

From time to time, but not from batch to batch, the water absorption characters of the flour will change. This means that more or less water is needed to give a desired consistency of dough. The factors that affect flour water absorption are principally the flour moisture content, its protein level, and the amount of damaged starch. These properties can be controlled by the flour miller. It is very likely that the water absorption of flour will differ if it originates from different flour mills. The effect of changes in flour water absorption on biscuit doughs will generally be minimal except for those with very low fat and sugar contents such as crackers where the dough water requirement is relatively high. It is possible to use specialised dough rheology instruments to measure flour water absorption values but the biscuit makers are not interested in the flour *per se*: they want to know how the biscuit dough is affected and this involves many other ingredients. It is not common to measure biscuit dough consistency but penetrometers can give empirical results which may be slightly better than the manual squeezing and stretching test used by experienced operators.

Changes in the dough temperature can also affect the consistency. It is common to mix doughs on a time basis. This means that when the mixer bowl is cold the dough will be cooler after a given mixing period. Mixing of developed doughs should be to a final temperature and not to a time: however, the time must be long enough to allow adequate blending and dough development. (Please see notes about mixing in each of the recipe sections.) The dough temperature may change in the period of handling before it reaches the forming machinery, it may cool at the edges of a tub left in a cold place or it may be different because it has been used sooner than normal after completion of mixing.

Short doughs have a minimal mixing after the flour has been added. At the end of mixing insufficient time has elapsed for the flour hydration to have been completed. This means that the dough is soft and sticky. Within about 30 minutes of standing the consistency will have changed significantly and although the change continues for much longer the size of the change is thereafter relatively slow. Dough passing through a forming machine that is significantly changing in consistency can be expected to give operation problems so it is highly recommended to stand the dough before use.

The effects of changes in dough consistency are noticed principally on the forming machine. A soft dough will pass more easily through a sheeter and gauge rolls and give a thinner sheet. If the rolls are cold this will chill and toughen the dough, and as the cutter scrap dough is reincorporated the consistency will be toughened because this dough is always more dense than fresh dough. Cutter scrap can therefore be a problem at start-up and certain other times during plant running if not handled thoughtfully.

The most important single parameter in controlling baked biscuit quality is the weight of the dough piece. Heavier dough pieces will give thicker biscuits, paler bakes with high moisture content and the shape may differ. It is an essential task of process control to maintain a correct biscuit weight and this is done by controlling the dough piece weight. If the dough consistency is changing, operators of the forming machinery, whether of sheeting and cutting, moulding or extrusion, will have great difficulty in maintaining constant dough piece weights. There are practically no in-line dough piece weight monitoring instruments so automatic feedback to compensate for dough piece weight variation is not at present a practical option.

3.4 Can the dough water requirement be predicted?

This was discussed in Section 2.2, where the correlation between dough fat and water levels was demonstrated. The conclusions may be summarised as follows:

- All other factors being equal, an increase in the sugar in a recipe will result in a lower requirement for water, provided there is enough water present to dissolve all the sugar.
- Doughs where there is more sugar present than can dissolve in the available water will show a strong softening effect as the temperature rises. This is because more sugar will dissolve and there is a general softening of dough due to higher temperature. Thus short doughs in summer

> conditions where the temperature is not controlled will probably need significantly less water. It is well known that the greater the water level in short doughs the better is the structural development during baking, so if the dough is warm and the water level reduced the structural development may be affected. It is therefore good to try to keep short-dough temperatures within the range 20–22 °C at all times of the year.

It would be useful to be able to adjust the dough water level before the completion of the mixing to achieve a desired consistency. Much attention has been applied to this idea. The technique used for assessing flour water absorption using the Brabender farinograph does involve measuring the consistency of a flour/water/salt dough with some water withheld and then adding extra water to a desired consistency. Many experiments were made by the author and colleagues when they worked at Baker Perkins (now APV Baker) using the whole mixer as a type of farinograph. The power taken by the motor during mixing was plotted against time and the shape of the curve noted against a standard when dough of desired consistency had been made. It will be appreciated that the motor is extremely load sensitive so errors of metering give exaggerated results. Also it was found that the ways in which the doughs came together at the early stages of mixing varied and there seemed to be differences in the way the mixer moved the dough from time to time. Generally it was found that the technique was not useful for *controlling* dough consistency; however, the technique was useful for detecting differences between batches of dough. These differences arose principally because of errors in ingredient metering. Such a dough quality monitoring system may be very useful where entirely automatic loading, mixing and discharging systems of dough making are involved.

The author has come across a 'standard' process control test which is used in former USSR countries. This involves the rapid measurement of dough moisture content. The idea is that this is a check on both recipe and dough consistency. From what has been told above and displayed in the charts it can be seen that the value of this test is, at best, marginal.

4
Baking techniques

4.1 Introduction

The reason for wanting to know details of biscuit recipes is to enable a developer to create a product similar to another that he or she has seen or been told about. It is hoped that with the notes to be found in this book on recipes, mixing techniques and dough consistency the developer will be able to reach a good starting point quickly. It remains to give some consideration to baking techniques to avoid misunderstandings and disappointments.

Most biscuits are now baked in tunnel ovens where there are at least two zones with independently controlled heating systems. In a test bakery it is more likely that a static oven is used and in this case it is not possible to change the heating conditions during the bake time.

Baking involves three major changes to the dough piece in its transformation into a biscuit. These changes are: an increase in thickness (the development of an open internal structure); development of a reddish brown surface colouration (due principally to the Maillard reaction); and a significant reduction in moisture. All of these changes are accomplished by the supply of heat to the dough piece. If the heat is not supplied at the optimum rate one or all of the desired changes will be different from that which is the target. This means that even if the recipe and dough preparation processes are good or correct it may be that the baked biscuit is disappointing due to unsatisfactory baking. The developer may think that it is the recipe that is at fault and spend much time with changes to the recipe and still fail to make the desired product.

Consideration of what happens in the oven and how the controls should be set to achieve optimum results is therefore most important in product development.

4.2 Controlling heat in an oven

In a *static* oven it is possible to set:

- The temperature (possibly with differential power supplied to the top and bottom heaters).
- The extraction.
- The supply of steam to increase the oven atmosphere 'humidity'.

The baking time for biscuits is usually less than 10 minutes so to obtain reproducible results it is important that the door of the warm oven is not open for too long for loading and that the head space (the distance between the dough piece and the top of the oven) is small. The temperature is displayed and the controls to the heating elements (electricity or gas) may be of the on/off type or modulated by a more sophisticated proportional controller. There is no indication of heat transfer rate at the dough piece and most of the heat will be supplied as radiant heat.

If steam can be injected into the oven there is no indication by how much the 'humidity' has been increased. The extraction, to remove moisture derived from the baking biscuit, is with a crude damper in a flue pipe and the calibration is neither linear nor precise.

It will be appreciated that control of the heating conditions in a typical static oven is not very precise and depends almost entirely on the temperature of the oven structure when the pieces were loaded.

There are some static ovens which have forced convection and this means that air is circulated around the oven chamber and over the heating elements. Theoretically, this makes the heating much more uniform between top and bottom of the oven and also from side to side. Instead of radiant heat most of it is supplied as convected heat. However, it is unlikely that the speed of the air flow can be controlled so it may be that the draught of hot air will dry the surface of the dough piece too rapidly to allow optimum internal development before the dough piece surfaces are set firm.

In each zone of a *tunnel* oven it is possible to set:

- The temperature (with differential power supplied above and below the oven band by altering the ratio of heat supplied to the top or bottom of the oven).
- The extraction.
- Possibly the amount of forced circulation, depending on the type of oven system.

The power to each zone is controlled by thermocouples sited somewhere in the zone. The indicated temperature in the zone is probably from only one thermometer positioned in that zone. Whether the temperature is truly representative of the temperature near the dough piece is very questionable. Heat is supplied to dough pieces as a combination of conducted heat (from the oven band), radiant heat (from the walls of the oven and glowing burners) and convected heat (air moving in the oven either by forced convection or as a result of draughts from live gas flames or currents being drawn to extraction ducts). It is almost impossible to measure the relative amounts of heat from the different sources or indeed the total heat flux at the surfaces of the dough piece.

Extraction is required to remove the products of combustion and water vapour from the baking dough pieces. The extraction may be by natural convection or, more usually, forced by a fan in the flue pipe. The amount of extraction is usually controlled in a crude manner with a damper in the flue pipe. It is quite common for there to be too much extraction so that cool air is drawn into the mouth or exit of the oven (effectively reducing the baking time) or from adjacent zones. If oven extraction is excessive there is also a waste of heat energy.

There is considerable uncertainty about the most desirable 'humidity' in the zones of the oven and in any case no instruments are normally provided to measure it. Setting the extraction tends to be an art rather than a scientific skill. It should be remembered that, as the temperature throughout the oven is always greater than 100 °C, the boiling point of water, even at very high 'humidity' levels it is inevitable for moisture to be lost from the baking biscuit. Forced convection is particularly useful in the further zones of the oven as it improves heat transfer and helps the drying process. It is a difficult process to remove the last amounts of moisture that remain in the centres of baked biscuits.

The important point to realise is that using the controls and instruments provided with ovens it is difficult to set the heat transfer regimes that may, in theory, have been decided to be ideal for a product. To give temperature profiles for baking is of very limited use because they depend upon where the thermometers are situated and the nature of air movements in the oven. Tests to measure temperatures in ovens by passing recording instruments through at the same time as dough pieces show dramatically how inadequate are the static thermometers placed in the oven for indicating baking conditions. It must also be remembered that thermometers do not reveal the heat transfer potentials as this is a combination of radiant, convected and conducted heat collectively known as heat flux.

4.3 Setting temperatures for baking

Indications are given in each of the recipe sections of this book on the baking conditions considered best for the different types of product. It is impossible to be precise because no two ovens perform the same. Before setting the oven temperatures and other controls the bakers should try to visualise how heat will be transferred to the baking dough piece and control the relative effects of radiant and convective heat as necessary and possible. They should remember that the extraction must prevent a pressure build-up in the oven but not be so great that cold air is drawn in at the mouth and exit or be so excessive in one zone that heat is drawn from adjacent zones.

Generally, the temperatures in the oven should rise to a peak somewhere in the centre of the oven and then fall towards the exit. If a drop and then a rise in temperature occurs during the bake it is likely that the developing structure will collapse and not be reformed.

It is very difficult to scale up baking settings used in a test bakery static oven to a tunnel oven: in fact, it is unusual for the settings on two apparently identical tunnel ovens to be the same to get similar results. If there is a window in the static oven it is useful to watch what happens in terms of development and colouration while dough pieces are baked at different starting temperatures or at different levels of convection so that the results from a tunnel oven can be matched as required.

Remember that the results of baking dough pieces of varying *weight* may be very different.

Bibliography

[1] MANLEY, D J R (2000) *Technology of Biscuits, Crackers and Cookies, 3rd edition*, Chapter 38, Baking. Woodhead Publishing, Cambridge.

[2] MANLEY, D J R (1998) *Biscuit, Cookie and Cracker Manufacturing Manuals, 4. Baking and cooling of biscuits,* Woodhead Publishing, Cambridge.

5 Recipes for hard doughs

5.1 Introduction

The recipes for products in this group are characterised by the fact that they result, after mixing, in doughs that are rich in gluten so are elastic and extensible. They can, to varying degrees, be pulled out and suspended.

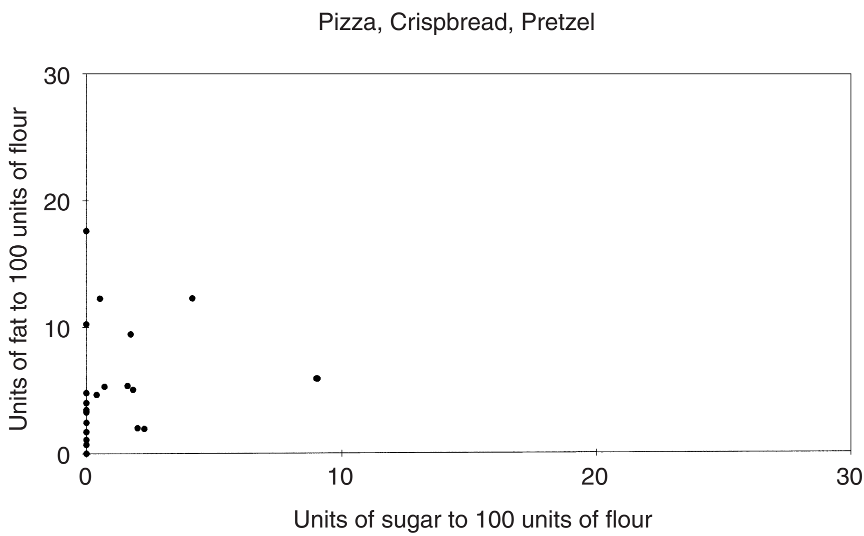
There are a number of subdivisions which are shown on the enrichment graph Fig. 2.1, the relevant parts of which are shown again here as figures in this chapter. It will be seen that in all cases the levels of fat and sugar are low or relatively low. In order to make a manageable dough a considerable amount of water has to be used and this water hydrates the flour proteins and, by mixing, gluten is formed. It is the gluten that gives the doughs their elastic and extensible characters.

From the consumers' point of view these products range from long shelf-life bread substitutes (Cream Crackers, Soda Crackers and Water Biscuits) which have little or no sugar and very little fat, to crisp biscuits which have low sugar and fat and which are known as semisweet biscuits (Tea Biscuits, Cabin, Gem, Morning Coffee, etc.). The group also includes cocktail and savoury 'crackers' which are eaten largely as accompaniments for drinks or as snacks (savoury crackers, pretzels, etc.).

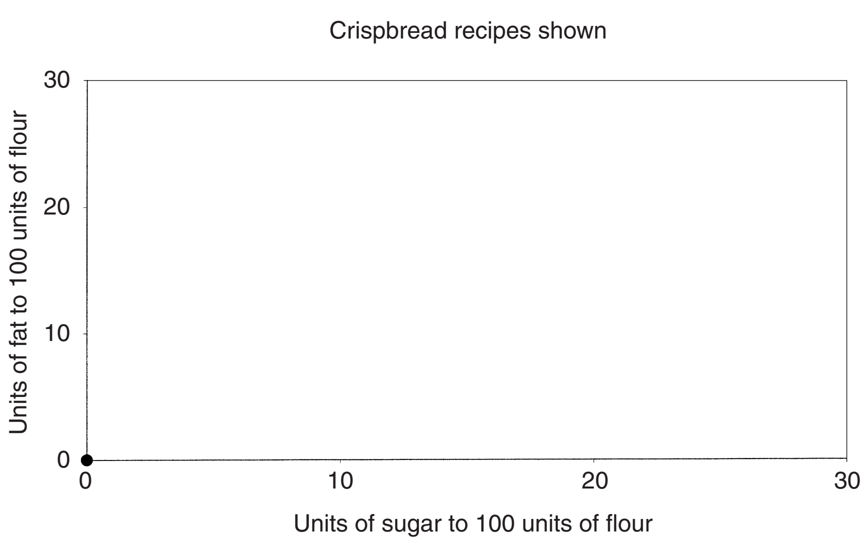
With very few exceptions dough pieces are formed from all these doughs by the techniques of sheeting and cutting. A major process control problem is the maintenance of biscuit size and shape because the gluten in the dough is more or less elastic and the dough piece shrinks after cutting and during the early stages of baking. The amount of this shrinkage is a function of the flour quality, the modification to the gluten quality that can be made during mixing (by the use of chemicals and enzymes or by fermentation with yeast) and lastly, the amount of dough relaxation that is given before cutting.

As these doughs all require much water for their formation another processing problem is the adequate removal of this water during baking. The later stages of baking that principally involve drying are very critical because if there is a large moisture gradient between the centre and edges of a biscuit when it leaves the oven subsequent equilibration may result in spontaneous cracking, a phenomenon known as **checking**.

As the recipes of products in this group are relatively cheap in terms of ingredients it is unsurprising that its members are found very widely throughout the world and most manufacturers produce at least some of the types.



5.1 Enrichment of pizza, crispbread and pretzel recipes.



5.2 Enrichment of crispbread recipes shown.

5.2 Pizza, crispbread and pretzel

Typical products in this group are made from doughs that are fermented with yeast and are thus similar to bread. The two biggest representatives are crispbreads and pretzels. The enrichment of pizza, crispbread and pretzel recipes is shown in Fig. 5.1.

Pizzas are not biscuit products but they are mentioned here because biscuit plant may be used to prepare the pizza bases by the process of sheeting and cutting. The dough pieces are partially baked then topped with tomato paste, cheese and other ingredients before being chilled or frozen. Final cooking is done just before the pizzas are consumed.

5.2.1 Crispbread

Recipe no. Type product	1 crispbread	2 crispbread
wholemeal wheat flour	100.00	
rye flour		100.00
salt	1.15	1.33
fresh yeast		2.70
added water	129	70

Critical ingredients Flours, uniformity of quality is most important.

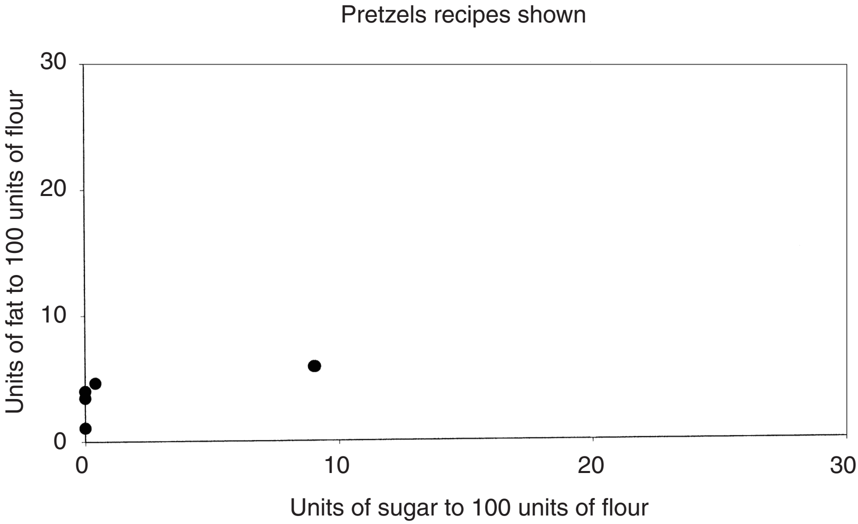
Mixing Recipe 1 is made from an aerated dough and recipe 2 is fermented with yeast. For the aerated dough a density of about 0.35 g/cc at not more than 6 °C is required. This is achieved with an Oakes type, high shear continuous mixer. Disperse the yeast in some of the water.

Dough handling For the fermented dough, ferment for about 3 hours at c 30 °C to allow the growth of the yeast.

Dough piece forming Crispbread doughs are exceedingly sticky due to the rye flour, the high water content and no added fat. The method of sheeting is very special and the product is usually baked as a complete sheet which is sawn into pieces after the oven. Some details of production techniques can be found in Bressler.[1]

Baking on a wire mesh band. The temperatures and time depend on the thickness of the dough sheet but a profile of 380, 300, 180 °C with bake time c 6 minutes will be typical. The product is usually dried further, to about 5% moisture, after leaving the oven.

The enrichment of these crispbread recipes is shown in Fig. 5.2.



5.3 Enrichment of pretzel recipes shown.

5.2.2 Pretzel knots, by sheeting and cutting

Recipe no.	3	4	5
Type product	pretzel	pretzel	pretzel
sponge			
flour, medium		13.04	13.64
fresh yeast		0.11	0.04
added water		13	8
dough			
sponge dough		as above	as above
flour, weak	100.00	86.96	86.36
dough fat	4.00	1.09	3.45
salt	1.00	0.87	1.30
fresh yeast	0.38		
added water	35	22	36

Critical ingredients Flour, the protein content should be as shown and between batch uniformity is important.

Mixing One stage for straight doughs, two stages for sponge and dough method. Recipes 4 and 5 involve a sponge and dough technique and 3 is a straight dough. Disperse the yeast in some of the water and keep away from salt in the straight dough.

Dough handling Sponge doughs are fermented for 5 hours or more and the subsequent dough for only a short time.

Dough piece forming Traditional pretzel knots were formed by hand from continuous extrusions as for pretzel sticks (see below). Now they are normally formed by sheeting and cutting or by rotary moulding. Removal of the centre pieces of unwanted dough after cutting requires some engineering ingenuity and various techniques are used.

After cutting, the dough pieces pass through a lye bath. The lye is a 1 or 2 % solution of sodium hydroxide (more rarely a 2 % solution of sodium carbonate) at a temperature higher than 65 °C. The dough pieces are in the warm lye for up to only 20 seconds but this is enough time for the alkaline solution to produce a skin of starch degraded to dextrin and it is this that gives the characteristic dark brown and shiny surface during baking. After passing through the lye bath, and before baking, it is normal to dust with a small amount of coarse crystal or flake salt.

Baking on a wire mesh band at temperatures typically, 240, 220, 200 °C for c 4–10 minutes depending on the size of the pretzels.

The enrichment of pretzel recipes in given in Fig. 5.3.

5.2.3 Pretzel knots by rotary moulding

Recipe no.	6	7	8
Type product	pretzel	pretzel	pretzel
flour, weak	92.85	100.00	100.00
cornflour	7.15		
granulated sugar		5.30	
invert syrup 70%		5.30	5.33
malt extract 80%	0.50		
dough fat	4.52		
margarine		7.00	7.00
lecithin	0.12		
amm. bic.	0.35	0.60	0.60
salt	0.50	2.00	2.00
SMS		0.033	0.033
fresh yeast	1.07		
added water	32	21	21

Critical ingredients Flour, the protein content should be less than 9% and between batch uniformity is important.

Mixing Ingredients all in together. Doughs to be rotary moulded must be much tighter (lower water content) than those for sheeting and cutting.

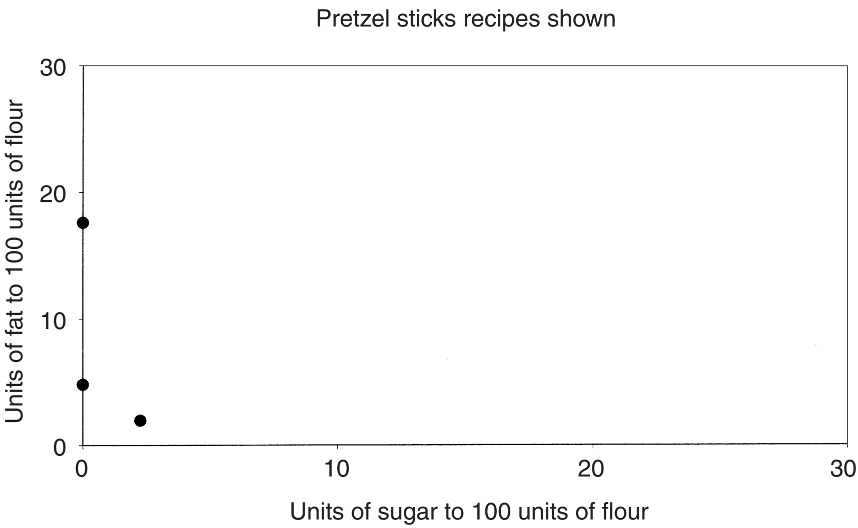
Dough handling It is not normal to allow any fermentation time and the quality of the product is generally harder and more dense than the sheeted products.

Dough piece forming Rotary moulding. The dough pieces pass through a lye bath and may have salt applied before baking in the same way as for the sheeted products in 5.2.2.

Baking on a wire mesh band at temperatures of 240, 220, 200 °C for c 4 minutes.

5.2.4 Pretzel sticks (by extrusion)

Recipe no.	9	10	11
Type product	sticks	sticks	sticks
flour, strong	97.00		
flour, weak		100.00	100.00
cornflour	3.00	4.76	
malt extract 80%	2.83		
dough fat	1.94	4.80	17.60
amm. bic.	0.50	0.05	0.09
soda	0.35	0.8	
ACP	0.30		
salt	1.89	1.0	2.4
SMS			0.090
fresh yeast	2.47	1.90	
added water	45	38	32



5.4 Enrichment of pretzel sticks recipes shown.

Critical ingredients Flour, the protein content should be as shown and between batch uniformity is important.

Mixing One stage. Disperse the yeast in some of the water and keep away from salt in the straight dough.

Dough handling About one hour fermentation.

Dough piece forming By extrusion. The dough is softer than for sheeting and cutting and is continuously extruded through nozzles of about 4 mm diameter. The ‘ropes’ produced pass through a lye bath and are dusted with salt as described in section 5.2.2. Before baking a cutter nicks the ropes (making a partial cut as the ropes are too soft and sticky to make a complete cut) and the sticks easily break at these points after baking.

Baking on a wire mesh band at temperatures of 240, 220, 200 °C for c 6 minutes.

The enrichment of pretzel sticks recipes is given in Fig. 5.4.

5.2.5 Chemicals present in the recipes of this group

From the database of all recipes in this group of crispbreads and pretzels it is found that aeration is often achieved by the use of yeast with fermentation.

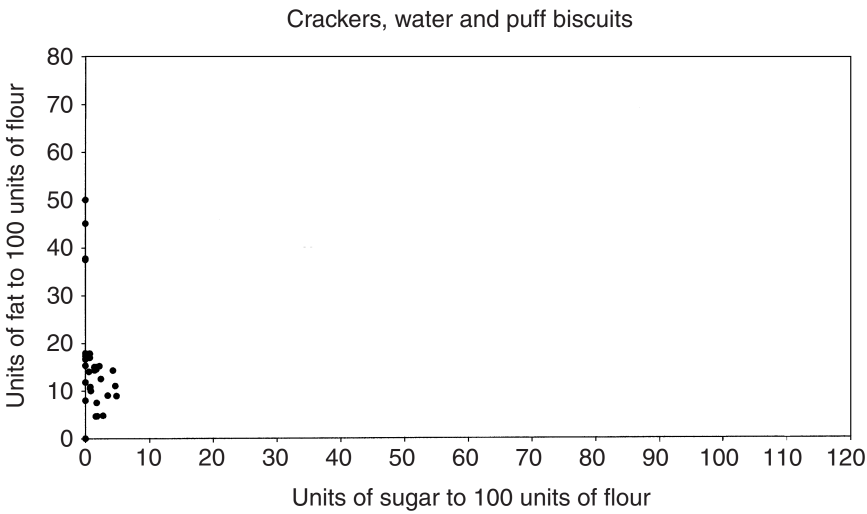
Only a minority use ammonium bicarbonate and where this is so the average amount is 0.35 units.

Surprisingly few recipes use sodium bicarbonate so product pH control is clearly unimportant.

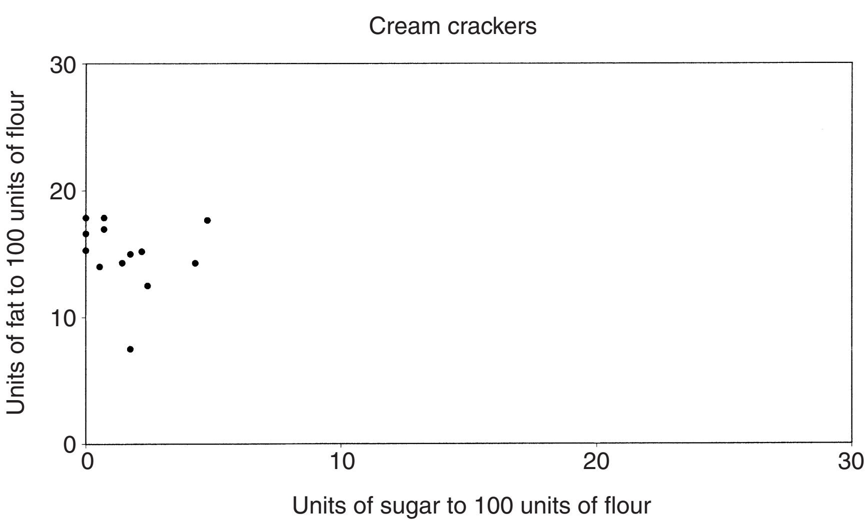
All use salt in the recipe and at the high average level of 1.46 units. This means that many of these products are very salty in taste because salt is often applied as a topping before baking.

5.2.6 Secondary processes

The salty and snack nature of these products means that no secondary process is used. Full coating of crispbreads with chocolate has been known but is currently rare or non-existent.



5.5 Enrichment of crackers, water biscuits and puff biscuits.



5.6 Enrichment of cream cracker recipes.

5.3 Cream crackers, soda crackers and water biscuits

Biscuits in this group are all used as long shelf-life bread substitutes and can be called crackers. The recipes are low in sugar, most of the doughs are fermented with yeast and are processed to give products with a dry flaky character. The flavour of the crackers is said to arise significantly from the products of fermentation so those made by long fermentation can be expected to have stronger flavours than those with short fermentation. During long fermentation not only does the added yeast grow but also the adventitious microflora, mostly bacteria, present in the flour. Long standing times for dough are very inconvenient and there is no knowing how much activity will arise from the flour microflora. For these reasons a continuous fermentation technique is now available to standardise the flavour development and to reduce the dough holding times.

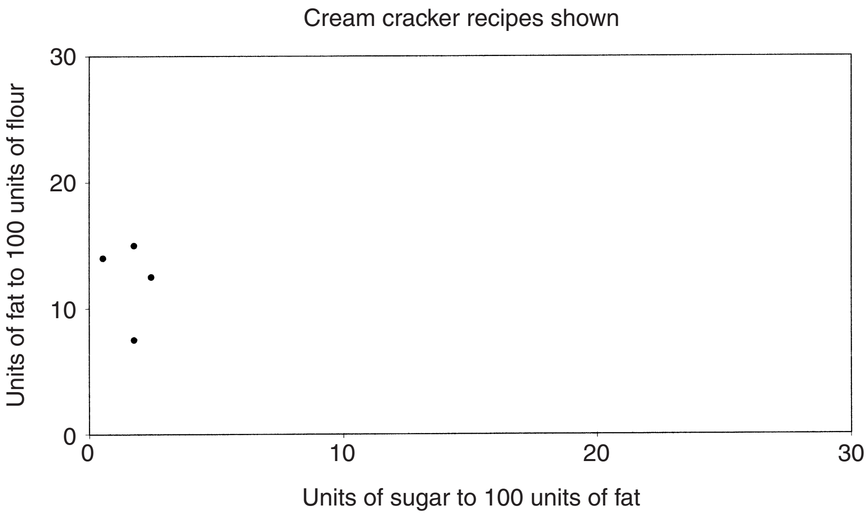
The enrichment of crackers, water biscuits and puff biscuits is shown in Fig. 5.5.

5.3.1 Cream crackers

Cream crackers are a typical British product, although they originated in Ireland in about 1885 and are now made in very many countries. The original character of a large square cracker with a soft flaky structure has often been lost and many products called cream crackers are not like this. Crackers like Hotel crackers have the same structure but are smaller. The recipes and details given here are for more or less typical cream crackers.

A range of enrichment of cream cracker recipes is shown in Fig. 5.6.

Recipe no. Type product	12 cream cracker	13 hotel cracker	14 cream cracker	15 cream cracker
sponge				
flour, strong	33.3			
fresh yeast	0.5			
salt	0.02			
added water	13			
dough				
sponge dough	as above			
flour, strong			100.00	100.00
flour, weak	66.7	97.50		
dried gluten		2.50		
granulated sugar			1.75	1.75
cane syrup 80%		0.89		
malt extract 80%	1.34	2.14		
dough fat	28.0	12.25	7.50	15.00
lecithin		0.25		
soda	0.67	0.13		
salt	1.68	0.98	0.63	0.63
P. enzyme			0.100	0.100
fresh yeast		1.61	0.90	0.90
added water	40	32	31	27



5.7 Enrichment of cream cracker recipes shown.

Typical flour/fat mixture for incorporation during laminating.

flour, weak	100
fat (hydrogenated and plasticised)	33
salt	1

These constituents are mixed to a powdery consistency which is kept in a cool place to prevent the fat melting. The hard fat ensures that the mass is not sticky and lumpy.

It is used at a rate of between 9 and 18% of the dough during laminating.

Critical ingredients Flour strength. A bread flour is normally used. The use of proteolytic enzyme is to weaken the dough to improve sheeting. In long fermentation the microflora provides the enzyme action.

Mixing One stage for straight doughs, two stage for sponge and dough method. Recipe 12 involves a sponge and dough technique and the others are straight doughs. Always disperse the yeast in some of the water and keep away from salt in the straight dough. Mix to 33–36 °C for optimum growth of the yeast.

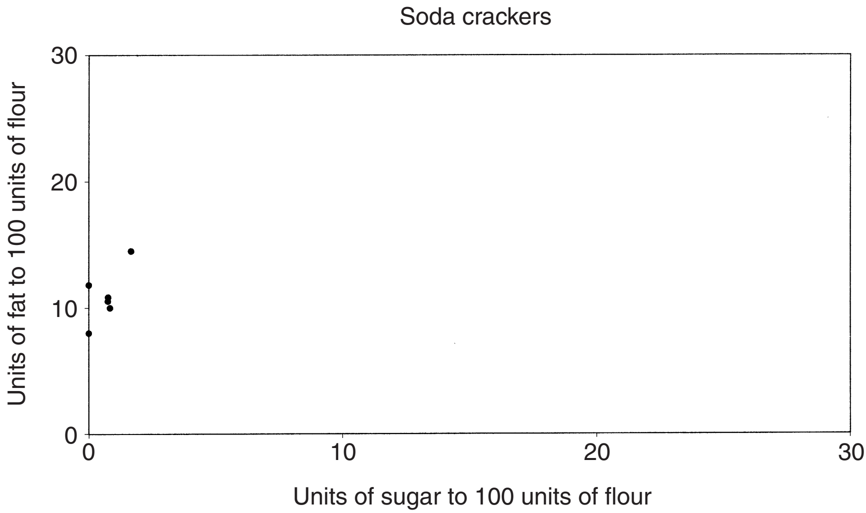
Dough handling All doughs require a standing time to allow the yeast to ferment. For the sponge dough this may be as long as 16 hours and for straight doughs and doughs after incorporation of the sponge dough, the fermentation time is usually about 3 hours but can be as short as 1 hour or as long as 5 hours. For short fermentations more yeast must be added to the dough and as a rough rule the fermenting dough should double its volume by the time it is taken for use. Fermenting doughs must be held in temperature- and humidity-controlled areas.

Dough piece forming A sheeting and cutting technique is always used. After sheeting the dough must be laminated and usually a flour/fat mixture is dusted between the layers. This encourages separation of the layers during baking and adds fat to the recipe which gives a softer eating biscuit. Inclusion of significant amounts of flour/fat mixture may give a problem because the cutter scrap dough is richer in fat than the fresh dough. If this scrap dough is irregularly included in the top of the sheet at the time of cutting the uniformity of colour of baked crackers will be affected. Recipe 15 compared with 14 shows how more fat can be used in the recipe and less flour/fat mixture, or a mixture with less fat, can be used at the time of laminating.

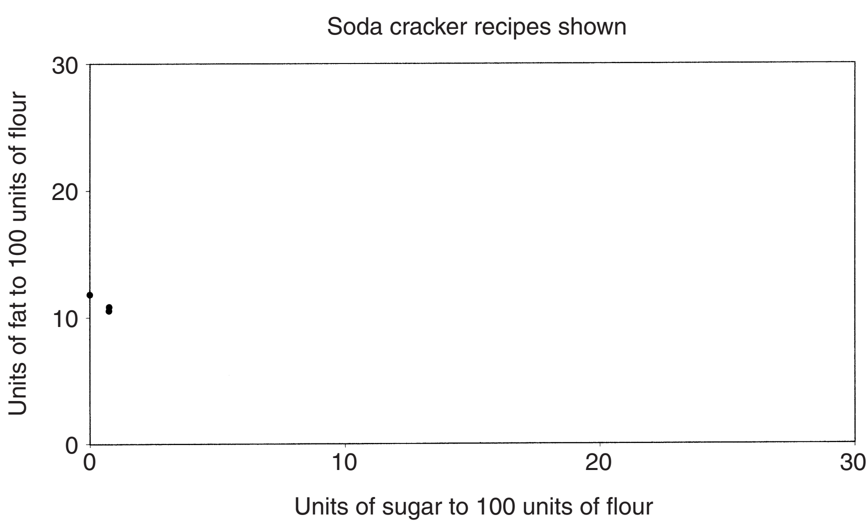
Baking Development of an open structure demands rapid heating of the dough piece. An open wire mesh band is used which is preheated.

Baking time	c 3.0 minutes at 310, 290, 270, 250 °C
	c 5.5 minutes at 250, 250, 240, 210 °C

The enrichment of cream cracker recipes shown is given in Fig. 5.7.



5.8 Enrichment of soda cracker recipes.



5.9 Enrichment of soda cracker recipes shown.

5.3.2 Soda crackers

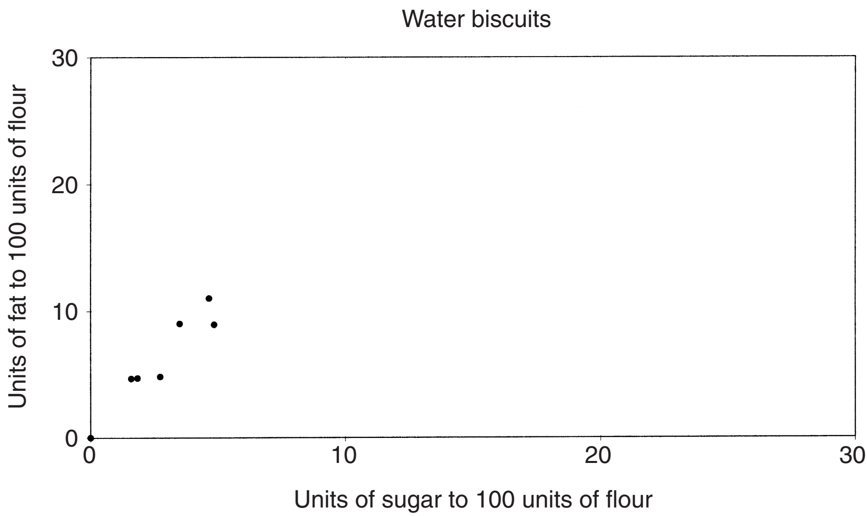
These crackers are typical of the USA where they may be known as saltines or premium crackers. They tend to be made and eaten in countries that do not have cream crackers. Typically, the crackers are squares but much smaller than cream crackers. They are made by the sponge and dough method and a significant amount of sodium bicarbonate is added at the dough stage which gives them a higher pH than cream crackers and hence the name 'soda crackers'. As for cream crackers there has been some confusion in the naming of soda crackers and some 'soda crackers' are leavened with ammonium bicarbonate and oil sprayed like savoury crackers (see section 5.4).

Recipe no. Type product	16 soda cracker	17 soda cracker	18 soda cracker
sponge			
flour, strong	19.8	63.1	66.7
flour, weak	49.6		
fresh yeast	0.15	0.63	0.17
dough fat	5.91		5.0
butter		12.6	
lecithin		0.24	0.53
malt extract 80%			0.95
added water	29.5	23.7	28
dough			
sponge dough	as above	as above	as above
flour, weak	30.6	36.9	33.3
malt extract 80%		0.95	
dough fat	5.91		5.0
SMP	3.7		
soda	0.89	0.49	0.60
salt	1.62	1.89	1.5
P. enzyme		0.005	
added water	0	5	4

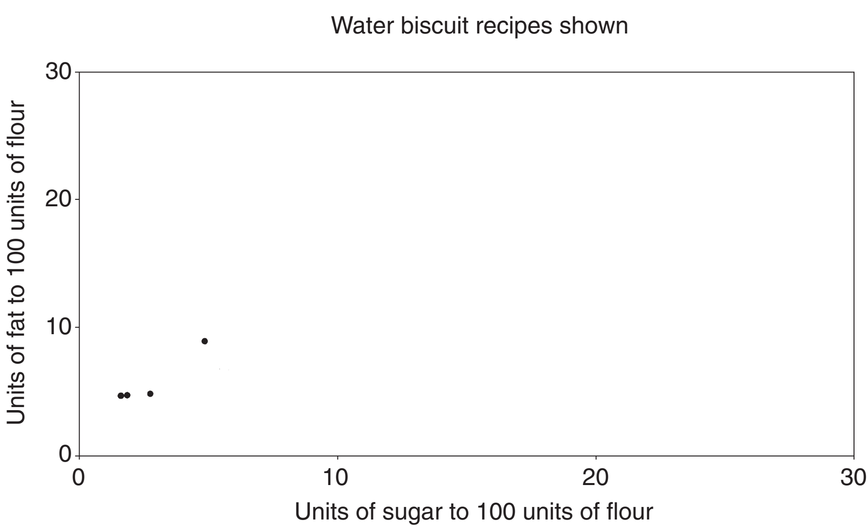
Critical ingredients Flour strength. The use of proteolytic enzyme is to weaken the dough to improve sheeting.

Mixing Always a two-stage, sponge and dough method. Disperse the yeast in some of the water and keep away from salt. Mix to 33–36 °C for optimum growth of the yeast, but the mix time for the sponge dough is usually very short so warm water should be used. It will be noted that the proportion of sponge dough in the whole is greater than for cream cracker and also that it is usual to include some or all of the fat in the sponge dough.

Dough handling The sponge dough is fermented for 16–24 hours and the remixed dough stage for about 3–5 hours. Fermenting doughs must be held in temperature- and humidity-controlled areas.



5.10 Enrichment of water biscuits.



5.11 Enrichment of water biscuits shown.

Dough piece forming A sheeting and cutting technique is always used. After sheeting the dough must be laminated but there is no inclusion of dusting between the layers.

Baking Usually on a heavy woven oven band which is preheated before the dough pieces are placed on it. Bake time 2.5–3.0 minutes at 300, 280, 250 °C.

The enrichment of soda cracker recipes is given in Fig. 5.8, and of soda cracker recipes shown is given in Fig. 5.9.

5.3.3 Water biscuits

These are a very basic form of laminated cracker. The dough is much harder (lower in water) than cream or soda crackers and the eating quality is much harder and crisper.

Recipe no. Type product	19 water biscuits	20 water biscuits	21 water biscuits	22 water biscuits
flour, strong	50.00	25.00	50.00	39.60
flour, weak	50.00	75.00	50.00	60.40
granulated sugar			1.74	
cane syrup 80 %		5.36	1.25	2.30
invert syrup 70 %	2.28			
malt extract 80 %		0.71		
dough fat	4.66	8.93	4.82	4.70
soda	0.08		0.08	0.08
salt	1.01	1.61	1.01	1.00
fresh yeast		0.54	1.74	
added water	31	27	30	31

Critical ingredients Flour strength.

Mixing The mix time may be prolonged but the dough is crumbly and it does not form a cohesive mass.

Dough handling The dough may be used immediately after mixing or it may be stood for up to 3 hours to allow some fermentation or relaxation of the gluten with the aid of the flour microflora.

Dough piece forming A sheeting and cutting technique is always used. After sheeting the dough must be laminated but there is no inclusion of dusting between the layers. The dough is hard and tough. The sheeter needs to be strong to handle such dough.

Baking On the lightest possible wire band in the hottest possible oven. Typical baking is for 2.5 to 4 minutes at 350, 300, 250 °C. The surface of the biscuit should be strongly blistered.

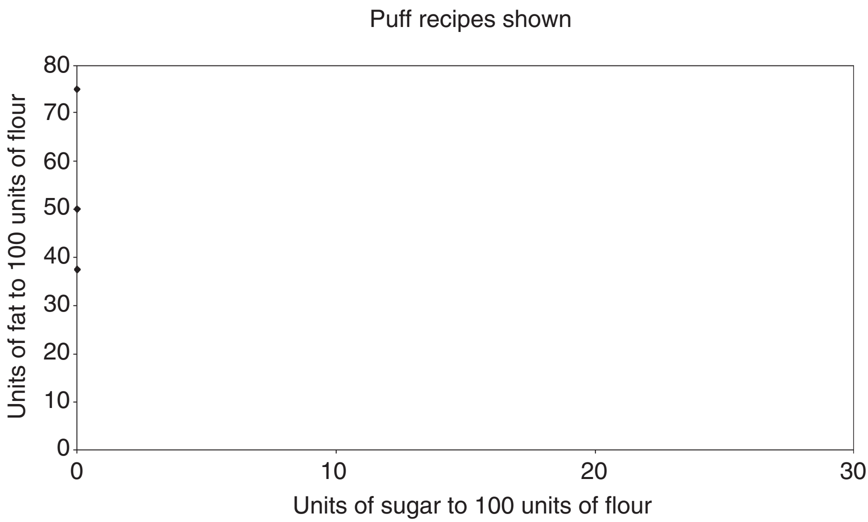
The enrichment of water biscuits is given in Fig. 5.10, and of water biscuits shown in Fig. 5.11.

5.3.4 Review of chemical use

Being bread substitutes, both in use and to a large extent in formulation, salt is used in all recipes (average level about 1.27 units) and soda is commonly used to modify the cracker pH and provide some leavening (average level 0.37 units). Ammonium bicarbonate is not used.

5.3.5 Secondary processes

The dry structure of these products means that secondary processes are rarely used.



5.12 Enrichment of puff recipes shown.

5.4 Puff biscuits

Puff biscuits are crackers with a more defined flaky structure than cream crackers and with a much higher fat content. The essential character of puff biscuits is a very open and distinctly flaky structure. Puff biscuits are used as bread substitutes (crackers) or as shells for a cream sandwich. There are also some speciality products based on puff dough that are beyond the scope of this book.

Recipe no. Type product	23 lemon puff	24 half paste	25 three-quarter paste
flour, strong		50.00	50.00
flour, weak	98.50	50.00	50.00
dried gluten	1.50		
dough fat		7.00	9.00
whey powder	1.94		
salt	1.40	1.79	1.79
SMS	0.019		
added water	43	48	46
layering fat mixture	56.3		
layering fat		43.00	66.00

Critical ingredients Flour strength and physical characters of the layering fat. The layering fat must be firm and plastic at the dough temperature. In order to avoid using fat with a high melting point ‘tail’ which is unpleasant to eat, the dough temperature must be cold, not more than 18 °C, but preferably less. In recipe 23 the layering fat is a mixture of 67% fat, 33% flour. The mixture has been blended and plasticised. The addition of the flour makes it easier to plasticise the mass and also extends the volume of the layering fat.

Mixing There are two basic mixing methods. In one the dough ingredients, except the layering fat, are roughly mixed and then lumps (about 30 mm cubes) of the layering fat are added and the mixing continues to give a good distribution of these lumps. The mixing must be stopped before the lumps of layering fat break up (recipe 23). This is known as rough puff. In the other mixing method the dough ingredients include a small amount of dough fat and mixing is to a clear dough. There is no late addition of fat in the mixer.

Dough handling It is normal to relax puff doughs both before use and as much as possible during the processing of dough piece forming. It is essential that this relaxation takes place in cool conditions otherwise the layering fat will melt and be less effective.

Dough piece forming A sheeting and cutting method is always used. Laminating is an essential process and as the dough may be firm and cool a cut sheet laminator is to be preferred. In the case of the rough puff doughs the sheeted dough is laminated (usually there are two laminators set at 90° to each other) and the laminated dough is gauged to a thickness suitable for cutting. In other cases two sheets are formed and layering fat is spread between these sheets before laminating. This method allows much more fat to be included in the laminated dough. The dough handles better and the eating quality of the baked biscuit is softer and less crisp.

Dough pieces may be dusted with fine sugar before baking. The structural development during baking means that a very thin layer of dough supports this sugar dusting and allows the oven heat to melt it. The result is an attractive glossy surface of sugar glass. This technique is used for sweet products like Lemon Puff cream sandwiches.

Baking on a wire band at 250, 250, 180 °C for 5–6 minutes.

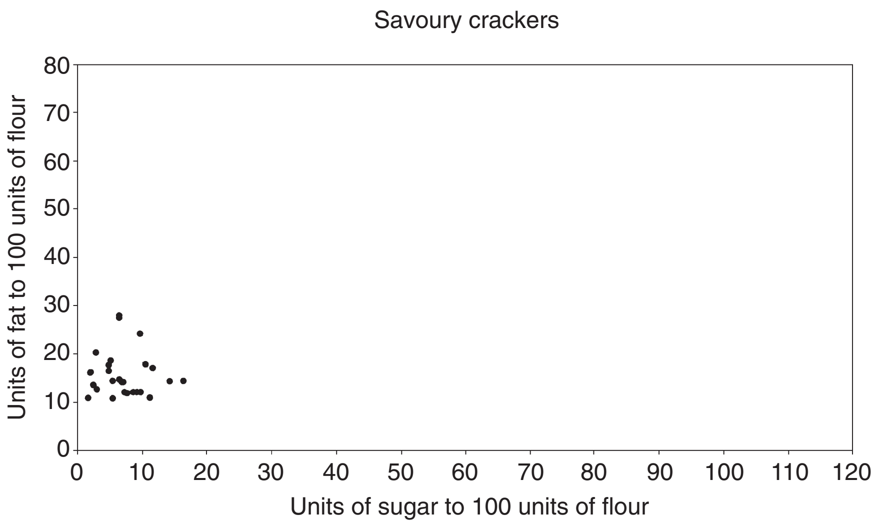
The enrichment of puff recipes shown is given in Fig. 5.12.

5.4.1 Review of chemical use

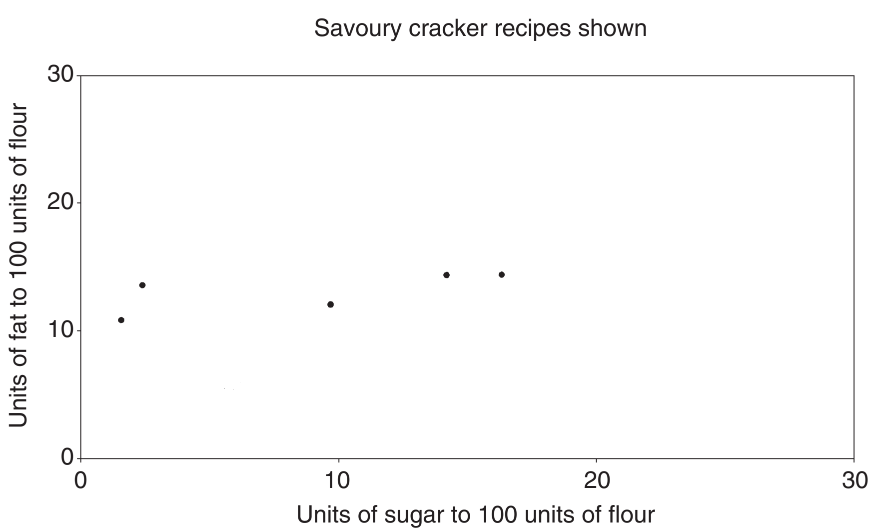
The only chemicals used are salt and sometimes SMS which is useful for improving the extensibility of the gluten. Salt is included as a flavour enhancer at the relatively very high average level of 1.71 units. Sodium bicarbonate and ammonium bicarbonate are not normally used.

5.4.2 Secondary processes

Cream sandwiching is the only common secondary process.



5.13 Enrichment of savoury cracker recipes.



5.14 Enrichment of unflavoured savoury cracker recipes shown.

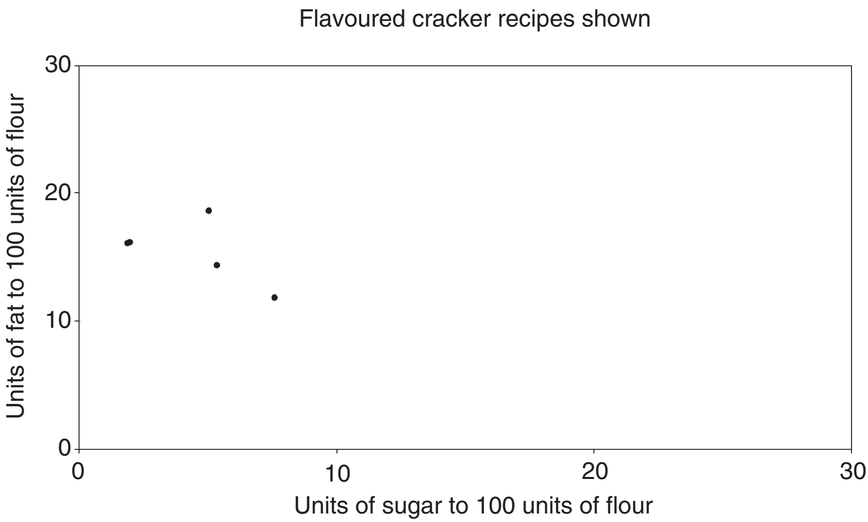
5.5 Savoury or snack crackers

This is a group of cracker type biscuits that are variously salted, flavoured and fat-sprayed after baking. Because they are made in a very wide range of shapes and sizes they can be regarded as savoury snacks, nibbles or biscuits for cheese. These biscuits are characterised by very open textures and soft eating mouthfeel. This texture is created by the action of proteolytic enzyme on the gluten in the dough and the use of high levels of ammonium bicarbonate. Usually they are simple biscuits but sometimes they may be cream sandwiched with a savoury, non-sweet, cream often based on cheese powder. Well known products such as TUC, Ritz, Fishes and Cheddars belong in this group.

The enrichment of savoury cracker recipes is shown in Fig. 5.13.

5.5.1 Unflavoured crackers

Recipe no. Type product	26 snack cracker	27 fishes	28 mini pizza	29 TUC type	30 Ritz type
flour, weak	90.00	90.00	95.24	100.00	100.00
cornflour	10.00	10.00	4.76		
granulated sugar		3.33			
powdered sugar	3.00				6.00
invert syrup 70%	16.00	8.67	6.80	1.04	3.00
malt extract 80%				2.08	2.00
glucose syrup 80%		8.67			
dough fat	14.00	14.00		13.54	12.00
margarine			16.33		
lecithin	0.28	0.30	0.27		
cheese powder			5.44		
amm. bic.	3.00	5.00	4.90	2.60	1.00
soda	1.00	1.10	0.54	0.44	1.05
ACP/tartar				0.05	1.10
salt	1.00	1.00	1.09	1.23	0.90
SMS	0.050	0.130	0.068		
P. enzyme				0.180	0.200
herbs	2.00				
MSG				0.42	
biscuit recycle		8.33			
added water	25	20	27	25	20



5.15 Enrichment of flavoured savoury cracker recipes shown.

5.5.2 Flavoured crackers

Recipe no. Type product	31 savoury cracker	32 savoury cracker	33 bacon cracker	34 cheese cracker	35 Cheddars type
flour, weak	100.00	100.00	100.00	100.00	100.00
granulated sugar		4.00			
powdered sugar	5.36				3.08
invert syrup 70 %			0.92	1.04	2.82
malt extract 80 %		4.50	1.56	1.56	
maltodextrin	1.52				
dough fat	10.50	10.00	13.02	11.46	
oil					12.82
lecithin	0.20				
GMS		0.50			
cheese, fresh	10.70				
cheese powder		4.00	6.77	10.42	12.82
SMP	1.52	1.33			
amm. bic.	5.71	1.75	2.86	2.60	3.59
soda		0.87	0.44	0.47	0.75
ACP			0.05	0.05	
salt	1.79	0.75	1.23	1.23	0.77
SMS	0.045	0.060			0.021
P. enzyme			0.180	0.180	0.154
powder flavour			0.10		
MSG	0.13		0.42	0.42	0.15
lactic acid					0.38
colour*			0.10		
added water	30	33	26	26	35

* This ingredient is not represented by accurate quantity.

Critical ingredients Amount and activity of proteolytic enzyme relative to dough standing time. Quality and flavour of cheese or cheese powder. Stability of oil used for post oven spraying.

Mixing All-in mixing. Mixed to about 40 °C for SMS doughs and about 33 °C for proteinase doughs. Where cheese powder is used it is best to blend this powder with the fat before adding the flour and water. To achieve a good and strong cheese flavour is a difficult task as addition of cheese powder interrupts the dough structure and tends to result in loss of structural development during baking.

Dough handling SMS doughs are used immediately after mixing and should be kept warm. Proteinase doughs must be stood to allow the enzyme to react with the gluten. It is recommended that a standing time of about 3 hours at 35 °C is used, longer times require an appropriate adjustment of the quantity of enzyme.

Dough piece forming A sheeting and cutting method is always used. Laminating is an option but is not essential. The dough pieces are often lightly dusted with fine salt before baking. The Mini pizza, recipe 28, is topped with tomato paste and dustings of cheese and herbs before baking. Bacon crackers can be made by laminating a red-coloured dough between two uncoloured doughs.

Baking Always on a wire band preferably with preheating. Baking times and conditions depend on the size of the dough piece but are generally around 5 minutes at 220, 220, 180 °C. High bottom heat should be used in the first part of the oven.

Post-baking Immediately after baking, and while the biscuits are still hot, there is an application of warm oil to the top or both surfaces. This improves the colouration (making it more golden brown) and the eating quality. It is essential that high-stability oil is used and coconut oil is recommended. The amount of oil applied ranges from 8 to 18% by weight.

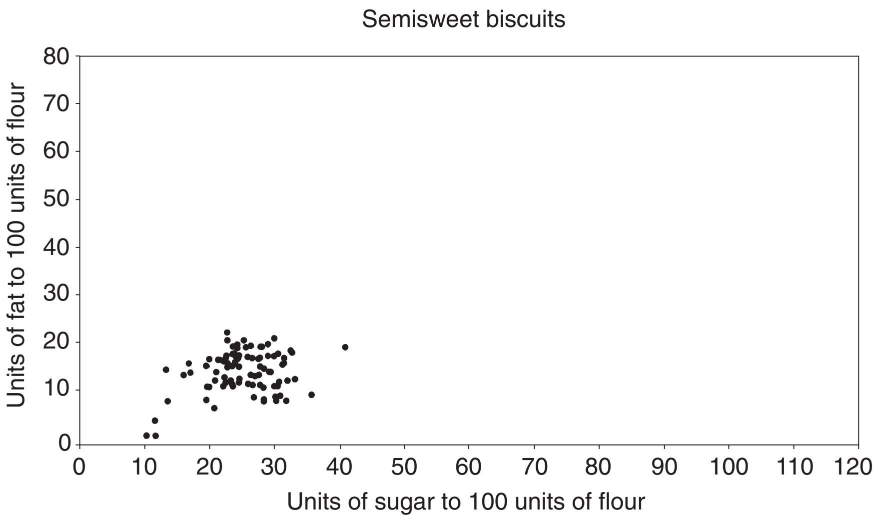
The enrichment of unflavoured savoury crackers shown is given in Fig. 5.14 and of flavoured crackers shown in Fig. 5.15.

5.5.3 Review of chemical use

The main feature of these recipes is the high usage of ammonium bicarbonate. The average amount is 3 units but amounts of up to 5.7 units have been recorded. The sodium bicarbonate levels average 0.32 units and salt, as a component of the dough and not as dusting, averages 1.13 units. The use of proteinase enzyme contributes to the characteristic tender texture of these crackers. However, there are many recipes that rely on SMS to increase the extensibility of the gluten and this is principally because the reaction of proteinase requires a dough standing time of ideally 3 hours or more. This is not convenient in many factories.

5.5.4 Secondary processes

Cream sandwiching is the only common secondary process. As the biscuits tend to be soft eating, the cream should be made with a soft fat compatible with the eating texture of the shell biscuits. The creams are savoury, i.e. they are not based on sugar (see section 10.2.3).



5.16 Enrichment of semisweet dough recipes.

5.6 Semisweet biscuits

All biscuits in this group are characterised by doughs which contain a well-developed gluten network but, with increasing amounts of sugar and fat, the gluten becomes less elastic and more extensible. The prime requirement is a biscuit with a smooth surface which has a slight shine or sheen and an open even texture giving a bite that ranges from hard to delicate. This is achieved by a subtle balance between the requirements of recipe and processing.

Best biscuits are made from flour with low protein, in the range 7–8%, but such flour is often difficult to source. When flour with higher protein is used the gluten is not extensible enough (it is too tough and elastic) and some form of modification technique is required. Usually this is done with SMS, but increasingly proteolytic enzyme is being used. The latter does not act in the same way as SMS but it does produce doughs that are easier to sheet.

The most common method of dough preparation involves a vigorous or extended mixing to produce a developed dough. As a result of the mixing action heat is developed. Dough is normally used at 35–40 °C. However, there is another mixing technique common in mainland Europe where the dough is made in a two-stage process similar to that used for short doughs. Mixing is much less vigorous and final dough temperatures lower. These doughs are referred to here as ‘continental semisweets’. Their baked texture is generally softer and less crisp than biscuits from developed doughs. These doughs usually require less water.

For developed doughs there are maximum levels of fat and sugar that can be used. If these levels are exceeded it is not possible to produce an extensible dough: the dough is short. The following sets of recipes serve to illustrate the lowest and highest levels of fat and sugar that are encountered in biscuits of this group.

Semisweet biscuits are ‘basic’ biscuits which are significant in the markets of many countries, particularly developing countries where the low cost of the formulation is attractive. They provide useful carriers for very sweet additions such as cream, chocolate and icing applied during secondary processing.

The enrichment of semisweet dough recipes is shown in Fig. 5.16.

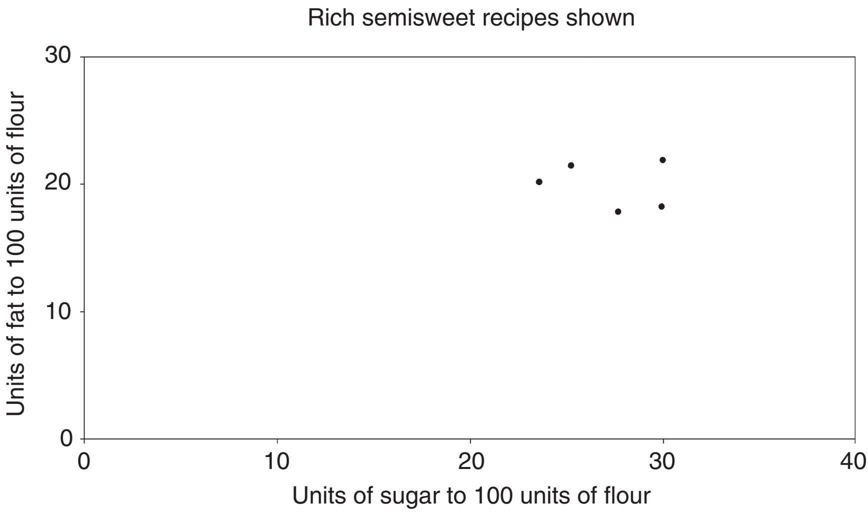
5.17 Enrichment of lean semisweet dough recipes shown.

5.6.1 Developed doughs

Low fat and/or low sugar semisweet biscuits

Recipe no.	36	37	38	39	40
Type product	cabin	rich tea	cabin	gem	petit beurre
flour, weak	100.00	100.00	100.00	94.34	90.45
cornflour				5.66	9.55
granulated sugar				16.98	17.83
powdered sugar	10.30		10.29		
cane syrup 80%		20.00			
invert syrup 70%	2.00				4.46
glucose syrup 80%				3.77	
honey 80%					1.91
dough fat		14.30	1.82	9.43	12.74
margarine	2.14			2.64	
lecithin				0.19	
amm. bic.	0.86	0.78	0.86	0.38	0.13
soda	1.00	0.64	1.00	0.75	0.96
salt	0.86	1.16	0.86	0.75	0.76
SMS	0.006	0.024	0.006	0.008	0.050
vanilla/in*				0.10	0.10
liquid flavour*				0.10	
biscuit recycle				1.89	
added water	29	20	29	19	21

* These ingredients are not represented by accurate quantities.

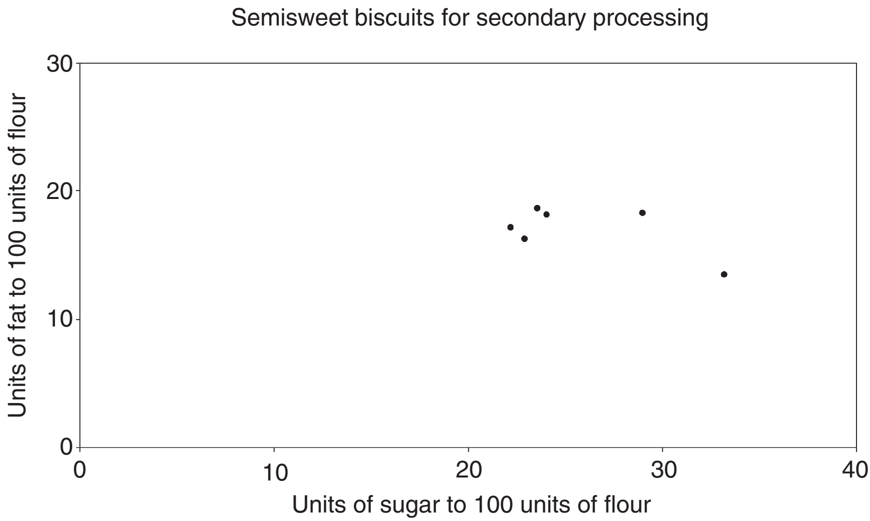


5.18 Enrichment of rich semisweet dough recipes shown.

High fat and/or high sugar semisweet biscuits

Recipe no. Type product	41 rich tea	42 marie	43 petit beurre	44 tea finger	45 marie
flour, weak	100.00	100.00	100.00	100.00	98.98
cornflour					1.02
granulated sugar			17.97		
powdered sugar	25.00	21.40			28.79
cane syrup 80%	6.25	2.68		3.37	
malt extract 80%		2.14		2.59	
glucose syrup 80%			7.03		1.44
liquid sugar 67%				34.21	
dough fat	21.80	21.40	8.00		
margarine					21.60
butter			11.72	17.76	
lecithin			0.39		
SMP			3.13		9.00
whey powder	0.89				
dried egg			0.78		
amm. bic.	0.36	0.85	2.34	0.13	0.42
soda	0.54	0.45	0.63	0.50	0.48
salt	0.71	1.25	0.70	1.09	0.99
SMS	0.034	0.039	0.070	0.039	
liquid flavour*			0.10		
biscuit recycle			2.34		
added water	21	20	18	6	20

* This ingredient is not represented by accurate quantity.



5.19 Enrichment of typical semisweet doughs for biscuits for secondary processing.

Semisweet biscuit shells for sandwich creaming, etc.

Recipe no. Type product	46 shell for cream	47 shell for cream	48 shell for ice cream	49 shell for icing	50 pencils	51 garibaldi
flour, weak	96.55	100.00	100.00	100.00	100.00	100.00
cornflour	3.45					
granulated sugar			31.40			
powdered sugar	20.69	10.71		24.00	17.90	20.70
cane syrup 80%	2.76	16.67			3.57	3.57
invert syrup 70%			2.55	6.20		
malt extract 80%				0.80	1.79	
dough fat	15.54	18.10	13.14	18.20	16.80	18.23
lecithin	0.66		0.26		0.30	0.37
SMP	1.72				2.14	
amm. bic.	0.60	0.12		0.36	0.54	0.49
soda	0.69	0.50	0.91	0.36	0.71	0.18
ACP	0.52				0.58	
SAPP		0.16	0.22			
salt	0.69	0.67	0.73	0.36	0.89	0.71
tartaric acid				0.18		
SMS	0.004	0.072	0.180		0.009	0.022
vanilla/in*			0.10		0.02	
spice*						0.10
liquid flavour*						0.10
cocoa			8.76			
colour*	0.10					
caramel colour		0.12				
biscuit recycle		7.00	10.90			
added water	19	24	22	17	22	21

* These ingredients are not represented by accurate quantities.

Critical ingredients Flour quality: if the protein content of the flour is higher than 10% there could be problems in sheeting the dough even after treatment with SMS. The fat should be semi solid and plasticised, if the fat must be added as liquid oil it is desirable to add the sugar as a solution. As fat level is critical to both the recipe cost and the eating quality of the biscuit the use of some emulsifier like lecithin allows the fat to be more effective in its shortening properties. Despite the name Petit Beurre biscuits do not always use butter! If butter is used it should be at about 25°C (not melted) to allow good dough development. Flavouring of these biscuits is difficult because the water removal during baking strips out volatile chemicals.

Mixing Normally an all mixing method is used. A two-stage method to allow some dissolution of the sugar in the water or plasticising of block fat is not uncommon. Disperse the ammonium bicarbonate in some of the water before adding to the mixer. Keep the acid salts away from the soda if possible.

Adequate time must be allowed for dissolution of the sugars, hydration of the flour and development of extensible gluten. To achieve this, to keep the dough water level as low as possible and to have a good dough consistency it is best to mix until the dough reaches a set temperature (40 °C is recommended for SMS doughs) rather than mixing to time.

Doughs made with proteinase will probably be mixed to lower temperatures and be stood before use.

Dough handling Except where the dough is cured with proteinase the dough should be used without delay and kept warm.

Dough piece forming With extremely rare exceptions (when rotary moulding is used) the sheeting and cutting method is used. In many cases laminating is used but this is only necessary where the extensibility of the dough is not as good as it should be. In these cases laminating may help a little as it gives more work to the dough and provides some relaxation before cutting. Adequate dough relaxation is required before cutting and this also provides a process control technique for maintaining the correct shape of biscuits due to shrinkage after cutting and during baking.

Occasionally a milk wash or a dusting with sugar is given to the dough pieces before baking.

Baking Usually on a wire band but sometimes (particularly for Marie) a steel band is used. Bake times are about 5 to 6.5 minutes at 200, 220, 180 °C. Keeping the first part of the oven humid will give an attractive sheen to the biscuit surface. Baking to a moisture level of less than 1.5% will normally prevent the problems of checking.

The enrichment of lean semisweet dough recipes shown is given in Fig. 5.17 and of rich semisweet dough recipes shown in Fig. 5.18.

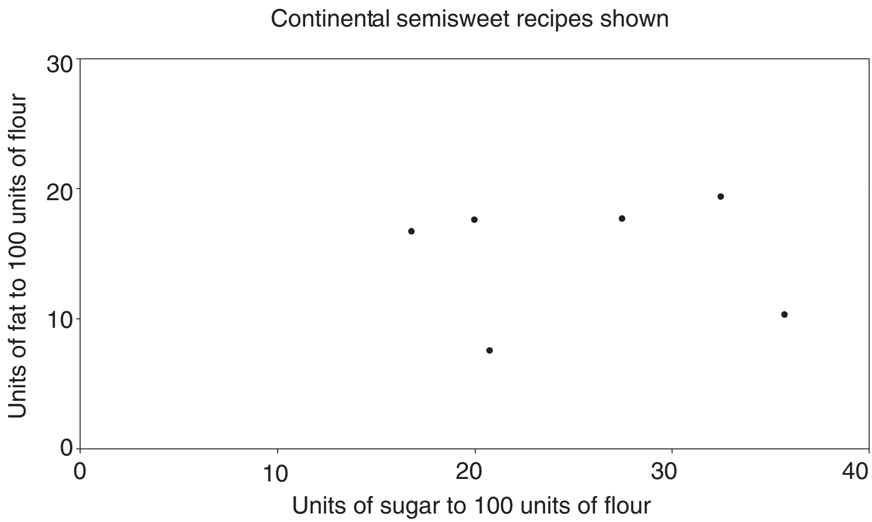
5.6.1.1 Chemicals present in the recipes of this group

All recipes contain ammonium bicarbonate. The average level is 0.73 with a range up to 1.54. All use sodium bicarbonate and where no acid salt such as SAPP is used the average amount is 0.60. The range is from 0.18 to 1.41. All use salt. The average level is 0.78 with a range from 0.30 to 1.58.

Most use sodium metabisulphite (SMS). Where used the average level is 0.041 with a range from 0.006 to 0.18. Any amounts greater than 0.08 indicate serious problems with flour protein quality for this type of dough. About 12% of the recipes use proteinase, sometimes in combination with SMS.

5.6.1.2 Secondary processes

It is common to use shells for cream sandwiching. The creams are sweet and have various flavours: vanilla, lemon, chocolate and strawberry are the most common.



5.20 Enrichment of continental semisweet recipes shown.

Shells may be used for icing (see 10.3).

Biscuits may be used for the centres of chocolate, either fully enrobed (see the Pencils recipe, 50), half-coated or as centres for moulded bars.

An unusual form is the Garibaldi biscuit which is formed by including currants between two sheets of dough. Full details of the processing of this may be found in Manley.[2]

The enrichment of typical semisweet doughs for biscuits for secondary processes is shown in Fig. 5.19.

5.6.2 Continental semisweet

Recipe no. Type product	52 military	53 casse croute	54 petit beurre	55 petit beurre	56 shell for cream	57 centre for chocolate
1st stage mixing						
granulated sugar			27.50			
powdered sugar	6.67	17.90		17.54	31.60	35.73
cane syrup 80%		3.57				
invert syrup 70%				3.51	1.30	
malt extract 80%	2.22					
dextrose	8.36					
dough fat	16.67		5.00	17.54	18.60	
butter			15.00			12.14
margarine		8.93				
soya flour				1.14		
SMP	6.67	1.79	2.80			0.74
FCMP					2.60	
sweet condensed milk				1.75		
amm. bic.	0.59	0.34	0.30	0.96	0.67	1.49
soda		0.54	0.50	0.18	0.50	0.55
ACP		0.09	0.12			
salt	1.51	0.54	0.30	0.70	1.00	1.09
tartaric acid			0.15			
citric acid						0.15
SMS	0.013					
P. enzyme	0.1000					
L-cysteine						0.03
vanilla/in*					0.10	0.10
liquid flavour*		0.10				
biscuit recycle						10.92
added water	24	22	26	14	20	29
2nd stage of mixing						
flour weak	66.67	89.30	100.00	87.72	100.00	96.28
cornflour		10.70		12.28		3.72
potato starch	33.33					

* These ingredients are not represented by accurate quantities.

Critical ingredients As detailed in section 5.6.1.

Mixing This is often a multistage process. For the recipes above, two stages are defined. Often the situation is much more complex but basically the hydration and development of the gluten is less than for developed doughs. The resulting dough is relatively short and often sticky. The stickiness reduces on standing but can be a problem during dough piece forming.

Dough handling The dough may be used immediately after mixing or may be stood for about 30 minutes. This helps to reduce the stickiness.

Dough piece forming Always by sheeting and cutting and rarely involves laminating. The dough tends to be sticky and this may give release problems at the gauge rolls particularly at the final one. Various techniques are used to overcome this problem including flouring of the dough sheet, washing of the upper roll and continuously passing a blanket web through the roll pair on top of the dough sheet. As the surface of the dough pieces is not as smooth and clear as it is for developed doughs it is common to wash the surfaces with an egg or milk wash before baking. This improves the colouration during baking and imparts a shine.

Baking Similar to developed doughs.

The enrichment of continental semisweet recipes is shown in Fig. 5.20.

5.6.2.1 Chemicals present in the recipes of this group

The number of recipes in the database for continental semisweets is much lower than for the developed type of semisweet. All use ammonium bicarbonate with an average level of 0.54, all use sodium bicarbonate with an average level of 0.53 and all use salt with an average level of 0.71.

Not one uses SMS and the use of proteinase is uncommon.

5.6.2.2 Secondary processes

Secondary processes are similar to those detailed in section 5.6.1.2.

References

[1] BRESSLER, S (1978) 'New opportunities for Swedish Crispbread', *Food Eng*. November.

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

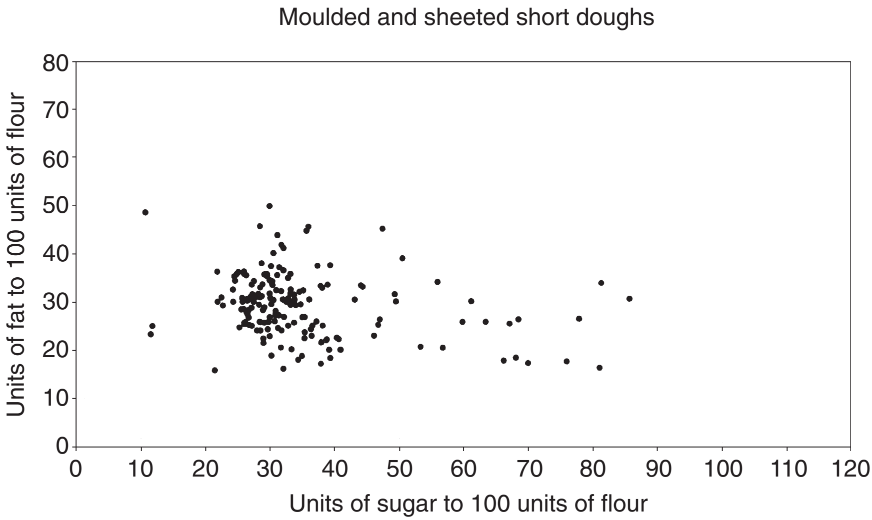
6
Recipes for short doughs

6.1 Introduction

Biscuits in this group make up most of the worldwide biscuit market. It is a very diverse group ranging from varieties high or low in fat and high or low sugar in more or less any combination. Biscuits in this group are used in all types of secondary processing thereby increasing the diversification of products. There is a clear distinction between these short doughs and the hard doughs which have lower sugar and fat contents (and therefore more water). This was shown in Fig. 2.2. However, there is no clear distinction between recipes in this group and those of subsequent groups which are formed by extrusion or deposition. Both of the latter allow the formation of products that are well distinguished from those in this group in terms of their appearance and shape.

Doughs from recipes in this group are distinguished from those called hard doughs in that they lack extensibility and elasticity, they readily break when pulled and this is where the term 'short' comes from. A significant amount of fat is usually involved and this is how dough fat comes to be called 'shortening'.

To achieve a tender eating quality it is important that the mixing of the dough does not allow development of much gluten. This will not happen if there is a lot of fat present (and therefore not much water) but if the fat level is relatively low the amount of mixing when flour is in the dough should be as little as possible. Overmixing is a common fault and gives harder, tougher and less acceptable biscuits. It is the fat that contributes mostly to a tender eating quality and the effectiveness of the fat in the dough can be increased by using a small quantity of emulsifier. There are many emulsifiers available



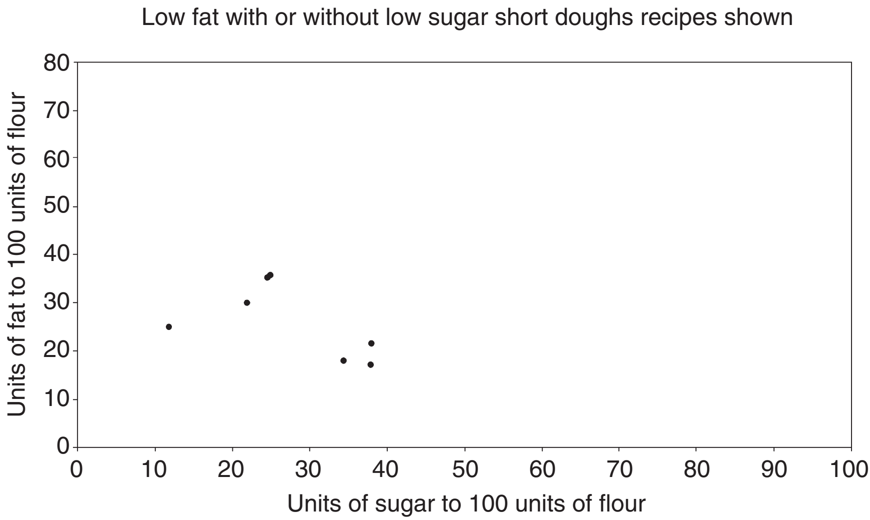
6.1 Enrichment of moulded and sheeted short doughs.

but the one most commonly used, because it is a natural product, is soya lecithin. In its liquid form this is an unpleasant material to handle and to be most effective it should be well blended with the fat. Powder lecithin is also available but this is the liquid form spray dried onto a powder such as that of skimmed milk and is therefore more expensive. It is best to use lecithin at a rate of about 2% of the fat rate. At higher rates the effectiveness is not particularly enhanced and the taste of the lecithin is not attractive. It will be seen in the following recipes that many have not followed this recommendation for lecithin or other emulsifiers. They probably experience some economic loss as a result.

During baking it is common for the dough pieces to expand in length and width. They should never shrink, as those of hard dough do, though this may happen if the dough has been overmixed. The expansion, often called 'spread', during baking puts some constraints on the type of baking band. Those that spread significantly must be baked on steel bands, not wire bands, as they would be impossible to remove after baking if they had sunk down into the wire. Those that spread most are rich in sugar. Others less rich in fat and sugar spread only a little so can be baked on wire bands or perforated steel bands.

The following recipes are grouped together for convenience. It would not be ethical to show recipes for well known brands, and the names would not be understood in all parts of the world, so the aim has been to give a number of representative recipes to show what is possible in terms of fat and sugar enrichment and also to show how manufacturers use a wide range of ingredients. All the recipes are of products that are, or have been, produced commercially.

The enrichment of moulded and sheeted short doughs is shown in Fig. 6.1.



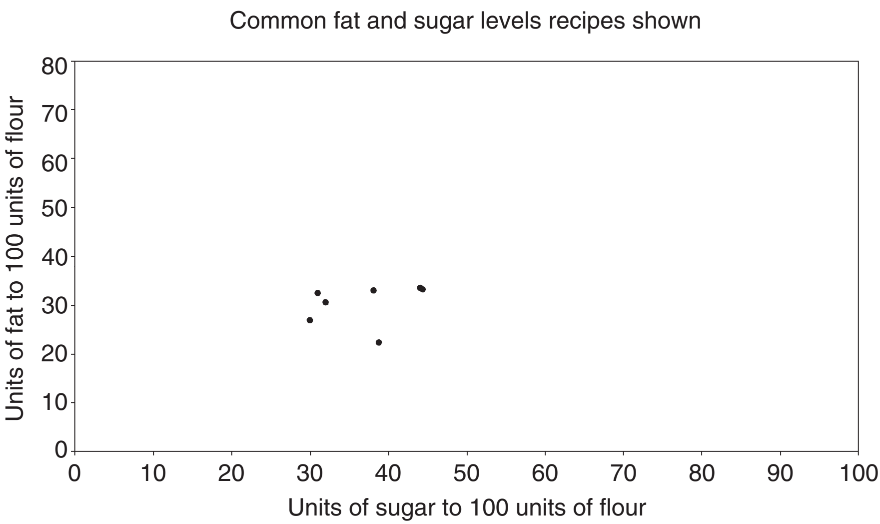
6.2 Enrichment of low fat with or without low sugar recipes shown.

6.2 Plain biscuits

6.2.1 Low fat and/or low sugar

Recipe no. Type product	58 oatcakes	59 Lincoln	60 digestive*	61 digestive	62 Nice	63 Nice	64 milk biscuit
flour, weak	54.00	100.00	81.57	67.23	100.00	100.00	100.00
wholemeal			18.67	26.26			
wheat bran				1.05			
cornflour				5.46			
oatmeal/flakes	46.00						
granulated sugar	11.00		22.00	15.23	35.71		
powdered sugar		21.92					32.38
caster sugar						37.90	
Demerara/ brown sugar				6.30			
cane syrup 80 %	1.00		3.18	3.15	2.85		
invert syrup 70 %							2.86
malt extract 80 %				1.05			
dough fat	25.00	30.00	34.52	25.21	12.50	17.10	17.86
margarine					10.72		
oil				10.50			
lecithin			0.70	0.01			0.10
SMP				2.10	1.44		0.24
whey powder	8.00	2.12				1.78	
amm. bic.	0.10	0.58	0.47	0.38	0.17	0.48	0.17
soda	1.00	0.35	1.69	1.58	0.35	0.58	0.76
ACP				0.05	0.04		0.10
salt	2.00	1.05	1.29	0.86	0.53	0.71	0.29
tartaric acid			0.71				
SMS				0.003			
vanilla/in†		0.10			0.10		
liquid flavour†		0.10		0.10	0.10		0.10
des. coconut					7.15	17.10	
colour†				0.10	0.10		
biscuit recycle							7.14
added water	27	9	9	9	13	19	23

* Digestive biscuits are also known as wheatmeal or granola, particularly in the USA where the use of the word 'digestive' is not permitted as it suggests a medical aid.
† These ingredients are not represented by accurate quantities.



6.3 Enrichment of common fat and sugar recipes shown.

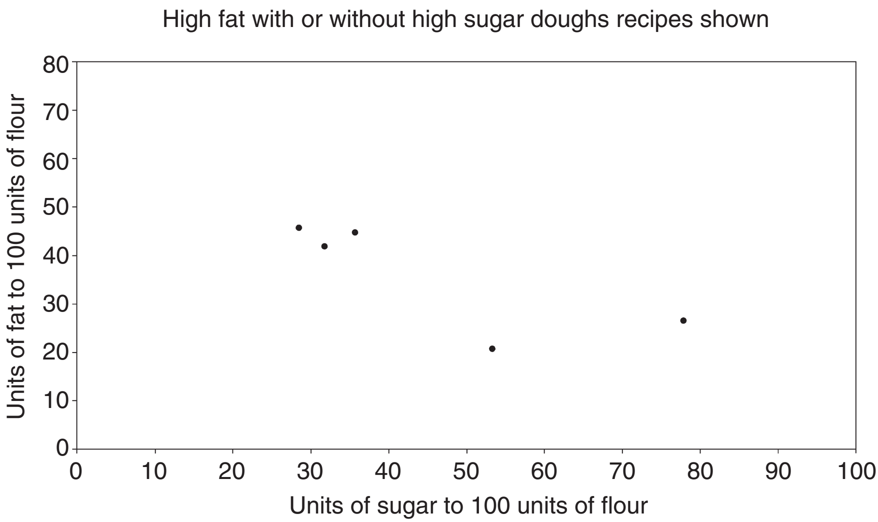
The enrichment of low fat and/or low sugar recipes shown is given in Fig. 6.2.

6.2.2 Common levels of fat and sugar

Recipe no. Type product	65 shortcake	66 malted biscuit	67 oatmeal crunch	68 coconut rings	69 printed biscuit	70 fruit and nut biscuit
flour, weak	100.00	100.00	36.17	100.00	90.00	100.00
oatmeal/flakes			63.83			
tapioca starch					10.00	
granulated sugar			32.34	17.19		22.00
powdered sugar	28.60	25.00		17.19	30.00	13.00
cane syrup 80%	2.50		6.81			7.75
malt extract 80%	1.79	7.50				
glucose syrup 80%			1.28	4.69		4.00
dough fat	29.80	32.10	22.13	25.00	26.25	33.00
oil				7.81		
lecithin	0.60			0.01	0.50	
SMP			3.40	1.56	2.00	
FCMP		0.89				
whey powder						1.50
amm. bic.	0.71	0.54	1.17	0.19	0.90	0.78
soda	0.18		0.89	0.78	0.90	0.78
ACP	0.18					
salt	0.89	1.07	0.89	0.08	0.90	1.55
vanilla/in*	0.14					
liquid flavour*			0.10	0.10		
currants						18.75
des. coconut				31.25		
colour*	0.10			0.10		
nuts						10.00
total added water	13	9	8	20	12	7

* These ingredients are not represented by accurate quantities.

The enrichment of common fat and sugar recipes shown is given in Fig. 6.3.



6.4 Enrichment of high fat with or without high sugar recipes shown.

6.2.3 High levels of fat and/or sugar

Recipe no. Type product	71 short bread	72 fruit shortie	73 butter cookie	74 pepperkarkor	75 ginger
flour, weak	100.00	100.00	100.00	100.00	100.00
granulated sugar	7.10		16.67		52.63
powdered sugar	21.40	32.86	15.15	33.33	
cane syrup 80%		3.57		25.00	31.58
dough fat		44.64		20.56	26.32
butter	54.30		49.70		
fresh egg			3.79		
amm. bic.		0.14	0.45	0.28	0.11
soda		0.40	0.17	0.83	1.05
ACP					0.22
salt	0.31	0.89	0.76	0.83	1.05
spice*				0.83	1.05
liquid flavour*				0.18	
currants		10.71			
colour*		0.10			
added water	2	10	0.00	12	5

* These ingredients are not represented by accurate quantities.

The enrichment of high fat and/or high sugar recipes shown is given in Fig. 6.4.

Critical ingredients The particle size of the sugar may have a strong effect on the spread during baking. The finer the particle size the more the dough will spread. (There are several other factors that affect the amount of spread during baking, see Manley.[1]) As there is generally insufficient water in the dough to dissolve all the crystal sugar the size of the undissolved sugar crystals will also affect the eating quality of the biscuit. It may be desirable to have a gritty, crunchy biscuit with large sugar crystals but a fine sugar will give a smoother eating texture. The fat and syrups will impart flavour. The texture of the fat will affect the dough consistency and the efficiency of the mixing. The fat should be semisolid and plastic: it should be neither liquid nor hard. The flour quality will be largely irrelevant except where wholemeal or branny flour is required.

Mixing For best results this should always be done in at least two stages. The simplest arrangement is firstly to mix together all the ingredients, except the flour, and when the sugar has dissolved as much as possible and the fat has been emulsified with the water to make a semisolid and homogeneous 'cream', the flour is added. Thereafter mixing is for a *minimum* time to produce a homogeneous blend. In a good mixer this may be done in 1 minute but it should never be more than 3 minutes at a slow mixing speed. The result will be a soft, short and somewhat sticky dough. (It may be found that dough mixed in this way is too short for optimum extraction from the moulds of the rotary moulder. If this is the case the final mixing time may be extended *a little* to toughen the dough slightly and make it more cohesive.) The best development of the biscuit during baking occurs where the water content of the dough is at its *maximum*. Thus in order to have acceptable dough consistency and high water content it is necessary to make the dough as cold as possible. The optimum temperature of short doughs is between 18 and 22 °C. It is often difficult to get this as there is limited opportunity to control the ingredient temperatures.

Dough handling Freshly mixed dough will be too soft and too sticky to handle efficiently on either a rotary moulder or a sheeting and cutting machine. If the dough has been mixed correctly and is allowed to stand for about 30 minutes the consistency will increase and the stickiness decrease significantly. This is because the water is passively absorbed onto the flour and other cereal components. The dough effectively 'dries in'. Water is not lost to the atmosphere so it does not 'dry out' like hard doughs. These changes in dough consistency and quality continue throughout the life of the dough but after 30 minutes these changes take place much more slowly so it is normally still satisfactory to use a dough which is 60 or 90 minutes old. The standing period must not involve dough agitation as this will 'mix' the dough more and may toughen it. After standing for 30 minutes it is much less likely that dough agitation or working of the dough (as for example in a dough feeder, a sheeter or rotary moulder) will result in toughening.

Dough piece forming The most common and efficient method is rotary moulding. It is also possible, in most cases, to sheet and cut short doughs but there are some critical aspects to this method. Gauging a sheet of short dough is not as easy as gauging hard doughs as there is little strength in the sheet to allow it to pass over gaps, as it emerges from a gauge roll, for example. It is thus unlikely to be possible to use more than one gauge roll to give a sheet of correct thickness for cutting. Cutting may be simple, as for hard doughs, or of an embossing type to give a strong relief of the dough piece surface. Removal of the cutter scrap dough can be difficult as a thin sheet has little strength so to lift it away is a delicate operation.

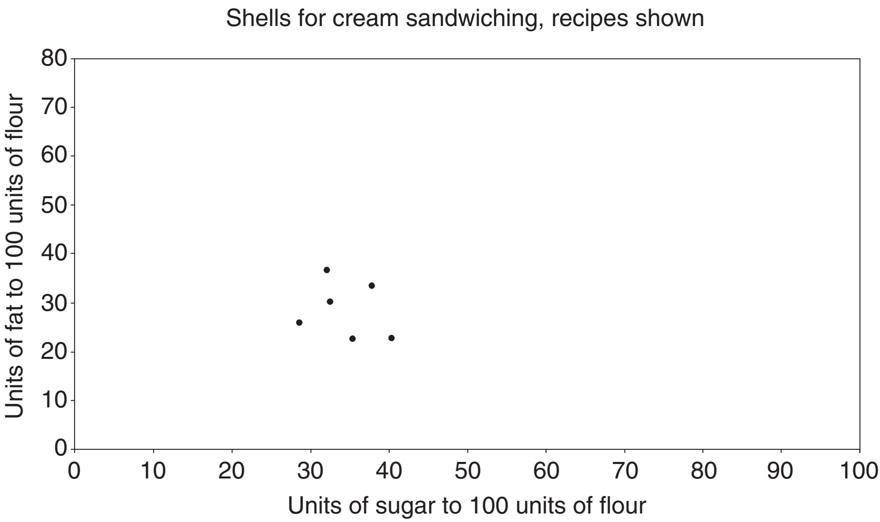
Rotary moulding is not suitable for doughs with currants and does not allow dusting of the dough pieces *before* formation. Sheeting and cutting toughens the dough so that the cutter scrap is not of the same consistency as the fresh dough. This means that in most cases rotary moulding is a superior method of dough piece forming.

Baking The demands for baking of short doughs are somewhat different from those for hard doughs. There is much less water to extract and complete removal is unnecessary as stress cracking (i.e. checking) is very rarely a problem. The expansion of the dough is in a syrupy and fatty medium and the contribution of a gluten matrix and gelatinisation of starch to form a rigid structure is very much less apparent. It is therefore best to allow a slow expansion and to let a setting of the structure occur gently. Too fast an expansion will lead to collapse before the structure can hold the gas bubbles. There is always some collapse after expansion but to get the best biscuit textures the collapse should be minimal. Thus the oven temperatures are typically as follows:

- For shortbread 205, 230, 230 °C Bake time 11 minutes.
- For digestives 180, 240, 170 °C Bake time 7.0 minutes.
- For gingernuts 150, 180, 180 °C Bake time 8.5 minutes.

Baking times of between 5.5 and 15 minutes are common depending on the thickness of the dough pieces.

In order to encourage spread a humid first zone of the oven is useful and this may be enhanced by injecting steam into the mouth of the oven. The increase in humidity softens the top of the dough piece and then allows more expansion upwards and sideways followed by collapse and cracking of the surface. This cracked surface is an attractive feature of such biscuits as gingernuts and crunch.



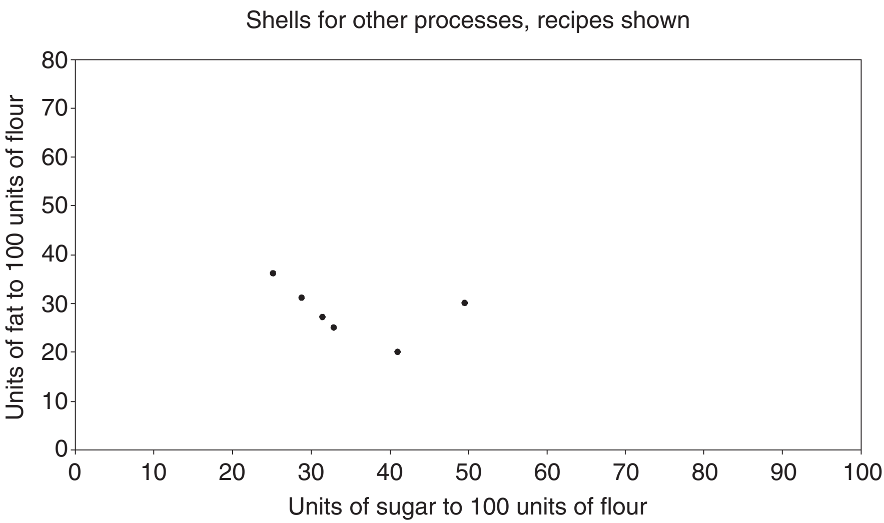
6.5 Enrichment of recipes for biscuit shells shown.

6.3 Biscuits for cream sandwiching

Recipe no.	76	77	78	79	80	81
Type product	Bourbon cream	Swiss cream	custard cream	orange cream	enrobed cream	coffee cream
flour, weak	100.00	100.00	100.00	100.00	100.00	100.00
powdered sugar	37.50	28.60	29.29	35.00	31.30	28.00
cane syrup 80%	3.57		3.57	3.57	4.70	
invert syrup 70%					0.45	
dough fat	22.05	25.19	36.43	33.21	22.40	23.52
lecithin	0.45	0.51				0.48
whey powder		1.79				1.00
amm. bic.		0.71	0.27	0.31	0.15	0.72
soda	0.45	0.18	0.31	0.31	0.30	0.44
ACP	0.45					
salt	0.45	0.45	0.54	0.54		1.00
vanilla/in*	0.10					
liquid flavour*				0.10		
cocoa	4.50					
colour*		0.10	0.10	0.10		
caramel colour					2.20	0.60
total added water	14	18	9	8	8	12

* These ingredients are not represented by accurate quantities.

Enrichment of recipes for shells for cream sandwiching is shown in Fig. 6.5.



6.6 Enrichment of recipes for shells, etc. shown.

6.4 Biscuits for other secondary processing

Recipe no. Type product	82 icing base	83 icing base	84 jam sandwich	85 marshmallow base	86 marshmallow sandwich	87 chocolate crunch
flour, weak	100.00	100.00	100.00	100.00	94.48	100.00
cornflour					5.52	
granulated sugar					21.76	38.10
powdered sugar	27.90	21.43	28.57	30.00		
cane syrup 80%	1.10	14.29	3.57			14.30
invert syrup 70%				10.00		
malt extract 80%					1.06	
glucose syrup 80%				5.00	3.18	
dough fat	29.80	25.00	27.14	20.00	25.48	29.40
oil					10.62	
lecithin	1.31				0.01	0.60
SMP	1.79				2.12	
amm. bic.			0.85	0.27	0.19	0.89
soda	0.27	0.27		0.36	1.38	
ACP	0.36			0.09	0.80	
salt	0.80	0.71	0.71	1.26	0.87	1.43
SMS			0.022		0.003	
vanilla/in*	0.16					0.10
spice*		0.22				
liquid flavour*				0.10	0.10	
des. coconut						4.64
colour*	0.10		0.10	0.10	0.10	
total added water	14	9	13	15	11	14

* These ingredients are not represented by accurate quantities.

Enrichment of recipes for shells for other secondary processing is shown in Fig. 6.6.

6.5 Chemicals present in the recipes of this group

Ammonium bicarbonate is found in 93% of the recipes and where used the average level is 0.47 units and the range is 0.04 to 1.77 units.

An acid salt such as SAPP or an acid, for instance, tartaric or citric is present in 41% of the recipes. Sodium bicarbonate (soda) is found in 96% of the recipes and where used the average level is 0.73 units and the range is 0.18 to 1.92 units. However, the quantity of soda does not seem to be greater to compensate for the reaction which takes place with soda in the dough. Soda is used both as a source of chemical aeration and as a means of adjusting the biscuit pH. This latter significantly affects the flavour and it seems that insufficient attention is given to this aspect of the recipes.

Almost all the recipes use salt as a flavour enhancer and the average level is 0.90 units. Where used the range is 0.19 to 2.00 units. In some cases the salt is provided in butter.

A very few recipes contain sodium metabisulphite, SMS, but this is regarded as unnecessary in short doughs because there should be little or no gluten development if the mixing is done correctly.

6.6 Secondary processes used for products of this group

As can be seen from the names of the recipes given a full range of secondary processing is common.

Chocolate Half coating with chocolate (or chocolate flavoured coating) by enrobing is very popular. Less frequently biscuits are fully coated. There is a problem of fat migration from the biscuit into the chocolate which, in time, makes the chocolate soft and 'cheesy'. This becomes worse where the fat level in the biscuit is high and the storage temperature of the biscuits is above 18 °C. Cream sandwiched biscuits which are fully enrobed with chocolate are common as 'count lines', that is, individually wrapped biscuits.

Many of these biscuits also form the centres for moulded chocolate bars, either plain, cream sandwiched or with an addition of caramel toffee.

Cream sandwiching After chocolate coating this is the most common form of secondary processing. All the creams are sweet and may be of vanilla, fruit or chocolate flavour.

Marshmallow The use of marshmallow provides a useful second texture to the product. The principal applications are either as:

- A marshmallow sandwich which is then fully coated with chocolate flavoured coating.
- A top deposit of marshmallow and a small deposit of jam which is then fully coated with chocolate flavoured coating (these are called Teacakes).
- A top deposit of marshmallow which is then dusted with desiccated coconut.

Icing A half coating with an icing mixture which is then dried to give a hard shiny surface. The icing may be coloured in various ways and patterned. This product is particularly popular with children.

Jam and/or cream sandwiching As the name implies, the centre is jam and often one of the sandwich shells has holes to expose the jam filling. These holes may be in the form of some design which appeals to children such as the shape of eyes, nose or mouth.

For more details of recipes for secondary processing see chapter 10.

Reference

[1] MANLEY, D J R (1998) *Biscuit, Cookie and Cracker Manufacturing Manuals, 4. Baking and cooling of biscuits.* Woodhead Publishing, Cambridge.

7
Recipes for extruded and deposited doughs

7.1 Introduction

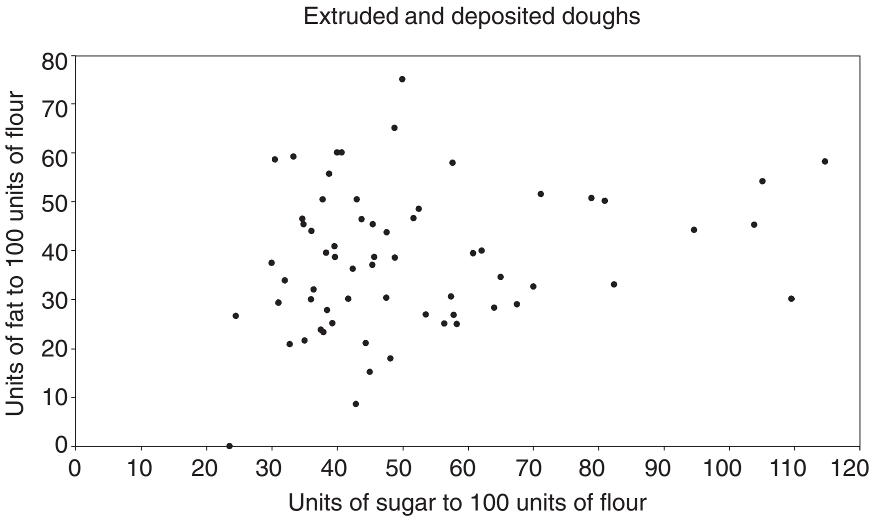
These are all short doughs so have the same basic characters and mixing requirements as those described in section 6.1. They are generally softer, sometimes much softer, and often include particles such as chocolate chips, nut pieces and fruit pieces.

Wire-cut dough pieces give rise to somewhat irregular shaped cookies which seem ‘homemade’ and therefore attractive to consumers. They are usually formed from only one dough but, as can be seen in section 7.4.3, two doughs of different colour can be used with the appropriate machine.

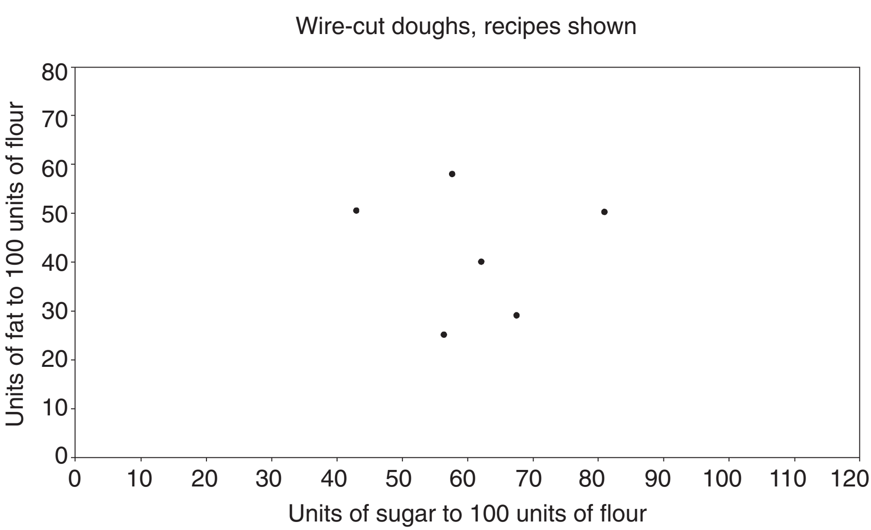
Coextrusion offers other opportunities for variety. If a tube of dough contains a fruit paste this extrusion may be cut either before or after baking. If the tube of dough contains a cream or another much softer dough the outer dough must be sealed into discrete dough pieces before baking.

Depositing involves relatively soft doughs that can be poured to a greater or lesser extent. These fatty doughs may be deposited in discrete quantities, either singly or in groups, on the oven band or as a continuous ribbon which is arranged in a zig zag pattern (see Spritz biscuits in section 7.5.1). As the recipes for deposited doughs are expensive and the production speeds are limited by the dough piece forming machines, biscuits in this group are luxury products which are often packed as assortments, for example, as components of Danish Butter Cookies.

The enrichment of extruded and deposited recipes is shown in Fig. 7.1.



7.1 Enrichment of extruded and deposited recipes.



7.2 Enrichment of wire-cut recipes shown.

7.2 Wire-cut doughs

Recipe no. / Type product	88 choc chip cookie	89 cookie	90 cookie	91 oatmeal soft cookie	92 butter cookie	93 choc chip cookie
flour, weak	59.00	50.00	100.00	78.97	100.00	60.00
oatmeal/flakes	41.00	50.00		21.03		40.00
granulated sugar	67.50	25.00	50.00	29.48		50.00
powdered sugar					43.00	
Demerara sugar		50.00				
cane syrup 80%						8.00
invert syrup 70%				10.53		
glucose syrup 80%				31.59		
honey 80%		7.50	9.60			
dough fat	28.32	29.00		39.88		25.00
butter		25.00	68.90		60.00	
lecithin	0.58					
SMP					7.00	
dried egg				2.08		
fresh egg			20.00			
amm. bic.		0.68		1.05	1.50	
soda	1.73	1.06		1.05	0.20	1.50
salt	1.66	0.53	0.61	2.08	1.10	1.00
mould inhibitor				0.69		
vanilla/in*			0.10	0.10	0.10	
spice*				1.18		
liquid flavour*	0.10				0.10	
currants		21.00		7.37		
raisin paste	4.80					
des. coconut					8.00	
biscuit recycle	4.50	12.00	11.00		10.00	
nuts	4.82					
choc chips	30					30
added water	24	15	5	27	4	10

* These ingredients are not represented by accurate quantities.

Critical ingredients The use of ingredients such as fruit, nuts and chocolate adds much eating interest. It is important that the size of these inclusions is appropriate to the cookie and to the wire-cutting system.

Mixing The doughs are always mixed in at least two stages as for other short doughs. Chocolate melts readily so it is necessary to arrange the mixing and the dough temperature so that as little chocolate as possible is melted before the dough piece reaches the oven. Cold dough water and deep frozen chocolate help. The chocolate is added as a final ingredient half-way through the mixing after the flour has been added.

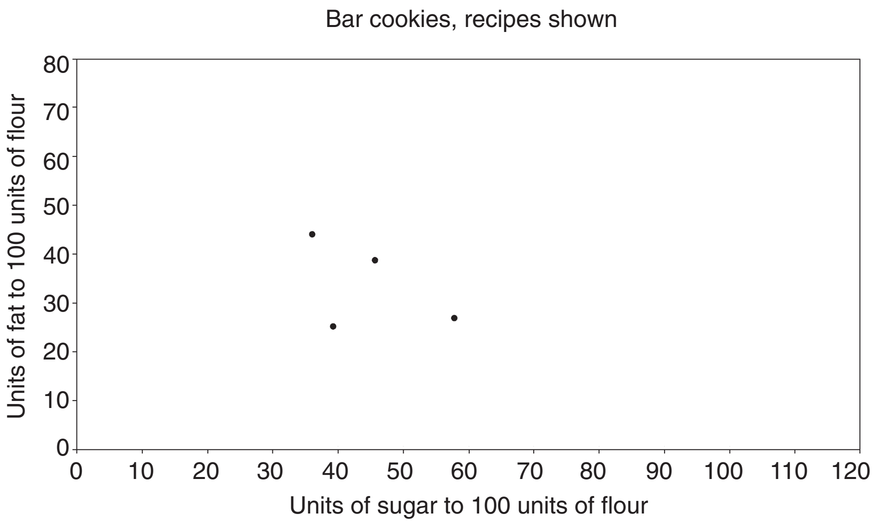
Dough handling Doughs should be held for about 30 minutes to allow the consistency to stabilise and become less sticky. However, if there is a temperature problem, such as with chocolate chips dough, the dough may have to be used with little or no standing time.

Dough piece forming Wire-cutting machines are notoriously difficult to control in terms of dough piece weights. The average weights vary as a result of dough consistency and height of the dough in the hopper. Between nozzle weight variations reflect problems in the general design of the machine. Great improvements in design have been available in recent years.

Baking The baking requirements and conditions are broadly similar to those described in section 6.2.3. When baking chocolate chip cookies it is important to have the oven temperatures high enough to caramelise the surface of exposed chips slightly. This reduces the chance of these chips being sticky and messy after cooling.

Most of these products show considerable amounts of spread during baking so attention to the conditions affecting this is necessary to maintain consistent biscuit sizes. All products in the group are baked on steel oven bands.

The enrichment of wire-cut recipes shown is given in Fig. 7.2.



7.3 Enrichment of bar cookie recipes shown.

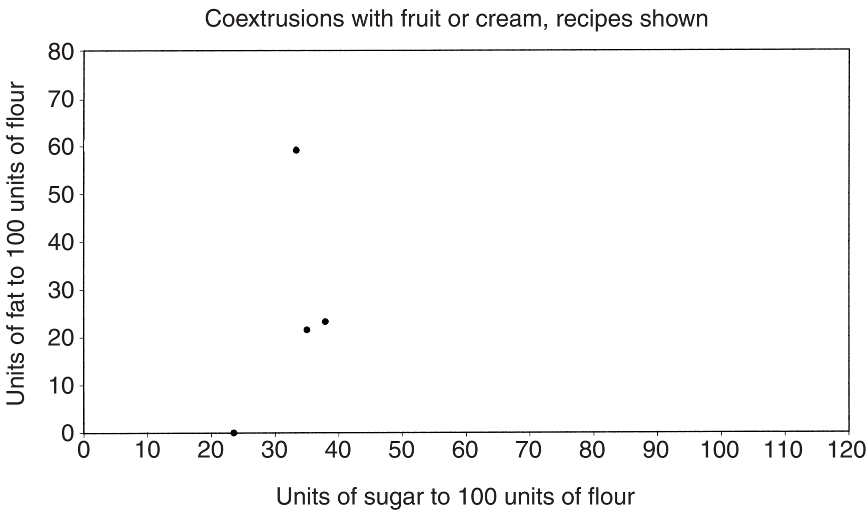
7.3 Bars/rout press doughs

There is no distinction between the doughs used for wire-cut products and those used for bar products except that the latter do not have large pieces of ingredients. The same machine can be used for bar products but the wire cutter is removed. The bars are thus continuous extrusions, usually from dies that have a flattened profile. The ribbons of dough are cut into lengths either before or after baking. Cutting before baking may give problems as the dough is soft and sticky.

The enrichment of bar cookie recipes shown is given in Fig. 7.3.

Recipe no. Type product	94 coconut rout bar	95 rout bar	96 rout bar	97 soft fruit bar
flour, weak	100.00	100.00	100.00	100.00
granulated sugar				35.50
powdered sugar	45.70	36.07	37.50	
invert syrup 70%			2.50	6.33
glucose syrup 80%				6.38
honey 80%				16.00
dough fat	37.83	43.93	25.00	26.75
lecithin	0.77		0.07	
SMP		3.39		1.33
whey powder			1.10	
dried egg				1.63
fresh egg			1.10	
amm. bic.	0.13		0.50	
soda		0.40	0.37	2.00
ACP/tartar			0.13	
salt		0.89	0.37	0.88
mould inhibitor				0.88
vanilla/in*		0.10	0.10	0.10
liquid flavour*			0.10	
currants/sultanas				60.00
des. coconut	22.90			
colour*	0.10	0.10		
biscuit recycle			12.00	
added water	21	8	27	36

* These ingredients are not represented by accurate quantities.



7.4 Enrichment of coextruded recipes (fruit or cream) shown.

7.4 Coextruded products

7.4.1 Doughs enclosing a paste or cream

Recipe no. Type product	98 fig roll	99 fatless fig roll	100 date roll	101 cream filled cookie
flour, weak	100.00	100.00	100.00	100.00
granulated sugar		15.56		33.33
powdered sugar	31.25	2.22	34.00	
invert syrup 70%			5.60	
glucose syrup 80%	4.69	7.22		
dough fat	13.75		23.00	29.17
oil	7.81			30.00
lecithin			0.25	
SMP	7.19	2.11	1.60	
dried egg		2.00		
fresh egg				17.78
amm. bic.	0.19	0.33	0.30	0.39
soda		0.33	0.23	0.28
salt		0.73	0.75	0.83
citric acid		0.10		
SMS			0.050	
vanilla/in*		0.10	0.10	
liquid flavour*	0.10			
cocoa				4.44
colour*		0.10		
added water	19	26	15	2

* These ingredients are not represented by accurate quantities.

The enrichment of the coextruded recipes shown is given in Fig. 7.4.

7.4.2 Pastes and creams for the above recipes

Recipe no.	102*	103*	104*	105*	106*	107*
Type product	fig filling	fig filling	fig filling	date filling	coextruded cream	coextruded cream
granulated sugar		21				
icing sugar	4				47	43
cane syrup 80%	46		47			
glucose syrup 80%		8		23.27		
special fat					22	25
lecithin					0.05	0.05
SMP					8	7
salt		0.15				
citric acid		0.06		0.22		
glycerine	4					
vanilla/in†					0.1	0.1
fig paste	39	52	42			
date paste				69.8		
cocoa					8	
cocoa mass					6	
caramel colour		0.26				
biscuit recycle	5		6			
fig roll recycle			5			
crushed corn flakes			6.50			
nut paste					8	25
added water	1	18	0	(5)	0	0

* These recipes are shown on a percentage basis.
† This ingredient is not represented by an accurate quantity.

Critical ingredients The composition of the fruit filling and cream requires careful attention to reduce the chance of ‘blowing’ during baking. This happens when a gap forms above the filling within the dough case. If the filling is aerated (incorporation of air during mixing) or the moisture content is too high ‘blowing’ is more likely to occur.

The filling is prepared by mixing other ingredients, as shown above, with the fig (or date) paste in order both to obtain a suitable consistency for extruding and to reduce the cost.

The choice of fat for the cream is probably critical for inclusion in a baked product. The cream needs to be soft in the cooled and equilibrated product: it should not be firm or hard as it is for cream sandwich biscuits. Therefore a fat with a melting curve more like a dough fat is used.

Mixing The dough must be plastic enough to be extruded as a continuous and unbroken tube. The moisture content should be as low as possible as this aids good baking. It is often the case that a long final mixing stage is needed to develop the plasticity required.

Dough handling The dough is normally used immediately after mixing without a standing period.

Dough piece forming Coextruders for the fruit bars are available from several suppliers. The two components are fed into separate hoppers. By feeding the dough (the outer component) alone, checks can be made on the extrusion speeds both in terms of the ratio of inner and outer material, and as nozzle to nozzle across the machine. Adjustments for giving desired weights can be made and uniformity across the band can be established. When the extrusion of the internal material is started the weights can be repeated to check that the ratios of inner and outer materials are correct and even across the band.

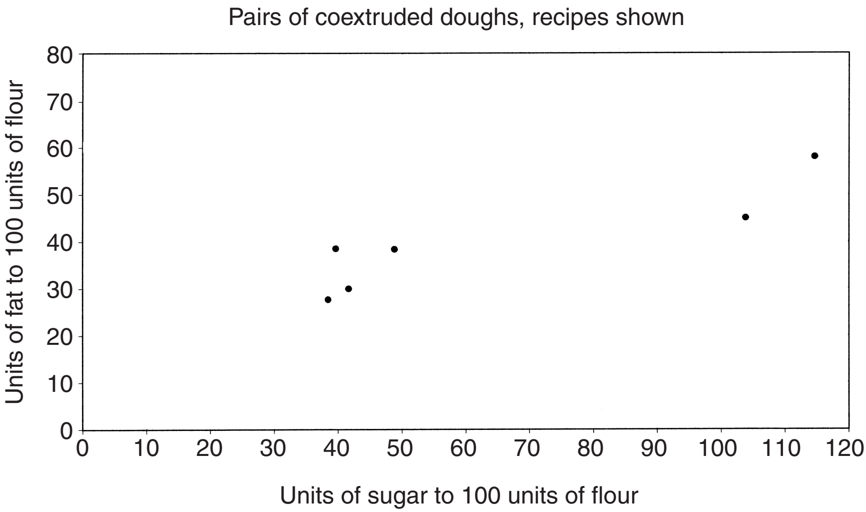
The bars are then cut into short lengths with a reciprocating guillotine either before or after baking. If they are cut before they are put in the oven there is a greater chance of the fruit filling escaping a little during baking.

For cream-filled cookies it is essential that the cream is sealed within the dough before baking. This is a critical operation probably made with a Rheon encrusting machine or a similar type of machine from another manufacturer.

Baking Baking must be at moderate temperatures so that the chance of ‘blowing’ is minimised. There is a fine balance required between supplying enough heat for baking the dough to a suitable texture and moisture and a small development of surface colouration and not supplying so much heat that it will cause ‘blowing’. Thus a long bake time (about 13 minutes) combined with a large heat gradient between top and bottom (higher at the top) is required. A typical profile could be:

Zone 1	Zone 2	Zone 3	Zone 4
250	250	210	180
180	200	200	175

These biscuits are always baked on a steel band.



7.5 Enrichment of coextruded recipes (doughs) shown.

7.4.3 Products composed of coextruded doughs

Recipe no.	108	109	110	111	112	113
Type product	round		square		US Crisp and Chewy	
	white	brown	brown	white	outer	inner
flour, weak	97.17	100.00	100.00	100.00	100.00	92.13
cornflour	2.83					7.87
granulated sugar					85.25	35.58
powdered sugar	39.68	40.83	41.67	38.46		
cane syrup 80%		10.00				
molasses 80%					4.10	
high fructose syrup 80%					19.13	98.88
dough fat	38.46	38.33	25.00	23.08	45.08	58.05
butter oil			4.17	3.85		
lecithin	0.12	0.12	0.92	0.85		
whey powder						2.81
fresh egg			16.67	15.38		
amm. bic.	0.14	0.14				
soda	0.14	0.14	0.42	0.38	1.37	1.50
salt	0.85	0.87	0.42	0.38	1.37	1.50
vanilla/in*			0.10	0.10		
liquid flavour*					0.10	0.10
cocoa		18.37	4.17			
colour*				0.10		
choc chips						76
added water	18	19	17	15	20	0

* These ingredients are not represented by accurate quantities.

General requirements There are two distinct types of product represented in these recipes. In each case a pair of recipes is used to make one product. Recipes 108 and 109 are two fairly similar doughs differing only in colour. They are extruded in a way that gives a swirl arrangement and short lengths are cut with a wire. Recipes 110 and 111 are used to make a similar type of product but here the extrusion is in a chequer configuration.

Recipes 112 and 113 are used to form a very different type of product. These are taken from a Procter and Gamble patent[1] for a Crisp and Chewy cookie. The idea is based on the fact that all freshly cooked cookies are crisp around the edges and the outer surfaces and softer within. Later, these cookies equilibrate into one texture. By combining two distinctly different doughs and allowing a significant amount of equilibration after baking the sugar crystal structure results in stable cookies that are crisper on the edges and outside than the centre. The centres are somewhat chewy giving a very acceptable, albeit a very sweet, product.

Critical ingredients The chocolate chips should be deep frozen to reduce the melting in the dough prior to extrusion.

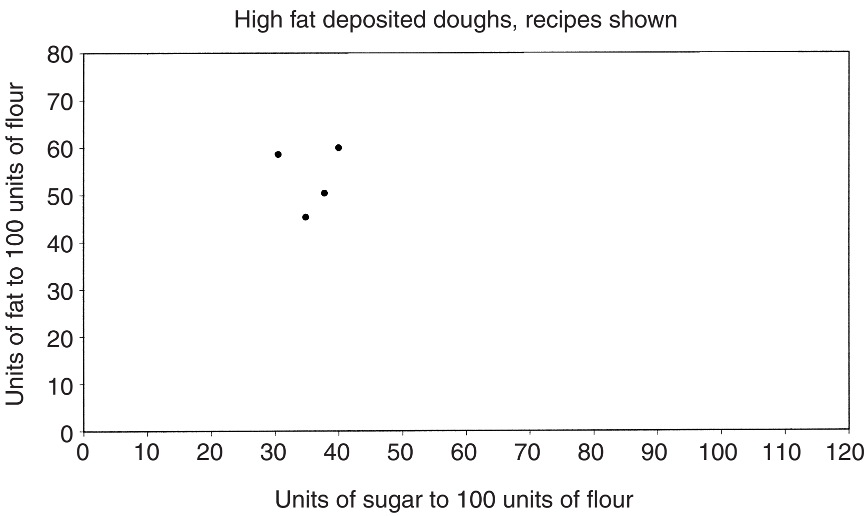
Mixing Generally these doughs are mixed by the two-stage method typical for short doughs. They have a soft consistency to allow for extrusion through complex nozzles.

Dough handling The doughs are normally used without delay after mixing.

Dough piece forming The complex patterns of the swirl and chequer cookies require special nozzles typical of Rheon extruders; other designs are possible with other makes of machine. The Crisp and Chewy cookies require that the coextrusions are cut and sealed before baking. This can be achieved either with a Rheon encrusting machine or a good coextruder like Bepex Hutt with a special cutting and sealing unit for each extrusion rope. The same machine can be used that is suitable for the cream filled cookie given in section 7.4.1.

Baking This is not a critical operation and oven temperatures of around 200 °C at about 6–8 minutes bake are used. Baking is always on a steel band as the dough becomes soft and often spreads.

The enrichment of coextruded recipes shown is given in Fig. 7.5.



7.6 Enrichment of high fat recipes shown.

7.5 Deposited doughs

7.5.1 Fat rich recipes

Recipe no. Type product	114 Spritz	115 Swedish cookie	116 butter cookie	117 butter cookie
flour, weak	100.00	100.00	100.00	100.00
granulated sugar			34.85	
powdered sugar	40.00	30.50		35.00
invert syrup 70%				4.00
dough fat	60.00	58.60		
butter			53.94	60.00
SMP				5.00
fresh egg			11.06	3.00
soda	1.00		0.20	0.20
SAPP	1.00			
salt	1.50		0.76	1.00
vanilla/in*		0.10		0.10
liquid flavour*				0.10
biscuit recycle			19.70	10.00
added water	13	0	0	7

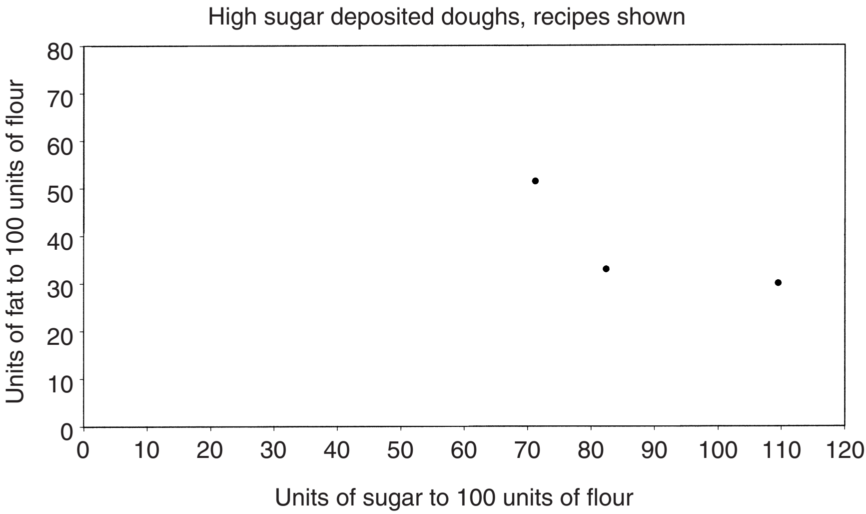
* These ingredients are not represented by accurate quantities.

Critical ingredients As the fat content is high the quality of this ingredient is important. Very often the fat is butter because of its superior flavour. The temperature and consistency of the fat, especially if it is butter, determine the quality of the dough. The fat should be well plasticised and preferably at a temperature of around 20–25 °C. Biscuit crumb (biscuit recycle) is often used to control the consistency of the dough. The sugar particle size strongly affects the amount of spread during baking.

Mixing A two-stage mixing typical of other short doughs is recommended. The final consistency is such that the dough can be poured to some extent.

Dough handling With low water levels, and high fat levels, standing time is not normally necessary for these doughs unless the consistency can be seen to be changing with time and thus affecting the extrusion rate.

Dough piece forming The extrusion may be either continuous (Spritz) or intermittent (butter cookies, etc.). In the case of the continuous extrusion it is common to oscillate the nozzle to produce a zig zag broad ribbon of dough that runs together to give a patterned bar during baking. The butter cookies are made as discrete deposits in the shape of either small strips, mounds or swirls. The surface patterns are formed because the edges of the nozzles are serrated and the swirls are formed when the nozzle is rotated as each deposit is made. In order to cause the dough piece to break away at each deposit the oven band is raised and lowered for each deposit and



7.7 Enrichment of high sugar recipes shown.

the short nature of the dough causes the break to occur at the nozzle exit. Some trial and error with corresponding adjustments are needed to find how high the band should be raised to ensure that the dough piece sticks to the band and does not fly off at the end of the deposit cycle. Some depositors have a reverse drive of the feed rollers to reduce the pressure of the dough at the nozzle at the moment that the extrusion must break off.

Baking Baking times are about 9 minutes. Temperatures around 200 °C throughout with more top heat than bottom. Baking is always on a steel band.

The enrichment of high fat recipes shown is given in Fig. 7.6.

7.5.2 Sugar rich recipes

Recipe no.	118	119	120
Type product	Barmouth	US coconut vanilla wafer	Italian luxury cookie
flour, weak	100.00	100.00	100.00
powdered sugar		74.91	71.20
caster sugar	102.57		
cane syrup 80 %	8.66	9.36	
dough fat	29.92	31.84	50.00
lecithin			0.60
FCMP		4.18	3.30
whey powder	5.01		
egg white			4.00
amm. bic.	0.27		
soda	0.31	0.85	
ACP/tartar		0.85	
salt	0.71		0.70
vanilla/in*	0.10	0.10	
liquid flavour*	0.10		0.10
des. coconut		9.36	
added water	56	56	39

* These ingredients are not represented by accurate quantities.

Mixing These doughs are usually very soft and more like batters. The mixing is in two stages with the flour added last. The type of mixer is determined more by the method for handling the dough than on the action of the beaters. It is best to use a detachable bowl mixer so that the dough can be taken to the hopper of the depositor where it can be tipped or poured.

Dough piece forming An extruder of similar form to that described in section 7.5.1 is required.

Baking The biscuits always spread significantly during baking so a steel oven band is essential. The edges of the dough pieces become thin due to the spread so the baking must be such that these edges do not burn before the centres are baked.

Typical baking conditions are a bake time of 12 minutes at temperatures of 170, 190, 180 °C.

There should be a long run-out after baking in the oven to allow the products to set before removal from the band.

The enrichment of high sugar recipes shown is given in Fig. 7.7.

7.6 Chemicals present in the recipes of this group

Only 58 % of these recipes contain ammonium bicarbonate. Where it occurs, the average level is 0.48 units and the range 0.1 to 1.05 units.

Sodium bicarbonate is used in about 84 % of the recipes and where used the average level is 0.79 units and the range is 0.14 to 2.00 units. An acid salt such as SAPP or ACP occurs in 20 % of the recipes but the level of soda usage does not seem to be greater to compensate for the reaction which takes place with soda in the dough.

All the recipes use salt either as a separate ingredient or contained in salted butter. The average level of added salt is 0.89 units and the range found is 0.10 to 2.08 units.

Reference

[1] European Patent 0 031 718 (1980) *Crisp and chewy cookie*, Procter and Gamble.

8
Recipes for sponge biscuits

8.1 Introduction

Sponge confections usually make one think of cakes and certainly we are on the borders of biscuits and cakes with these products. However, as they are manufactured by biscuit producers it seems appropriate to include a few examples here.

Sponge products derive their aeration from air contained in a batter which is a foam. The stability of the foam is from egg and the quantity of egg in the recipe is much higher than in any other biscuit product.

If the product is baked to a low moisture content it is hard and has a long shelf-life as for other biscuits. If the sponge is softer, as for example in Jaffa cakes, the composition of the total product should have a water content sufficiently low to preclude mould growth. The moisture-proof wrapping of high moisture sponge products must stop them from drying rather than from picking up moisture from the atmosphere as with other biscuits.

8.2 Recipes for sponge drop biscuits

Recipe no. Type product	121 Langues de Chat	122 sponge drops	123 Jaffa cake	124 Jaffa cake	125 boudoir
flour, weak	100.00	100.00	100.00	100.00	90.32
cornflour					9.68
granulated sugar				56.50	
icing sugar		150.00			
caster sugar	100.00		86.59	43.50	100.00
cane syrup 80%					0.77
glucose syrup 80%			6.95	6.50	
dough fat		70.00			
butter	100.00				
oil			2.57		
SMP		5.00			
fresh egg	80.00	70.00	69.52	97.80	90.30
amm. bic.			0.64		
soda			0.50	1.09	3.23
ACP			0.50		
SAPP				0.54	3.23
salt		1.25		0.06	
glycerine			3.09	2.17	
colour*			0.10	0.10	
Added water	0	25	3	5	0

* This ingredient is not represented by an accurate quantity.

Critical ingredients The quality of the egg is important and it is usual to use either freshly shelled whole eggs or carefully thawed frozen fresh eggs. The egg entrains the air and the batter is then pumped to a depositor. In the more luxurious products such as Langues de Chat the fat contributes greatly to the taste and eating texture so butter is used. The syrups and glycerine are used as humectants to prevent the baked product from drying too much and to maintain a softer eating texture.

Mixing This is usually done in two stages. Firstly, all the ingredients are blended together as a batch operation. This is followed by vigorous beating when air is incorporated to give a lower density. This latter stage is usually achieved as a continuous operation by passing the blended batter through a very high shear mixer inside a water cooled barrel under pressure (for example, an Oakes mixer). Air is injected into the mixer at a given rate and pressure to give a batter density of about 0.88 g/cc at around 19 °C. A back pressure valve at the exit of the mixer barrel gives better control of the pressure during mixing.

Dough handling The aerated batter is pumped without delay to the depositing head.

Batter drop forming By intermittent opening of nozzles in the depositing head measured volumes of batter are placed either on a steel oven band or into cavities in steel trays for baking. The pressure drops across the depositing head so nozzle aperture adjustment is necessary to maintain even weights delivered from all the nozzles.

As most sponge batters are low in fat and high in sugar there is a great tendency for the drops to stick firmly to the baking surface during baking. It is therefore necessary to oil or grease the band before depositing the batter. However, as the batter also tends to spread as it gets warm in the oven, before the heat sets the egg proteins, it is necessary to use a band greasing material that not only prevents sticking but also controls the amount of spread. If this critical part of the process is neglected the size and shape of the baked drops are very irregular. The band greasing is therefore usually of a special oil (with or without emulsifier) spread evenly and in a very thin film or a mixture of fat or oil and a cereal like wheat flour or starch which is also spread very evenly. In other cases the film of oil is evenly dusted with a trace of flour before the batter is deposited.

The shape of the drop is determined by the relative speed of the depositor head and the band during the time when the nozzles are open. Thus Jaffa drops are round because the head moves at the same speed as the band and deposits for boudoir consist of long fingers in trays because the head is stationary and the tray moves beneath the head as the nozzles deliver the batter. A dressing of granulated sugar or nut pieces may be dusted over the drops before baking.

Baking Most sponge drops are baked on a normal flat steel oven band. Boudoir and sponge boats are baked in formed trays which are fed onto chains to be passed through the oven. After baking these trays of product are cooled and then inverted and knocked to release the baked biscuits. Thorough cleaning and regreasing are necessary before reuse.

Bake times are about 7–8 minutes with a temperature profile of 200, 200, 150 °C. After leaving the oven the products are soft or delicate. It is necessary to allow them to cool and set before removal from the band. A roller may be used to depress, a little, the tops of the biscuits while they are still hot and thereby control the thickness.

Removal from the band is a critical operation. The biscuits must not be damaged and if a stripping knife is used it may collect messy band dressing materials which will be transferred to the edges of the biscuits and soil them. The use of wire fingers in place of a knife is recommended.

The oven band must be well cleaned before returning to be regreased and receiving new drops of batter.

Boudoir biscuits are also known as lady fingers, savoiardi and champagne biscuits.

9
Recipes for wafers

9.1 Introduction

Wafers are unlike any other types of biscuits both in their form and their manufacture. They may be thin sheets, deep relief sheets for making hollow wafers, cones made in formed cavities, cones made by rolling baked discs, discrete discs or tubes made by winding continuously baked strips. In all cases they are made from a batter and baked rapidly between two hot metal surfaces.

The majority of wafers are made by baking between flat heavy plates. These plates are commonly either 370 × 240 mm, 470 × 290 mm, 470 × 350 mm or 700 × 350 mm and produce wafer sheets of this size. The sheets commonly have flat surfaces with only moderate patterning (reeding) which is there principally for greater strength. The internal structure of wafers is very open so a wafer sheet of 3 mm overall thickness and size 470 × 290 mm will weigh only 50–56 g.

Wafer sheets are rarely eaten plain and most commonly are sandwiched with fat based creams. The sandwiches, made from the large flat sheets, are commonly called books and are composed of 3, 4 or 5 wafer sheets with 2, 3 or 4 layers of cream. The percentage of cream in the book is quite high. These books are then cut with wires or saws into squares or rectangles for packaging or chocolate coating.

There are very many variations on the above theme which gives rise to different forms of finished wafers. For the purposes of this account it is the flat sheets of wafer which will receive most attention.

9.2 Recipes for wafer batters for flat sheets

Water and wheat flour are by far the major ingredients of all wafer batters but there are many others that may be included. In a paper by Carey[1] of Nestlé it was stated that typical commercial wafers would consist of a combination of some, but not all, of the following ingredients in their batter recipes. For the benefit of those wishing to make the basic wafer sheet he also gave a recipe to start from.

		Starting point
flour	100	100.00
dough fat or oil	0.8–3.4	2.25
lecithin (liquid)	0.05–0.06	
lecithin (powder)	0.75–1.00	0.95
sugar (any crystal size)	1.05–3.5	
whole egg powder	up to 1.0	
whole liquid egg	0.75–4.0	
salt	0.16–0.25	0.25
soda	0.3–0.6	0.32
amm. bic.	0.75–1.0	
SMP/soya flour	1.4–3.0	
yeast (for 1 hr fermentation)	0.35–0.63	
water	128–147	137

This list of ingredients can be compared with selected commercial recipes given below. It can be seen that Carey's list, although long, is by no means complete!

Recipe no.	126	127	128	129	130
Type product	wafer batter	wafer batter	wafer batter	wafer batter	wafer batter
flour, weak	100.00	100.00	100.00	98.04	96.15
cornflour				1.96	
tapioca starch					3.85
powdered sugar	1.67	3.54			
malt extract 80%				2.94	
oil	3.75	2.71	3.25	2.35	2.50
lecithin			1.25	0.59	0.38
soya flour			2.50		
SMP	1.67	3.12		1.96	
dried egg	2.92	0.35			
amm. bic.		0.83			
soda	0.26	0.26	0.15	0.29	0.31
ACP					0.04
salt	0.17	0.17	0.15	0.20	0.38
SMS			0.025	0.050	
P. enzyme					0.077
magnesium carbonate				0.25	0.50
cocoa			0.75		
added water	133	145	172	141	142

Critical ingredients The water absorption of the flour will significantly affect the amount of water needed to give a suitable batter consistency. It is best to use a flour of weak to medium strength.

The wafer has a very bland taste so the quality of the oil or fat used should be good in terms of flavour and absence of rancidity. Some say that inclusion of a small amount of cocoa powder or sugar helps to stabilise the wafer flavour and gives a longer shelf life.

The use of milk powder or reducing sugars (as in malt extract) will cause the sheet to colour during baking so should be avoided if very white sheets are required. Wafers of various colours may be obtained by adding colouring to the batter.

Magnesium carbonate is occasionally used to aid wafer sheet release from the plates. The mechanism is not understood.

Mixing This is done as a batch system with a high shear mixer. Apart from dispersing all the ingredients in the water the aim is to prevent the formation of gluten strands following the hydration and mixing of the flour. If such strands form they will block screens and nozzles at the point of batter deposition. It is not clear which particular qualities of flour are more likely to give the gluten strands but generally their formation can be avoided if cold water is used and the flour is not left in static contact with the water before mixing starts.

Mixing provides the opportunity to get the optimum solids content and consistency of the batter which is critical for a desired quality of wafer sheet.

The mixing process entrains some air and this slowly rises out of the batter after the mixing has stopped. This makes it difficult to critically measure the consistency and viscosity of the batter and to adjust the water level as necessary.

Batter handling After mixing, the batter is transferred to a holding tank via a screen to remove lumps and gluten strands. From this tank either the batter is pumped to a small reservoir near the wafer oven or it is pumped around a ring main to the wafer oven(s) and back to the tank. The batter consistency will slacken with time so the holding time should not be long. There is also a tendency for sedimentation so the tank should be continuously agitated in a gentle manner.

In a few cases the batter is fermented with yeast and here the batter is stood in the tank for about one hour. The yeast probably acts by producing a supply of minute gas bubbles that form the nuclei for aeration in baking. It is not clear how this works better than chemicals such as sodium or ammonium bicarbonate.

Wafer sheet forming The wafer oven consists of a set of plate pairs which are carried continuously through a heated oven. The plates open at the front of the oven where the baked wafer falls out and almost immediately batter is spread onto the freed hot plate to form a new sheet. The batter is spread across each plate in a series of streams from a sparge pipe with nozzles. The plates are then locked closed and an explosive baking process starts. This spreads the batter evenly across the plate and a small amount is driven out through steam vents around the edges of the plate pair. The baking causes gelatinisation of the starch and protein in the flour, some colouring of the surfaces and of course great moisture reduction. At the point where the plates open the wafer is at about 2% moisture content and the opening of the plates allows a slight shrinkage of the sheet so that it falls away or is easily released from the plates with the aid of an air jet.

Baking usually takes about 2 minutes. The faster the baking, and thus the higher the plate temperatures, the lighter in weight will be the wafer sheets from a given batter. This is because the explosive expansion of the batter is greater and therefore the movement towards and through the vents is faster. Faster bakes tend to give less even moisture levels across the sheet.

Critical features of this wafer sheet formation and baking are:

- The batter should spread completely across the plate but not be so great in volume that a lot is expressed through the steam vents.
- The consistency of the batter will determine how readily the batter spreads across the plate.

- When baked, the moisture content of the sheet must be low and even otherwise there will be a release problem (the sheet may stick to the plate surface) or the sheet will warp badly as it cools. Conversely, over-baked and burnt sheets will also not release readily.
- The weight of the sheets determines the eating quality. A heavy sheet, made from a batter with low water and high solids will be harder and tougher than one made from a low solids batter.
- The balance between the spreadability of the batter and the desired wafer sheet weight can be adjusted with the level of ammonium bicarbonate in the batter. More ammonia will cause much greater spreading of the batter at the commencement of baking.
- The greater the levels of sugar and milk powder in the recipe the greater will be the tendency for wafer sheets to stick to the plates.

Critical aspects of the condition and maintenance of the wafer plates which affect the quality of the wafer sheets and the efficiency of the wafer-making operation are:

- Release of baked wafers from the plates is affected if the plates are not clean.
- Release of the wafers is also impaired if the gaps between the plates in a pair are not even or the settings of all the plate pairs are not the same.

9.3 Other types of wafer

As stated above, the main consideration here is with flat wafer sheets because these represent by far the main section of this market. There is a growing interest in rolled wafer sticks and a small specialised market for round wafer sheets that have been rolled (into cones) or folded to form wafers for desserts.

In order to make any wafer that can be rolled or folded the recipe has to have a significant level of sugar. The rolling or folding takes place immediately after the oven exit while the sugar is still molten. The wafers are thin and the internal structure is much less open than for typical flat wafers.

For rolled wafer sticks the ratio of sugar to flour is about 60 to 100 whereas for rolled wafer cones the ratio is about 35 to 40 parts of sugar to 100 of flour.

Recipe no. Type product	131 rolled wafer cones	132 wafer sticks
flour, weak	95.24	100.00
cornflour	4.76	
powdered sugar	40.00	75.00
oil/butter oil	2.86	2.00
lecithin	0.95	0.50
soya flour	2.38	4.00
whey powder		2.00
dried egg		2.00
salt	0.50	0.50
vanilla/in*	0.10	
added water	125	120

* This ingredient is not represented by an accurate quantity.

The rolled wafer cones are usually sold for filling with ice cream. The wafer sticks, which are formed by winding a continuous narrow strip of baked wafer to form a tube, are usually filled at the time of winding, with chocolate or some sort of sugar and fat cream mixture. They may also be partially coated with chocolate.

9.4 Secondary processing

As mentioned above, most flat wafers are sandwiched with cream. The composition of this cream is described in section 10.2.2.

The wafers may be sandwiched with toffee or caramel instead of, or in addition to, cream. See section 10.4.2.

Sandwiched wafers which have been cut into small pieces are commonly enrobed with chocolate or form the centres of moulded chocolate bars.

Reference

[1] CAREY, M (1993) *Processing of wafer biscuits*. Biscuit Development Seminar, Cambridge Biscuit Seminars, Selwyn College, Cambridge, unpublished.

10
Recipes for secondary processes

10.1 Introduction

Secondary processing refers to a procedure that happens after the biscuits have been baked and before they are packaged. These procedures include sandwiching and coating (sometimes both) and the materials used add interest, flavour, texture and enhanced appearance to the basic biscuit. They are very widely used in biscuit manufacturing.

This account will not explore the various machines and ways of doing the processing but will concentrate on the materials used and their critical properties. A great deal of additional information relating to secondary processing in general can be found in Manley.[1]

10.2 Sweet and savoury biscuit creams

10.2.1 Sweet creams for biscuit sandwiches

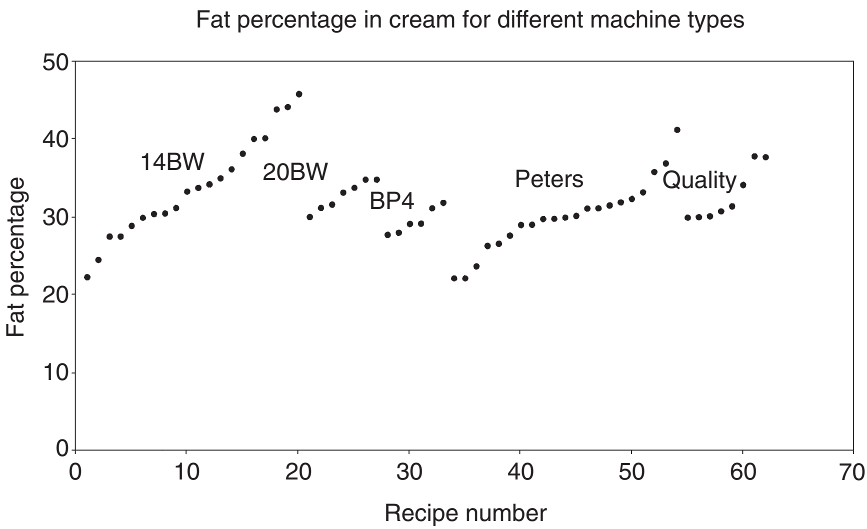
The filling for a biscuit sandwich is usually called a ‘cream’. To avoid confusion it must be stated that this type of cream has no relationship to the fatty material taken from milk. In some countries biscuit ‘creams’ are called ‘cremes’ and in others ‘fillings’. For this account the commonly used British term ‘cream’ will be used.

Sweet biscuit creams are basically sugar and fat mixtures. The quality of the fat and the particle size of the sugar very largely determine the eating quality.

It is desirable that the hardness of the cream in the biscuit sandwich at the time of eating is compatible with the hardness of the biscuit shells. If the cream is too soft the cream will squeeze out as a bite is taken and if it is too hard the cream will seem dry. As a semisolid fat is used the cream will be harder at lower temperatures. The greater the quantity of sugar in the cream recipe the harder and ‘drier’ will be the cream, the larger the sugar crystal size the more gritty will be the cream in the mouth. It is not necessary to have the sugar particle size as small in creams as in chocolate as the cream is mixed with biscuit while eating. Thus a maximum sugar particle size of about 40 μ will be acceptable for sugar in creams.

The situation for fat is a lot more complicated. Basically the consistency of a cream is determined by the solids content of the fat as the oil in the fat is the only contributor to the liquid phase. Clearly the higher the temperature the lower will be the fat solids and the softer will be the cream. It is necessary to have the cream soft at the time of stencilling or depositing but firm at the time of eating. Furthermore, the cream will taste better if the fat in the cream melts quickly in the mouth and has a very small fraction of solids that melt above blood temperature. If there are significant amounts of high-melting solids in the fat a waxy film will be left in the mouth. The preferred fats for creams are therefore those with a very steep melting curve which release sugar and flavours. The lauric fats, coconut and palm kernel oils, and blends made to match the physical characteristics of these are commonly used. Fats like these melt rapidly and draw latent heat from the mouth to give an attractive cool eating character.

The hardness of a cream in a sandwich at ambient temperature is also affected by the crystal size of the fat. Fats which have been mechanically agitated as they cool have small free crystals and are said to be plasticised. Fats which cool passively from liquid are much firmer at ambient temperature because the crystals have grown together in an interlocked form. This means that if there is a big difference between the temperature of the fat and the ambient temperature at the sandwiching time the cream will be firmer than if the temperature difference is small. In addition, if the cream is significantly aerated this will also cause the cream to appear softer when the cream cools.



10.1 Ranges of total fat in creams.

Many creams are batch mixed from plasticised fat with warm or cold icing sugar. During mixing air becomes entrained and if mixing continues sometimes even more air is included and the cream becomes ‘fluffy’. As the temperature rises the amount of air in the cream decreases. It is difficult to apply process control to give cream of a specific density when batch mixing.

When creams are made in a continuous process warm (liquid) fat is mixed with sugar and other ingredients and the mixture is passed through a scraped surface heat exchanger which plasticises the fat as it cools. At the same time air (or nitrogen) is metered into the mixture and a cream of desired density is obtained. Thereafter, the cream is pumped continuously to the cream sandwiching machine or machines, usually in a ring main. The problem is that the ring main is usually of such length that by a combination of trace heating and high pressure the air included in the cream coalesces to form larger bubbles and is readily released as soon as the pressure drops when it comes out of the ring main. This means that the cream deposited in the sandwich has a higher density than is expected.

Cream densities vary from 0.75 to 1.15 g/cc. Those of lower density give deposits which are thicker and therefore appear more generous for the same weight.

The author was involved, a few years ago, in two large surveys of commercial sandwich creams. One survey investigated whether the fat contents of creams were related to the types of cream sandwiching machines and the other was to see what types of fat were used in the creams (in general, fats with steep melting curves are more expensive and much more difficult to handle). Information on the types of cream sandwiching machines can be found in Manley.[1,2]

In the surveys more than 60 cream recipes were involved. Figure 10.1 shows the ranges of *total* fat in creams used on five different types of machine (some fat may be contributed by other ingredients in the cream). There would seem to be no significant relationship between fat content and machine type. The cream consistency is therefore adjusted principally by temperature if the machine requires firmer or softer cream. It can be seen that the range of fat extends from 22 to 46% and the average level is 33%. In the other survey it was found that some manufacturers use fats with *dough* fat melting curves for their creams. This type of fat always gives softer creams but this seemed to be acceptable if the amount of cream in the sandwich was low. (It was more like an adhesive layer than a source of flavour and pleasure!)

Be warned that if the fat content of the cream is too low there may be a problem with ‘splitting’ of the cream from the biscuit shells. This is because there are not enough fat crystals at the biscuit–cream interface to key into the biscuit shell when the fat has cooled.

The amount of cream in a sandwich ranges from about 17 to 36% with an average amount of 26%.

There is a great range of cream flavours. Brown 'chocolate' creams are the most popular and vanilla and 'creamy' vanilla the next. Others include fruit flavours such as lemon, orange, strawberry and raspberry. The chocolate creams are flavoured with cocoa or cocoa mass (milled roasted cocoa beans, the precursor of chocolate). The creamy vanilla creams have skimmed or full cream milk powder to mellow the vanilla flavour and the fruit flavoured creams include bottled fruit extracts or oils together with an appropriate amount of fruit acid (citric, tartaric or malic) to give tartness. In all cases the optimum effect is achieved if colour is added to 'suggest' the flavour. The flavour may be enhanced with small quantities of salt which has a very fine particle size and the recipe cost can be reduced (but not improved in flavour) by adding small amounts of starch or biscuit recycle dust.

The use of dextrose monohydrate as a partial replacement for sugar is interesting. The dextrose is less sweet than sucrose and dissolves in the mouth with a significant and pleasant cooling effect. Too much dextrose can lead to splitting problems because of a water activity problem (the biscuit shell expands as moisture migrates into it).

The inclusion of small amounts of lecithin is common. This emulsifier speeds the mixing of the cream but tends to give softer creams after cooling which reduce the value of the steep melting fat.

Recipe no. Cream name	133 custard	134 mint	135 Bourbon	136 Bourbon	137 lemon puff	138 choc	139 custard
fat	21.97	41.03	37.62	30.56	33.91	29.79	29.93
lecithin	0.44	0.54					
sugar	57.12	50.74	56.42	41.93	65.93	55.37	53.53
dextrose				16.98			12.17
FCMP		7.13					
SMP							4.14
whey powder	15.82						
starch						9.46	
recycle dust	4.39					0.04	
salt		0.38					
flavour*	0.07	0.19	0.10		0.11		0.12
fruit acid*					0.03		
cocoa powder			5.96			4.91	
chocolate				10.80			
colour*	0.19		0.10		0.02	0.44	0.12
total weight	**100**	**100**	**100**	**100**	**100**	**100**	**100**
total fat content	22.41	43.45	38.22	34.02	33.91	30.28	29.93

* These ingredients are not represented by accurate quantities.

Values shown in the recipes are in percentages. The first two recipes are examples of those with very low and very high fat contents. The other recipes illustrate how dextrose, salt, lecithin and other substances are sometimes used.

10.2.2 Sweet creams for sandwiched wafers

Sweet creams for wafers are very similar in recipe to those for biscuits except that they always include a significant amount of rework material. Having formed a wafer book from three or more wafer sheets and cut them there is waste from the trim at the edges and from any damaged pieces. When ground up this cream rich 'waste' is used in fresh cream of the same flavour. The amount of rework is usually up to 25% of the cream. As the rework contains particles of wafer it colours the cream.

Wafer creams are applied almost fluid but as they have similar total fat contents to other sweet creams it is necessary for the cream to be warmer.

The quantity of cream in a wafer book made up of three wafer sheets and two layers of cream is typically about 70 to 75% and in a four wafer with three layers of cream about 75%.

Recipe no. Cream name	140 wafer choc	141 wafer coconut	142 wafer orange	143 wafer vanilla	144 wafer coffee
fat	28.04	30.00	30.00	28.57	31.58
sugar	42.05	45.00	45.00	42.86	47.37
SMP	3.27			4.76	
flavour*	0.10	0.10	0.10	0.10	0.10
citric acid*	0.10	0.10	0.10	0.10	
cocoa	3.27				
colour*	0.10		0.10		0.10
wafer trimmings	23.37	25.00	25.00	23.81	21.05
total weight	**100**	**100**	**100**	**100**	**100**
total fat content	33.41	35.40	35.40	33.72	36.13

* These ingredients are not represented by accurate quantities.

10.2.3 Savoury creams

There are a few biscuits that have a savoury, non-sweet cream. Usually, the biscuit shells are salted crackers, like Ritz. The basic cream cannot have icing sugar as its main ingredient so non-sweet powders like milk powders, cheese powder, maltodextrin, starch and cracker dust must be used as bulking agents with the fat. These powders do not dissolve in the mouth as readily as sugar so it is necessary to have a higher fat content in the cream to make them more palatable. The flavouring agents, apart from bottled liquids, include meat extract powders, dried autolysed yeast and monosodium glutamate (MSG).

A typical recipe for a cheese cream is:

Recipe no.	145
Cream name	Cheese
fat	36.70
whey powder	10.00
cheese powder	36.70
starch	7.30
recycle dust	7.30
salt	0.50
flavour*†	1.38
colour*	0.04
total weight	**100**
total fat content	53.22

* These ingredients are not represented by accurate quantities.
† 'Flavour' includes dried autolysed yeast, other flavours and MSG.

10.3 Icing

Biscuits coated with sugar icing are not common but give attractive products that are not affected by hot weather as are chocolate coated biscuits. The icing can be coloured and plain or applied in stripes. By using a double icing process patterns may be stencilled onto a plain base to give designs or pictures which appeal to young children.

There are two principal methods of applying icing to biscuits. The main method is as a half coating and the other is as small shaped deposits usually on very small (Gem) biscuits. In both cases the icing mixture is a slurry of icing sugar in water with a small amount of gelatin, pectin or egg albumen to help set the icing as it dries and to give a gloss.

For flat icings gelatin is normally used. This should be at about 1% of the sugar weight, but the quantity is related to the water needed to give the icing the correct viscosity for the machine used for coating or depositing. Low bloom strength gelatin gives icing that is more tolerant to processing variables.

The procedure is to dissolve the gelatin in 50–75% of the water in the recipe at a temperature not exceeding 60 °C. The gelatin should be given plenty of time to fully hydrate, that is 15 minutes or more before the sugar is mixed in. After the sugar has been gently mixed in colourings, flavours and acids may be added. The mixture may be beaten to achieve some aeration if it has to be very thick, but for flat icings it is best to have no deliberate aeration as the air bubbles will spoil the surface of the icing on drying. The mixture should be used warm, at a temperature of at least 21 °C, otherwise the gelatin will start to set and give increased viscosity. The viscosity must be controlled by the amount of water present and not by the temperature.

The following is a typical recipe for a flat icing:

Recipe no.	146
Type product	Flat icing
icing sugar	100.00
citric acid	0.25
glycerine	0.32
gelatin	0.87
liquid creamy vanilla flavour	0.10
colour	as required
added water, to give desired consistency, about	24

The drying of the icing is a slow and critical procedure. If the temperature is too high bubbles in the icing expand and then coalesce to form a cavity between the surface of the icing and the biscuit. Under these circumstances the icing is fragile and can easily crack off the biscuit. The maximum temperature in the drying tunnel or chamber should be 80 °C and the drying time will be at least 30–50 minutes. Drying not only reduces the moisture content of the icing to a level that is acceptable for long shelf-life but also results in sugar crystal growth giving a hard set. By using small additions of glycerine the hardness of the dried coating may be reduced as required: 0.2–0.4% based on sugar weight is usually adequate.

10.4 Jams, jellies and caramel

Jams, jellies, caramels (soft toffee) and marshmallow (see 10.5) are water-based materials. When moist products are placed next to or in the same container as dry biscuits there is an equilibration such that the biscuits become softer and the moist material dries out and there may be a change in quality. In general, it is not wise to allow biscuits to soften with moisture as their texture, shelf life and possibly flavour deteriorate. The effects of the moisture equilibration can be predicted by understanding the water activity of the components. This is a complex subject and is dealt with elsewhere, for example in Manley.[1]

10.4.1 Jams and jellies

Jam or jelly can be applied to biscuits either as a secondary process or to the dough piece before baking.

Products formed as a result of secondary processing include types where:

- Shells are sandwiched together with a layer of jam.
- Jam is deposited in the centre of a ring of cream before or after sandwiching.
- Jam is deposited on a base of sponge prior to half coating with chocolate (for example, Jaffa Cakes).
- Jam is injected into a soft baked dough before cooling (for example, jam lebkuchen).

Products where jam is introduced before baking include:

- Sponge boats (where jam is deposited on the top of a batter deposit).
- Various jam toppings where wire-cut or deposited dough pieces are garnished with a small deposit of jam.
- Jam pouches where dough is folded over a jam deposit (for example, Pop Tarts which are designed for toasting immediately before eating).

Jam applied before baking and exposed in the oven dries and can become very hard and tough.

Jam can be considered as a three dimensional network of pectin with syrup held in it. The firmness of the jam is related to the amount of pectin present and the concentration of the sugar syrup which affects its viscosity. Jam is distinguished from jelly principally because it has fibrous or recognisable fruit particles suspended in it. If these insoluble solids are removed a clear jelly is obtained. Jelly can be made from fruit juice or from commercially prepared pectin and added flavours. In most countries there is a legal requirement to use a certain minimum amount of fruit material in the product if it is described as jam, but jellies, especially if they are called fruit flavoured jellies or merely jellies, may not have to contain any fruit base material.

The fibrous pieces in jam can present production problems if the jam is to be deposited through small nozzles in precise quantities so more and more jellies are used in biscuit manufacture. A jelly made from commercially standardised pectin, sugar, invert sugar or glucose syrup, flavour and colour can be manufactured to close tolerances with a minimum of skill and laboratory control. Recipes for fruit-based jams or jellies have to be adjusted to compensate for variations in fruit quality. This requires a considerable degree of skill and experience on the part of the production staff.

Traditionally, bakery jams and jellies have been purchased from specialist suppliers against specifications, but there has been difficulty in defining the viscosity, spreadability, setting characteristics, and so forth required for a particular application. Much work has been done to investigate test methods and effects of recipe on jam quality by the British Food Manufacturing Industries Research Association (BFMIRA), see Scholey[3,4] and Verkroost.[5] Also with the greater understanding of principles more biscuit manufacturers have decided to make their own jellies (and jams sometimes) so that handling and control are improved.

By a combination of low pH (around 3.0) and high sugar concentration (67% and above) microbial growth is prevented or greatly retarded at ambient temperatures. This is the principle of fruit preservation involved in jam. However, sucrose forms a saturated solution at 67% solids at 20°C and the solution is not particularly viscous but if the solid concentrations are higher, as a result of supersaturation, some crystallisation can be expected. Addition of invert sugar (which occurs naturally in jam manufacture, either because it is derived from the fruit juice or because the sucrose hydrolyses as the jam boils at low pH) increases the content of solids at which crystallisation occurs to about 75% at 20°C. This is why domestic jams with solids around 69% concentration do not crystallise.

By using glucose syrups instead of invert sugars this crystallisation can be prevented or at least retarded at an even higher percentage of solid contents in the jam (up to about 83%), but at these levels the jam tends to be rather tough in texture. Crystallisation is also retarded by the viscosity of the material.

Jams or jellies for use in conjunction with biscuits need to have higher solids contents than domestic jams because of problems of water activity. It can be shown that biscuits at about 9% moisture could be compatible with a sucrose/invert syrup (jam) of 76–78% solids. This is a high moisture content for biscuits and a very solid type of jam. Hence the dilemma and the need for compromise. As the biscuits draw moisture from the jam some crystallisation may occur in the jam. The smaller the mass of jam relative to the biscuit the less the biscuits will soften.

Pectin is a linear polysaccharide which has the ability to form gels under suitable conditions of sugar concentration and pH. All high solids bakery jams and jellies require slow setting high methoxyl pectin which has a rather narrow setting range between about pH 3.2–3.6, although under certain conditions the range is extended to pH 3.8. To reduce the viscosity of the jam it is usually necessary to handle and deposit it at temperatures of between

60–70 °C. At these temperatures and at pH 3.4 or so, inversion of the sucrose will be occurring at a rate which will soon change the character of the jam. Thus it is possible to heat a set jam which will redissolve the pectin and make the jam fluid and suitable for depositing but the break down of the sucrose to invert sugars will soon become significant. This will result in a jam that has a strong tendency to crystallise on cooling and storage. It is better to handle a 'jam' or jelly at a higher pH, about 4.5 (but not much higher because the pectin will be degraded) and to add acid to reduce the pH to the desired level for a set immediately prior to depositing. The jam at pH 4.5 will remain in a fluid non-set condition (at high viscosity but suitable for pumping) at ambient temperatures.

Process control of jams and jellies requires constant attention to soluble solids content, which can be checked either in-line or by sampling with a refractometer, and also acidity (pH). Refractometers are usually calibrated for sucrose solutions at 20 °C (in hot countries the standard temperature is 27 °C) and care should be taken that the appropriate correction is applied if other temperatures are involved. (Correction tables are usually supplied with the instrument.) pH meters are also temperature sensitive, but a temperature probe is usually incorporated to effect a correct read out. If jelly at high pH is pumped to the depositing head, acid in the form of citric acid solution can be mixed immediately prior to depositing and the amount that is added can be automatically controlled from an in-line pH meter. Setting is rapid as soon as the temperature falls, but even at the deposit temperature, setting will commence if the jelly contains too much pectin or there is a delay in reaching the depositor nozzles. Stringiness or a large increase in viscosity can upset the performance of the depositor.

It is possible to make jellies with gelling agents other than pectin, for example, alginates, natural gums and sodium carboxymethyl cellulose. There are special applications where these are beneficial. Also, it has been shown to be possible to aerate bakery jams to stable foams, but these situations are so rarely used for biscuit applications that they do not warrant detailed consideration here.

The preparation of jam involves the boiling of the sugar, syrup, fruit and pectin mixture until the solids content is raised to the desired level. If this boiling is done in an open vessel it takes some time and there is much opportunity for process inversion, the breakdown of sucrose into invert sugars. It is common now to do this boiling and solution concentration in a closed vessel under partial vacuum. This speeds the process and means that much lower temperatures are required so the process inversion is reduced and therefore the composition of the jam better controlled.

As with all other fruit-flavoured materials it is the perceived acidity as well as the aroma and colour that is important. In jam manufacture a buffer salt, usually sodium citrate, is used to control the pH necessary for good setting of the pectin. It is therefore neither possible nor desirable to increase the acidity (that is, to reduce the pH), for taste purposes. It is possible to change the acidic *taste* by adjusting the *quantity* of acid in the jam by increasing the amount of buffer salt as well. Thus the taste becomes more acid but the pH stays where it is needed, at about 3.3.

The starting recipe in terms of the sucrose : invert sugar : fruit ratio depends very much on the process to be used for the boiling and also on the quality of the fruit material. It is therefore not possible to give useful details of jam recipes here.

10.4.2 Caramel

Caramel is formed as a stiff brown mass when sugar is heated to just below its melting point. The flavour is rather bitter and the colour is dark brown. However, when 'caramel' is referred to in connection with biscuit fillings or confectionery, a toffee or butterscotch material is implied. These toffees and butterscotches owe their character mainly to the presence of milk, butter and certain hard fats like palm kernel oil when these have been heated together in the presence of sugar. The partial decomposition which gives the characteristic flavour is known as caramelisation.

Toffees are essentially supersaturated syrups relying on their high viscosities to prevent sucrose crystallisation. However, seeding of the cooling toffee with sugar will cause crystallisation and a fudge will be formed. The texture of a seeded toffee determines whether it is a fudge (with fine crystals) or a grained toffee (with larger crystals).

Toffees (or caramels) used for spreading on biscuit and wafer products must:

- Be plastic at ambient temperatures such that they are neither too short, too tough nor too hard when bitten.
- Have a consistency, at about 45 °C, such that they can be spread evenly and smoothly or deposited but be short enough to allow separation from the depositor.
- Have an Aw (water activity) of around 0.6 such that moisture migration will not adversely affect the eating qualities of toffee or biscuit.

Soft toffees have a moisture content of about 10% and a low Aw, so the moisture migration problems do not cause as much concern as they do with jams and jellies.

Preparation of these toffees to the desired flavours and homogeneity of the fat is a somewhat specialised procedure, similar to jam manufacture, if between-batch uniformity is to be maintained. As with jams, most biscuit makers purchase the toffee from confectionery manufacturers, but on the other hand most toffee biscuit products also involve chocolate and this puts them into the confectionery market rather than the biscuit market.

Caramel wafers are a typical biscuit product involving toffee with or without a layer of cream. They are formed by spreading a film of toffee onto wafer sheets followed by topping and 'book' building as for creamed wafers.

The relative humidities of the wafers and the toffee result in an appreciable loss of crispness of the wafer sheets. However, as the toffee proportion is about 70% of the product, the texture of the wafer is subsidiary to that of the toffee.

Process control requires a uniform composition of the toffee in terms of moisture content and consistency which results from the method of manufacture. Small variations in consistency can be compensated for at the time of spreading by alterations to the handling temperature.

Typical recipes for soft caramel toffee:

Recipe no. Type product	147 soft toffee	148 soft toffee
skimmed sweetened condensed milk	50	50
glucose syrup 42 DE (dextrose equivalent)	20	12
hardened palm kernel oil	21	21
invert syrup (70% solids)	19	6
glucose syrup 63 DE	–	24
flavours	as required	

10.5 Marshmallow

Marshmallow is a mechanically aerated foam composed of sugars in solution and including a foaming or stabilising agent. The latter may be albumen or agar-agar, but is more usually gelatin or Hyfoama, a proprietary product.

The moisture contents of marshmallow foams are in the range 15–18% and the water activities lie mid-way between jellies and toffees. This means that the potential for softening effects on biscuit bases can be appreciated.

The marshmallow for biscuits should be short, neither rubbery nor tough in texture, so that it can be deposited discretely via nozzles in a similar manner to jelly. The shortness can be promoted by the addition of icing sugar to the foam which causes some crystallisation of the sugar in the syrup.

Marshmallow is used in biscuits either as a filling for a sandwich which is then fully enrobed with chocolate-flavoured coating or as a topping. Where it is a topping the marshmallow may be garnished with desiccated coconut or enrobed with chocolate-flavoured coating. The coconut should be sprinkled on as soon as possible after the marshmallow has been deposited so that it sticks well to the surface. However, it is usual to 'skin' the marshmallow a little before enrobing with chocolate. This can be done by holding the product in a low humidity atmosphere at slightly lower temperature for a few minutes before passing to the enrober. It should be noted that moisture migration from the marshmallow into the base biscuit will cause a contraction in volume that may result in pulling away from the chocolate covering or a cracking of the chocolate. If the moisture content of the biscuit can be deliberately raised before the marshmallow is applied by a period of conditioning, this problem can be reduced.

It is important to prevent drying out of the foam or the marshmallow will become tough and unpleasant and will contract in volume. Good moisture-proof packaging is essential and even then the shelf-life will be less than for most other biscuit types.

Unlike jellies and toffee, marshmallow must be prepared immediately before use. This involves dissolving the sugar and the gelatin, blending in the invert and glucose syrups, cooling, aerating and pumping to the depositing machinery. The recipe and preparation depend on the type of machinery available, so it is difficult to generalise. Wherever possible an integrated plant for continuous manufacture should be used. This allows superior control of temperatures, pressures and aeration right up to the point of deposition. Guidance on preparation procedures and conditions should be sought from the manufacturer of the equipment. There is a potential for microbial growth during the preparation of marshmallow. This means that attention to hygiene and equipment cleaning are very important.

The following is a typical recipe for marshmallow:

Recipe no.	149
Type product	marshmallow
gelatin solution	
gelatin (175 bloom)	15
water	80
heat to 55 °C and stir until dissolved. Cool to 38 °C	
sugar solution	
water	55
granulated sugar	270
glucose syrup	220
invert syrup	135

Heat in a steam jacketed vessel to 50 °C. Mix in the gelatin solution, flavours and colour as required and 0.11 of sodium bicarbonate. Pump to a continuous aerating and cooling machine (such as an Oakes or Votator) and thence to the depositor for placement on the biscuits.

The density of the marshmallow at deposition should be between 0.4 and 0.5 g/cc.

10.6 Chocolate

Addition of chocolate to biscuits either as a covering or by means of moulding is probably the most important type of secondary processing. Despite the high price of chocolate, sales of chocolate biscuit products are very substantial in all but the hottest countries of the world. Legislation has been introduced to protect the name ‘chocolate’ by ensuring that the principal fat is cocoa butter, but as a result of recent fat technology there are many different ‘hard butter’ fats that are used as cocoa butter substitutes, meaning that they have physical properties very similar to cocoa butter or that they are also compatible with cocoa butter and can be used in real chocolate. Real chocolate used to coat biscuits is also known as couverture.

‘Chocolate’ made from non-cocoa butter fats must be called ‘chocolate flavoured coating’. Here the cost is lower and technology has developed very good qualities of flavour and texture. After cooling and setting coatings are more flexible so there are some technical advantages on biscuit products especially those where an expansion or contraction occurs as a result of moisture movement. World-wide much more coating is now used than real chocolate on biscuits.

The manufacture of chocolate is a complex and highly skilled process involving selection of cocoa beans, roasting, grinding, followed by addition of extra cocoa butter, sugar, flavour, emulsifier and, for milk chocolate, milk solids. After this there is a further grinding known as refining and usually a period of prolonged mixing known as conching when moisture levels are reduced and flavours optimised. If biscuit manufacturers make their own chocolate it is in a special unit with specialist operators and equipment. This process is well beyond the scope of this book.

Preparation of chocolate flavoured coatings is much simpler and they are often made by the biscuit manufacturer. The advantages of these coatings are:

- They are a lot cheaper than real chocolate because a fat of lower cost than cocoa butter is used.
- A range of qualities is possible starting with simple lauric fat (palm kernel or coconut oil) to sophisticated cocoa butter replacer fats which are made by fractionation and hydrogenation of various vegetable fats.
- The starting material is cocoa powder which is easy to store and handle.
- It is not necessary to temper at the time of application to biscuits.
- The application temperature can be at any level up to about 50 °C so the viscosity can be adjusted somewhat with temperature.
- Cooling can be faster and is less critical than for real chocolate.
- They are more flexible after setting so they do not crack or break away from the biscuit so readily.
- Being made from appropriate fats the melting point can be increased to suit hotter climates.

However the disadvantages are:

- They do not taste as good as real chocolate, lacking the depth of flavour and often having a waxy tail when they melt in the mouth.
- They do not set as hard as real chocolate so have a more cheesy texture.
- They sometimes develop a whitish fat bloom on the surface during storage.

Examples of some typical recipes:

Recipe no. Type product	150 milk coating	151 milk coating	152 dark coating	153 dark coating	154 white coating
sugar	100.00	100.00	100.00	100.00	100.00
HPKO/lauric	69.00		74.00		
lauric CBR		63.00		64.60	66.70
lecithin	0.80	0.80	0.80	0.80	0.80
SMP		21.70		14.60	41.70
FCMP	39.00	21.70			
cocoa powder 10/12	11.00	10.90	44.00	29.00	
vanilla flavour	trace	trace	trace	trace	trace

HPKO/lauric is a fat based on hardened palm kernel oil. Lauric CBR is lauric cocoa butter replacer fat. The lecithin is a viscosity controller and can be used at up to about 0.4% of the whole. The cocoa powder with 10–12% fat can be chosen with the appropriate colour and flavour. It is recommended that the level of cocoa powder be restricted to a maximum of 14% if the fat used is lauric. Above this level of cocoa, the cocoa butter contained in the cocoa may affect the setting properties of the coating.

After making the mixture it is necessary to refine (reduce the particle size) and this can be done either with refining rolls or in a ball mill.

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11
Recipes for dietetic biscuits

11.1 Introduction

Nutrition and the roles and effects of food on human well-being have become extremely topical subjects, at least in developed countries. In addition to the food itself there is concern about unhealthy substances such as pesticides and noxious environmental chemicals which may become incorporated into food. Clearly these should be avoided and it is the aim of organic products to minimise the inclusion of such substances by using only ingredients that have a proven history of clean production. There is also the desire to eat healthily which means increasing the intake of certain substances or avoiding those food ingredients that are perceived to harm or to which one's metabolism is intolerant. This is a very inexact area that is often promoted irresponsibly but there does seem to be an increase in intolerance to specific food substances. The medical profession is very wary of publicity about food intolerance claims because there is a strong possibility of nutritional deficiency problems occurring in people who change their diet in an uncontrolled way.

The subject of nutrition is extremely complex, not only because we are all individuals and react differently to what we eat but also because we consume a great variety of foods in the course of a day or week. Thus the effect of any one ingredient or product in such a circumstance cannot normally be proved to be good or bad for us. It is important that we do have a mixed and balanced diet to be healthy.[1] In this way our requirements for energy, proteins, vitamins, fibres and minerals will be met without the need to be concerned or to calculate what should or should not be eaten.

Medical science has progressed so much in the last 100 years that most serious infectious diseases have been controlled and are treatable. Freedom from these diseases has revealed health problems resulting from what we eat or from lifestyles and these are becoming more obvious, possibly more common, and thus of concern to us. Certain foods cause problems because our individual constitution is unable to cope, especially if the food is eaten in excess. This phenomenon is called food intolerance and the effects may be minor, such as aches, hives, pains in the joints and headaches or more seriously, severe gastrointestinal and respiratory symptoms including nausea, vomiting, throat swelling, asthma and breathing troubles. If the reaction to a particular substance is severe it is called an allergy. The most serious food-allergic reaction is anaphylactic shock, which is a severe shock reaction that can include any of the symptoms described above, but also involve a dangerous drop in blood pressure and sometimes cardiac arrhythmia. Anaphylactic shock can be life-threatening if not treated immediately.

Research into genetics reveals predictable problems in our metabolisms and susceptibilities and it is likely that in the foreseeable future it will be possible to define what substances individuals should or should not eat to optimise their growth, health or chosen pursuits. 'Functional' foods are those that claim to promote health or vigour because of the inclusion of specific substances.

Food is a very important social and cultural component for most people. We not only eat to live but also use food as a feature in our relationships with others. As our disposable income rises above the level needed for mere existence we buy more food, especially tasty foods and those rich in sugar and fat. We tend to eat much more food than we need. Eating too much results in obesity and this is the cause of most food-related illness.

Biscuits are the ultimate in convenience food because they can be eaten at any time and when well packaged have long shelf-life. They are therefore seen as a good medium for providing special dietary needs that range from health promotion to famine relief.

The promotion of 'healthy' or 'functional' foods is therefore largely a marketing idea. Although these products undoubtedly do no harm they can only be valuable in the context of the rest of one's diet which should be very varied. Marketing of food ultimately depends on acceptance by consumers. Not only should the claims be correct but the product should look and taste good. Unfortunately very many 'special needs' biscuits have failed in both appearance and taste. A medicine does not have to taste horrible to be effective!

It is not possible here to give a review of human nutrition to show what is considered a healthy diet and how biscuits can fit into it. However, some recipes will be given to indicate the approaches that have been taken to provide products for specific dietary needs. These recipes are based on either exclusion, inclusion or reduction of the amounts of specific ingredients. Great care should be taken that extravagant or incorrect claims are not made. In the case of medical biscuits, checks should be made with experts before products are offered for sale.

11.2 Recipes based on exclusion or substitution of particular ingredients

Biscuits in this group are principally for individuals with medical problems manifest as either intolerances or allergies. The labelling will claim either ‘free from’ or ‘suitable for’ wording. The list of suspect ingredients seems to be growing but the most common are listed below as well as the most common specific dietary groups of people.

‘Free from’ ingredients:

- Wheat (flour and derivatives such as starch, proteins, bran, germ).
- Rye (flour and derivatives such as starch, proteins, bran, germ).
- Barley (flour and derivatives such as starch, proteins, bran, germ).
- Oats (flour/flakes and derivatives such as starch, proteins, bran, germ).
- Gluten (includes proteins from wheat, barley, rye and oats).
- Casein (a milk protein).
- Milk products (including derivatives such as whey, cheese, lactose, yoghourt).
- Egg products.
- Honey.
- Artificial colours.
- Preservatives.
- Yeast and yeast products.
- Peanuts, groundnut oil.
- Contact with nut products.
- Genetically modified organisms (GMO) products.

Products ‘suitable for’:

- Vegetarians.
- Vegans.
- Lacto-intolerants.
- Gluten intolerants (coeliac disease).
- Nut intolerants.
- Halal (certification needed).
- Kosher (certification needed).

Claims that a product is free from one or more substances imply that not only is the recipe free but also that there could not be contamination from imperfectly cleaned equipment, including storage containers used in the manufacture. Consider also if dust or other sources of contamination such as dirty hands or overalls are a possibility to violate a claim.

11.2.1 Gluten-free and low-protein biscuits

Individuals suffering from gluten intolerance, also known as coeliac disease, have a sensitivity of the gut which is affected by proteins from wheat, barley, rye and oats. As wheat flour is almost universally used in baked products it will be appreciated that the production of gluten-free biscuits presents a challenge.

Many people, for various medical reasons, are required to follow a low protein diet. Babies can be born with a rare disorder called phenylketonuria (PKU) and their metabolism cannot cope with the normal amounts of the amino acid, phenylalanine, which occurs in proteins. For individuals suffering from phenylketonuria foods must be prepared with low levels of protein. Clearly, gluten-free biscuits are potentially much lower in protein than normal biscuits.

As the market for gluten-free and low protein biscuits is relatively small it is common to offer the same biscuits for both these groups of people. The production conditions, to ensure no cross-contamination, must be extremely strict so manufacture of these biscuits is confined to specialist producers who usually have small biscuit production plants.

The structure and hence the texture of most biscuits is related to the leavening during baking and gluten plays a major role in this. It is impossible to make a developed dough, suitable for crackers and semisweet biscuits, without gluten so gluten-free biscuits have to be of the short dough type. Although great care is taken to have little gluten development in typical short dough biscuits (by minimum mixing and low water content of the dough) it would seem that some of the structure is derived from the wheat protein. This means that when other starchy ingredients are substituted for wheat flour the biscuit texture tends to be very dense.

Colouration of the surface of dense textured biscuits during baking is always difficult. The colouration during baking is principally the result of the Maillard reaction which involves reactions between amino acids and reducing sugars so the extent of this reaction is clearly small in low protein biscuits. Thus in addition to poor structure gluten-free and low-protein biscuits often have an unattractive surface appearance.

Recipe no. Type product	155 gluten-free	156 gluten-free	157 gluten-free cream shell	158 gluten-free	159 gluten-free choc chip cookie
cornflour	97.08		88.72	94.01	90.00
pregel tapioca starch		66.67	11.28	6	10
pregelatinised starch	2.92				
defatted soya flour		33.33			
granulated sugar					45.62
powdered sugar	36.96	30	22.57	41.01	
invert syrup 70%		5			
glucose syrup 80%	1.95				
maltodextrin			33.85	10.17	20
dough fat	11.67	20.00	39.38	35.89	45.62
butter	11.67				
soya flour			28.2	25.62	15
GMS		1			
delactosated skim. milk	9.73				
fresh egg	5.84				
lactoalbumin	1.52				
caseinate	12.65				
amm. bic.	2.04	0.42			0.74
soda		0.83			0.74
ACP	0.51	0.83			
salt		1.00		1.09	1.12
vanilla/in*	0.1				
liquid flavour*	0.1				
coconut					10.00
cocoa					0.97
nuts					10.00
choc chips					20
added water	18	30	20	32	32

* These ingredients are not represented by accurate quantities.

Mixing All doughs are short and are mixed by a two-stage procedure, the starches and soya flour being added at the second stage. As no gluten is being developed the length of the second stage mixing is not critical.

Dough handling The dough should be held for a time to let the starches hydrate and to let the dough consistency stabilise.

Dough piece forming Dough pieces are formed by rotary moulding.

Baking Bake on either a wire or steel band at about 200 °C for 7 minutes.

It is possible to use normal biscuit creams with sandwich biscuit shells but milk powders should be avoided if low protein claims are made.

11.2.2 Biscuits for diabetics

Individuals suffering from *diabetes mellitus,* which is known as diabetes, have a malfunction of glucose metabolism. After taking a meal the glucose level in the blood rises and later it falls again. The glucose arises from the breakdown of carbohydrates in the food. The range of glucose in the blood for normal people is remarkably small and this is because it is controlled by a complex mechanism which involves several hormones that take into account the energy needs of the body. Only one of these hormones, insulin, is capable of reducing the glucose level. Insulin is produced in the pancreas: it allows the glucose to penetrate cells and hence be removed from the blood. If the glucose level is not controlled the person suffers unpleasant or even life-threatening effects.

Sufferers of diabetes must control their *carbohydrate* intake and often need to inject themselves with insulin. They must also monitor the types of carbohydrate they eat because different carbohydrates are digested at different speeds. It is normal, therefore, to keep the levels of sucrose and all other sugars, except fructose, as low as possible as these are absorbed particularly quickly. Thus sucrose, glucose (dextrose), invert syrup, honey, molasses, maltose, lactose and maltodextrins should be avoided. The recommended quantity of fructose per day is 50–100 g taken in two or four doses so as not to over stress the fructose metabolism which occurs mainly in the liver and does not stimulate secretion of insulin.

Biscuits for diabetic patients should therefore be low in small molecular weight carbohydrates (sugars) and the composition and quantities of the carbohydrates clearly labelled. Unfortunately, the lack of sugar in a biscuit recipe causes difficulties with structure and texture. The sweet materials that are *usually* acceptable are fructose, the polyols (such as sorbitol, and mannitol, which unfortunately have a laxative effect) and the intense sweeteners like saccharin, acesulfame and cyclamate. Also a food bulking agent, polydextrose, is acceptable as this reduces the overall calorific content. All of these ingredients except fructose are classified as additives and have European E-numbers.

The best substitutes for sucrose in biscuit recipes are a mixture of polydextrose and isomalt or Maltitol with some fructose and/or an intense sweetener such as acesulfame, which is bake stable, to increase sweetness.

Recipe no. Type product	160 diabetic shortcake	161 diabetic cream shell	162 diabetic digestive	163 diabetic sweet
flour, weak	62.47	100.00	76.00	100.00
dried gluten	30.78			
wholemeal flour			16.00	
wheat bran			4.00	
oat flakes			4.00	
pregel tapioca starch	6.75			
saccharin	0.12	0.03	0.05	
acesulfame				0.2
sorbitol	16.70	24.84	22.00	
dough fat	32.06	29.69	33.60	22.00
lecithin				0.3
soya flour	9.86	1.77	6.81	
SSL (emulsifier)	0.51	0.04		
SMP	1.04	1.59	2.80	2.00
amm. bic.	1.30	0.36	0.11	0.40
soda	1.04	0.58	0.50	0.40
SAPP	1.30	0.50	0.70	
salt	1.30	1.41	0.41	0.75
SMS		0.030		
polydextrose	16.7			24
isomalt				6
vanilla/in*	0.1			
liquid flavour*	0.1		0.1	0.1
colour*	0.10	0.10		
biscuit recycle			9.98	
added water	17	10	16	10

* These ingredients are not represented by accurate quantities.

Mixing All these doughs are short and are mixed by a two-stage procedure. As for other short doughs the second stage should be for a minimum time to avoid developing the gluten.

Dough handling The dough should be held for a time to let the dough consistency stabilise passively.

Dough piece forming Dough pieces are formed by rotary moulding.

Baking Bake on either a wire or steel band at about 200 °C for 7 minutes.

Clearly, biscuit sandwich creams based on icing sugar are also unacceptable to diabetics. The following recipes may be used.

Recipe no.	164	165	166
Type product	lemon cream for diabetics	hazelnut cream for diabetics	custard cream for diabetics
fat	100	100	100
lecithin	0.9	1.39	
sorbitol	122		144
fructose powder	61		
aspartame	0.23	0.5	
saccharin			0.07
polydextrose		163	
isomalt		102	
whey powder	18		
SMP			15.2
FCMP			15.2
citric acid	0.15		
flavour*	0.1	0.1	0.1
colour*	0.1		0.1
hazelnut paste		70	
cocoa		27	

* These ingredients are not represented by accurate quantities.

11.2.3 Biscuits with other omissions

It is much easier to avoid other ingredients that cause medical intolerance such as nuts, egg and artificial colours than it is to avoid gluten and sugar.

Nuts are only a flavour ingredient but if peanuts are a problem groundnut oil should also be avoided so the supplier of the dough fat should be alerted.

Lecithin can be obtained from soya flour rather than from egg yolk.

Artificial colours are not used extensively now but there are many natural alternatives: caramel and cocoas can also be used.

Milk powders are commonly added to increase the Maillard colouring reaction and, to a lesser extent, to add flavour and texture. They can be omitted and some reducing sugar, such as invert syrup, added to aid colouration during baking. Milk products are not used in non-dairy Kosher biscuits.

11.3 Recipes based on inclusion of particular ingredients

Attempts have been made to specify the amount of food each person requires to sustain a healthy life. These are called RDAs, Recommended Daily Amounts (UK) or Allowances (USA). The directives published[2–7] cover energy, protein, minerals (calcium and iron) and vitamins (thiamine, riboflavin, niacin, vitamins A, C and D).

Energy is measured as kilocalories (kcal) or kilojoules (kJ). One gram of carbohydrate gives about 3.75 kcal (16 kJ), one gram of protein gives about 4 kcals (17 kJ) and one gram of fat gives 9 kcal (37 kJ) (see McCance and Widdowson[8]). The amount of energy required by a person varies very much depending on such factors as their size and level of activity. Children require much more than adults and old people the least. The basal metabolic rate, BMR, requires approximately 7.56 MJ per day for a 65 kg man and 5.98 MJ for a 55 kg woman (a MJ is a million joules). So in kcal, the *minimum* energy requirements are about 1800 and 1450 respectively.

Biscuits have a high fat content, rarely less than 12 % and often more than 30 % (in creamed or chocolate biscuits). As the major ingredients of all biscuits are flour, sugar and fat it is readily seen that they are a major source of energy.

It has been considered best if no more than 11 % of a human's carbohydrate intake should be as non-milk sugar (mostly sucrose). In 1984 the Committee on Medical Aspects of Food Policy (COMA) also produced a report[9] about diet in relation to cardiovascular disease. This drew attention to the apparent dangers to health of too much fat in the diet and also stated that saturated fats are more harmful than unsaturated. The COMA report recommended that fats should supply only up to 30–35 % of the energy value of the food we consume per day. This called for a significant reduction by most people in affluent countries.

Against this background biscuits can be formulated to modify nutritional intakes but claims must be made with great care.

11.3.1 Vitamin enrichment

Many foods are now marketed which are enriched with vitamins and minerals. Nutritionists are divided on the need to augment foods. It could be argued that with a varied and balanced diet we are receiving all the nutrients we need but there is also a school of thought which maintains that a surprisingly large number of people are deficient in certain vitamins and minerals. The proponents of this view cite cases where patients with long term health problems have been greatly helped by specific vitamin and mineral supplements. In most cases we do not need extra nutrients of these types in our diet but if the food is tailored to a group where it is likely to be a major or the only item of the diet, enrichment is important. Products for infants and the elderly are typical examples.

Table 11.1 Losses of labile micronutrients in biscuits, after Bednarcyk[10]

	Average loss of potency (%)
thiamine	32
niacin	5
vitamin A	18
vitamin B1	20
vitamin B12	10
vitamin C	60
vitamin E	27
folic acid	7

Many vitamins and minerals come from the normal raw materials used to make biscuits and enrichment can be achieved by using proprietary blends. Unfortunately, all of the vitamins in a dough do not end up in the product which is consumed. Nothing happens to the minerals but vitamins are labile nutrients. Thiamine and vitamin C are the most affected by heat. Table 11.1 gives an idea of the nutrient losses that may be expected as a result of baking. Further losses may occur during storage but in biscuits of low moisture content these losses are generally small compared with baking.

The losses of vitamin C can be greatly reduced if it is added to the cream of a sandwiched biscuit. It is acid in taste so in creams is best used in conjunction with fruit flavours.

If a claim for enrichment is made it should be backed up with regular laboratory assays.

11.3.2 Protein enrichment and energy supplement biscuits

Biscuits enriched with protein, usually from soya flour and caseinate, have been developed for special feeding programmes usually for children in developing countries. Vital wheat gluten and milk powder are also useful sources of protein for supplementation. Bender[11] has shown, however, that in many cases malnutrition is caused by a lack of food in general; not just a lack of protein. Care should be taken about making nutritional claims, such as calling a biscuit ‘high protein’ as there are usually statutory requirements of quality and quantity to be observed. The main problem with soya-enriched biscuits is the strong and unattractive flavour imparted by the soya.

Recipe no.	167	168	169
Type product	Oxfam biscuit	basic high energy	protein enriched
flour, weak	100.00	100.00	90.91
dried gluten			5.45
cornflour			3.64
powdered sugar			28.91
caster sugar	31.44	25	
liquid sugar 67%			3.64
dough fat	14.01	32	14.91
lecithin	0.19		
soya flour	62.50		
SSL			0.27
SMP		30.00	
caseinate			18.18
amm. bic.	2.08		1.64
soda			0.45
ACP			0.18
salt	2.08	0.80	0.91
SMS			0.005
vanilla/in*	0.10		
added water	65	8	31

* This ingredient is not represented by accurate quantity.

Mixing These doughs are developed hard doughs that require mixing for several minutes to a set temperature. Dough temperatures at about 35 °C are recommended.

Dough handling The dough should be used without standing.

Dough piece forming The dough is sheeted and cut.

Baking Baking is the same as for semisweet biscuits and is usually on a wire band. Bake times are about 5 to 6.5 minutes at 200, 220, 180 °C. Keeping the first part of the oven humid will give an attractive sheen to the biscuit surface. Baking to a moisture level of less than 1.5% will normally prevent the problems of checking.

11.3.3 Biscuits for babies

In some countries it is popular to use small biscuits as a source of nutrition for weaning babies. A biscuit is dispersed in milk and fed to the baby either via a feeding bottle or with a spoon as a type of porridge. As mentioned above, these biscuits should be enriched and normally there is a long list of vitamins and minerals which have been added (a premix of these is available from specialist suppliers). Remember that some minerals such as iron and calcium may be added to flour by the miller so any extra quantities added should be based on those already in ingredients.

It is recommended that these products are not fed to the infant before

4 months of age but after the infant is about 9 months old the biscuits can be given to the child directly for him or her to hold and chew. A characteristic of most baby biscuits is that they disperse readily in warm milk. This is achieved by using, in addition to wheat flour, proportions of other cereal flours and starches and not baking to dark colours.

Manufacture of biscuits for babies demands extra vigilance on food hygiene as babies are particularly vulnerable to pathogenic bacteria.

Recipe no. Type product	170 baby biscuit	171 baby biscuit	172 baby rusk	173 baby rusk	174 baby rusk
flour, strong	73.52				
flour, weak		82.90	100.00	72.92	100.00
cornflour	6.17	14.51		27.08	
rice flour	4.94	2.59			
dextrinised flour	20.93				
granulated sugar			42.86		
powdered sugar	31.28	31.09			22
caster sugar				27.08	
malt extract 80%	1.98				
glucose syrup 80%				7.08	6.8
honey 80%	2.47	2.07			
maltodextrin				10.80	10.4
dough fat	10.53	11.40	8.57	20.83	12.00
butter	0.66				
oil	1.98				
lecithin		0.07			
soya flour		2.59		5.00	5.6
GMS (emulsifier)			2.86		6.7
SMP	9.05				
whey powder		2.59			
amm. bic.	2.74	1.19	2.62	2.60	2.50
salt	0.49	0.38			
citric acid*		0.1			
SMS		0.108		0.021	
calcium lactate	0.69				
vitamin mix*	0.1	0.1	0.1	0.1	0.1
biscuit recycle			7.86		
total added water	13	26	17	13	12

* These ingredients are not represented by accurate quantities.

Mixing These doughs are best made as developed hard doughs. Dough temperatures at about 35 °C are recommended.

Dough handling The dough should be used without standing.

Dough piece forming The dough is normally sheeted and cut.

Baking Baking takes place as for semisweet biscuits and is usually on a wire band. Bake times are about 5 to 6.5 minutes at 200, 220, 180 °C. Baking to a moisture level of less than 1.5% will normally prevent the problems of checking. Avoid developing dark surface colours as this will affect the flavour and the ability to disperse biscuits in milk or water.

11.3.4 Fibre enrichment

A major nutritional aspect of recent years has been the attention to dietary fibre. Apart from the more obvious role of this material it has also been shown that dietary fibre can help reduce the incidence of bowel cancer, diverticulitis, irritable bowel syndrome and heart disease. Oat fibre is particularly cited in this respect but there are many other types of dietary fibres. Biscuits containing ‘brown’ or wholemeal flour have always been popular but there is now a far greater variety which ranges from those with only a small fibre content to some which are very coarse and mealy.

Fibres act as fillers and as such they interrupt the gluten structure in developed doughs. It is thus more difficult to achieve the same degree of open texture in biscuits and crackers with added fibre compared with those made with white flour or no added fibre.

11.4 Recipes based on reduction of fat, sugar and salt

There is a strong development to provide traditional types of food with lowered calorie contents. These are the so called 'lite' foods of the USA. For biscuits the labelling varies and there is legislation to help prevent confusing and misleading claims. Common claims are: 'No Fat', 'Low Fat', 'Reduced Fat', 'x% Fat Free', 'No Added Sugar', 'Reduced Calorie'.

These products represent by far the largest groups of dietetic biscuits. They are for people who perceive a need to control their diets but do not have any specific medical disease. Biscuits with 'reduced' claims are only useful when viewed as components of a controlled diet and, as mentioned before, doctors have concerns about people moderating their food intake without professional advice. It may well be that those with excess weight problems, and therefore aiming to reduce their calorie intake, should not be eating biscuits at all! However, marketing of reduced calorie biscuits has been active and presumably successful.

11.4.1 Biscuits with reduced fat and calorific value

Fats have the highest calorific value of any normal ingredients used in biscuits. At 9 kcal/g fat has more than twice the number of calories per gram than do carbohydrates and proteins. Thus to reduce the fat content of biscuits will lead to significant lowering of the calorific values.

The value of fat in baked goods can be attributed to its ability to modify the mouth feel and textural characteristics. Fat makes the dough shorter, that is less cohesive and less extensible, and this shortening is also manifest in the baked biscuit. Simply reducing fat in a biscuit recipe usually results in a harder product which is less tasty. Many fat 'substitutes' have been developed to mimic the mouth feel of fat but these are only successful in high moisture food such as salad dressings and desserts. The most satisfactory technique used to reduce fat levels in biscuits is to improve the fat functionality by using surface active agents, emulsifiers. Most people know that by using the natural emulsifier, lecithin, at the rate of about 2% of the fat weight in a recipe the functionality of the fat can be improved so that about 10% less fat may be used to give similar eating biscuits.

In the UK, the fat content of the product must be reduced by a minimum of 25% to be classified as 'reduced fat'. To be classified 'low fat' the fat level has to be at least 50% less than the normal and, of course, for 'fat free' there should be no fat at all. By using special emulsifiers it is possible to extend the fat functionality and so get similar eating qualities with up to 20% less fat. The emulsifiers that have been found to be particularly effective are sodium-2-stearoyl lactylate and the data esters. With some rebalancing of the recipe particularly in terms of sucrose and leavening agents a more or less satisfactory biscuit with 25% less fat can be achieved. There are a number of 'fat free' biscuits but only those with a higher moisture content are really satisfactory. The higher moisture can be tolerated where fruit pastes are present as they are, for example, in fig rolls (e.g. Fig Newtons).

The development of the fake fat, Olestra (with zero calorific value), by the Procter and Gamble company may, in the future, when its use in food has been more widely approved, allow some very low calorie biscuits to be made.

Low fat doughs are tougher, harder and more sticky than normal doughs. This presents problems for machining and dough piece formation. Care should be taken to ensure that the normal sheeters and rotary moulders have enough power and are generally robustly constructed to take the higher pressures involved in handling these doughs.

Examples of fat/calorie reduced doughs:

Recipe no.	175	176	177	178	179	180
Type product	cream shell		snack cracker		soda cracker	
	normal	reduced	normal	reduced	normal	reduced
flour, weak	100.00	100.00	98.62	88.18	100.00	100.00
malt flour			1.38	1.23	0.5	0.5
modified starch				10.58		
granulated sugar			6.9	6.17		
powdered sugar	33	15.33				
glucose syrup 80%	12.5		2.96	2.65		
dough fat	28.00	9.55	11.83	0.00	12.00	0.00
emulsifier				1.76		
amm. bic.	0.50	1.65	1.48	2.65		
soda	1.00	1.07	1.28	1.15	0.80	0.80
ACP		0.27	1.18	1.05		
salt	0.75	0.95	0.74	0.66	1.00	1.00
P. enzyme			0.03	0.03		0.05
fresh yeast					0.25	0.3
polydextrose		25.45				
cellulose fibre (bulking)		4.12				
vanilla/in*		0.1				
cocoa	11.00	15.29				
caramel colour		0.82				
added water	10	30	29	30	30	32

* This ingredient is not represented by accurate quantity.

Recipe no. Type product	181 shortcake normal	182 shortcake reduced fat	183 shortcake reduced fat
flour, weak	100.00	100.00	100.00
powdered sugar	31.8	31.8	31.8
cane syrup 80%	1.79	1.79	1.79
dough fat	35.00	24.50	29.05
SSL			0.87
DATEM		0.87	
SMP	0.71	0.71	0.71
amm. bic.	0.27	0.27	0.27
soda	0.38	0.38	0.38
salt	1.21	1.21	1.21
added water	11	15	14

The fat-sparing effect of DATEM ester is most effective if the emulsifier is added with the fat. SSL, sodium stearoyl-2-lactylate, is best added in water.

Example of a fatless dough:

Recipe no. Type product	184 fatless fig bar dough
flour, weak	100.00
granulated sugar	15.56
powdered sugar	2.22
glucose syrup 80%	7.22
dried egg	2.00
amm. bic.	0.33
soda	0.33
salt	0.73
citric acid	0.10
vanilla/in*	0.10
colour*	0.10
added water	26

The cracker doughs are mixed, handled and baked as for normal crackers. All the other doughs are mixed and handled as short doughs. Particular care should be taken not to overmix the fatless dough or to use too much water as this will give a very tough and extensible dough that will be almost impossible to extrude with the fig bar machine.

11.4.2 Biscuits with reduced sugar

Some marketing confusion occurs here. ‘Sugar free’ requires that disaccharides and monosaccharides are less than 0.2 g per 100 g of product. However, 'no added sugar' usually means that sucrose is not used but fruit juices and pastes (which are high in monosaccharides) are used for the formulation. The calorific value of all sugars and other carbohydrates is the same so the claim of No Added Sugar would seem to have limited nutritional significance! Where sugar reduction is made to reduce the calorific value of the biscuit it is necessary to use a low calorie bulking agent like dietary fibre or polydextrose.

It was mentioned above that sucrose gives important structural and texture qualities to biscuits. Its removal is thus a problem except in crackers such as cream crackers and soda crackers where no sugar needs to be added.

Sugar-free biscuit sandwich creams have been described in section 11.2.2.

Typical recipes for 'no added sugar' cookies:

Recipe no.	185	186	187	188
Type product	Fruit and nut cookie Sugar free	Caraway cookie Sugar free	Oat cookie Sugar free	Coconut cookie Sugar free
wholemeal flour	100.00	100.00	55.55	100.00
oat flakes			44.45	
oil	36.84	36.84	25.93	46.67
soda	3.16	3.16	2.22	4.00
fruit pastes	150	100	18.52	133.33
fig juice			51.85	
coconut				63.33
caraway seeds		8.95		
added water	0	0	0	0

Mixing Blend the fruit paste and juice with the oil and then add the other ingredients and mix briefly until the dough is homogeneous.

Dough piece forming The dough is sticky and best formed into pieces by wire cutting. This produces irregularly shaped 'cookies'.

Baking Bake carefully at about 180°C for 8 minutes. Too high a temperature will cause excessive surface colouring.

11.4.3 Biscuits with reduced salt

Salt (sodium chloride) improves the flavour of most recipes by acting as a flavour enhancer. It is used at between 0.7 and 2.0 units per 100 units of flour. Unfortunately, it is also associated with high blood pressure due principally to the sodium ion. It is possible to use the potassium salt as an alternative but this is more expensive and tends to give a bitter taste. Sodium gluconate used with a lower level of sodium chloride is claimed as a good alternative. Sodium gluconate is supplied by Fujisawa Pharmaceutical Company in Japan and has little effect on blood pressure.

11.5 Labelling of dietetic biscuits

With the growing interest in food intolerances particular care should be taken to declare accurately ingredients particularly wheat, milk products, egg and nuts. If there is a possibility of cross contamination with any of these a note to this effect would be useful. Manufacturers should also protect themselves by getting clear and complete declarations of composition of each of the ingredients they purchase for use in their biscuits.

The nutrition label can be a marketing tool. There are clearly attractive marketing gains to be made if attention can be drawn to high or low contents of certain nutrients or ingredients. To protect the consumer legislation has been drawn up in most countries which defines the meanings of specific nutritional claims. The product developer and the marketing manager's attention is drawn to this fact! It may be useful or necessary to declare the quantity of each nutrient consumed in a normal serving or in 100 g of the product related to the Recommended Daily Amounts, RDAs. Instead of saying 'reduced fat' it may be better to say something like *xx*% fat free; this means that 97% fat free implies 3% fat.

There are a few people who do monitor their food intake and for these accurate declarations of composition and ingredients are important especially where attention is drawn to a particular ingredient or set of ingredients. To be very accurate, assays should be made by competent laboratories but for general composition lists it is acceptable to make calculations based on tables such as those provided by McCance and Widdowson.[8] The spreadsheet format given in Appendix 3 may be useful for determining nutritional information. For vitamins remember that there may be losses during baking and storage.

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Useful reading

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Appendix 1
Glossary of ingredient terms

Ingredients are described in detail in other books including the author's *Technology of Biscuits, Crackers and Cookies*. However, it may be useful to list briefly the meaning of most of the terms used throughout this book.

Cereal and starch ingredients

flour, protein content	Nitrogen determined by Kjeldahl and multiplied by 5.75. This is not a wet gluten value.
flour, strong	White flour with a protein content of 10.5 % or more. Usually used for bread making.
flour, weak	Often known as biscuit flour, ideally with a protein content of less than 9.0 % but certainly not more than 10.0 %. The ash content is usually in the range 0.51–0.63%.
semolina	A coarse particle grade of milled cereal, usually wheat or maize. Used to give a gritty texture to biscuits.
gluten, vital dried	The protein from wheat flour that has been separated from the starch by a wet system and has subsequently been dried in a way that does not denature and prevent it forming gluten when hydrated and mechanically worked. Used to increase the protein content of flours.
wholemeal	Wheat flour made from virtually 100 % of the wheat grain and therefore rich in bran. Also known as Graham flour. The ash content is usually greater than 2%.
wheat bran	Fibre-rich material which consists of the outer layers of the wheat berry removed and graded for size at the flour mill.
wheat starch	Starch obtained from wheat flour after removal of nearly all the protein.

wheat germ	The embryo of the wheat berry. Rich in fat and usually heat treated to retard the development of fat rancidity.
cornflour/corn starch	Protein-free starch extracted from maize. Cornflour (USA) can also mean a yellowish flour obtained by milling maize. It is not used in this way in this book.
rice flour	Flour or fine semolina obtained from milling rice.
oatmeal/flakes	Oatmeal is a coarse flour obtained by milling oats. The more normal form of oats as used in biscuits is as flakes. These are rolled pieces cut from whole grains of oats. The thickness can be specified. All oat products are heat treated to retard the onset of fat rancidity. This affects the water absorption of the materials.
malt flour	A brown flour obtained by milling dried wheat or barley grains after they have been allowed to germinate. Malt flour is typically rich in α-amylase enzyme and is used when dough is fermented with yeast.
malted wheat	Lightly germinated wheat that after drying is milled into a coarse meal. This material is used as a flavour and texture source.
potato starch	Starch obtained from potatoes.
tapioca starch	Also known as cassava starch and manioc. Obtained from the swollen roots of the tropical plant *Manihot utilissima*.
arrowroot	Obtained from the roots of a tropical plant. Now rarely used in biscuits.
rye flour	This flour is milled in the same way as wheat but the flour is darker and produces very sticky doughs.

Sugars and other sweeteners

sugar, granulated	White crystalline sucrose. The most commonly available grade.
sugar, powdered/icing	Powdered sugar is normally produced by rough milling of granulated sugar. It is dusty but with a wide particle-size range. Icing sugar has a uniform very fine particle size.
sugar, caster	White crystalline sucrose. With a finer and narrower particle size range than granulated sugar.
sugar, Demerara/brown	Used to indicate a range of brown crystalline sucrose sugars with a coating of syrup of varying colour and flavour.
cane syrup 80%	Used to indicate a broad range of syrups with 80% solids derived from the refining of cane sugar. They can range from very dark syrup like molasses to golden syrup which may be partially inverted. Used exclusively for their excellent flavours.
invert syrup 70%	A syrup of 70% solids made by acid hydrolysis of sucrose. The result is a 50 : 50 mixture of dextrose and fructose which are both reducing sugars and contribute to the Maillard reaction in baking.
malt extract 80%	A thick glutinous syrup of 80% solids usually non-diastatic and obtained by water extraction of malted wheat or barley. The heat treatment used to concentrate

	the solution destroys any enzymes. Used as an important flavour material. Rich in maltose, which is a reducing sugar.
glucose syrup 80%	A syrup with 80% solids derived by partial hydrolysis of corn starch. Also known as corn syrup. There are various grades such as DE 42, DE 60, DE 90 which indicate the equivalent concentration of dextrose in the syrup. The other solids are a mixture of carbohydrates with larger molecules such as dextrins and polysaccharides.
saccharin	An artificial sweetener with intense sweetening properties.
dextrose monohydrate	A fine white powder of dextrose, a reducing sugar.
liquid sugar 67%	A solution of sucrose at 67% solids.
honey 80%	A natural product made by bees. The composition is very similar to invert syrup but the flavour properties are exceptional.
maltodextrin	A more or less tasteless polysaccharide powder obtained by partial hydrolysis of corn starch.
high fructose syrup 80%	A syrup with 80% solids. A specific type of glucose syrup prepared to have a much higher fructose content than normal glucose syrup. It is thus sweeter.

Fats

dough fat	Used to indicate a non-specific blend of anhydrous vegetable fats designed to have physical properties similar to butter fat. They are handled as bulk plasticised fat at about 26°C or in boxes.
butter	Fat solids obtained from milk and plasticised with 16% of water.
margarine	A blend of fats usually all of vegetable origin plasticised with 16% water and possibly some milk solids and colour.
oil/ butter oil	Used to indicate either a liquid fat (oil) or anhydrous butter.
HPKO	Hardened palm kernel oil, used in biscuit creams and some chocolate flavoured coatings.
lauric fats	Coconut and palm kernel fats which are high in lauric acid esters. Used for biscuit creams and fat sprays.
CBR	Cocoa butter replacement fat. A fat used to make a chocolate flavoured coating. Usually a lauric fat.
lecithin	A complex natural surfactant usually obtained from soya beans.
data ester	A specific surfactant. See also DATEM.
sucrose ester	A specific surfactant.
soya flour	Used to indicate a defatted flour obtained from soya beans. Used principally as a source of lecithin in biscuits.
GMS	Glycerol monostearate. A general purpose surfactant (emulsifier).
SSL	Sodium stearoyl lactylate, a surfactant.
DATEM	Diacetyl tartaric acid ester of mono- or diglyceride of a fatty acid, a surfactant.

Dairy products

cheese	Fresh cheese, usually of Cheddar type as this has the strongest flavour.
cheese powder	Dried cheese, usually Cheddar.
SMP	Skimmed milk powder. Obtained by drying milk after the fat has been removed.
FCMP	Full cream milk powder. Obtained by drying milk. The flavour is good but the shelf life is much shorter than is that of SMP.
whey powder	Obtained by drying whey, which is a by-product of cheese manufacture. Fat free and if demineralised the flavour is less salty and bitter. Commonly used as a cheaper substitute for SMP.
lactose	Milk sugar. A reducing sugar but used principally as a flavour enhancer for savoury products.
egg, dried	Dried whole egg. Rich in lecithin but not useful for producing a foam, which is done with fresh eggs.
egg, fresh	Shelled eggs that are either fresh or carefully thawed from frozen. The latter are always pasteurised because of the common danger of *Salmonella* contamination from eggs.
egg white	Either separated from fresh eggs or reconstituted from dried albumen.
egg yolk	Dried powder rich in lecithin.
fresh milk	Pasteurised whole milk.
milk, sweet condensed	Milk that has been concentrated by evaporation with added sugar to act as preservative.

Chemicals and aeration aids

amm. bic.	Ammonium bicarbonate (volatile salt) ammonium hydrogen carbonate
soda	Sodium bicarbonate (sodium hydrogen carbonate)
ACP/cream of tartar	Used to indicate an acid salt. Acid calcium phosphate or cream of tartar (potassium acid tartrate).
SAPP	Sodium acid pyrophosphate.
salt	Sodium chloride.
tartaric acid	Acidification additive.
citric acid	Acidification additive.
SMS	Sodium metabisulphite (or pyrosulphite), $Na_2S_2O_5$, a reducing agent used to modify the strength of gluten in doughs.
P. enzyme	Proteolytic enzyme. Usually a white powder that requires care in handling, used to modify the strength of gluten in doughs.
yeast, fresh	Used to ferment bread and some cracker doughs.
glycerine	Used as a humectant in sponge batters and with dried fruit and pastes.
calcium lactate	Dietary supplement.
mould inhibitor	Usually calcium propionate included in moist products to retard the growth of fungal moulds.
vitamins	Standardised preparations used to fortify dietetic products especially those for babies and infants.

magnesium carb.	Occasionally used as a release aid in wafer batter.
L-cysteine	A rarely used alternative to SMS.

Flavours

vanilla/in	Source of vanilla flavour. Often the synthetic material ethyl vanillin.
spice/herbs	Used to indicate any powdered plant product which is used for flavouring. A spice or a herb.
liquid flavour	Used to indicate a bottled flavour.
powder flavour	Used to indicate a powdered flavour material not directly of plant origin.
MSG	Monosodium glutamate. A flavour enhancer for savoury products.
dried autolysed yeast	Derived from yeast and used as a savoury flavouring.
lactic acid	Flavouring material for savoury products.

Other ingredients

currants/sultanas	Dried grapes. Currants are black small seedless raisins from Greece, sultanas are usually golden brown and have been bleached at the time of drying.
raisin paste	A stiff black paste made by milling dried raisins. A valuable flavouring material.
fig paste	Macerate of dried whole figs of a moisture content about 24%.
des. coconut	Desiccated coconut, always of fine or flour grade for use in biscuits.
cocoa	Powder obtained by expressing the fat from roasted cocoa beans in the manufacture of chocolate. The fat content is normally 10–12% and the colour can be from pale red to black depending on the process used. Used principally in biscuits for colouration.
cocoa mass	Product of grinding and refining, to a very fine particle size, roasted cocoa beans. The precursor of chocolate and cocoa manufacture.
colour	Used to indicate some additional colouring material.
caramel	Also known as toffee. A viscous fat/syrup material with excellent flavour and texture.
caramel colour	A dark brown liquid derived from sugar. Used for colouring dough.
biscuit recycle	Milled baked biscuit material that is incorporated into a new dough or sandwich cream. Probably of variable quality.
nuts	Used to indicate fresh or roasted nuts of various particle size.
nut paste	Finely ground and refined nuts.
almonds, ground	A fine meal prepared from roasted almonds.
choc chips	Used to indicate pieces of chocolate. Either small lumps or uniformly shaped drops of various size.
minced peel	Candied peel usually of citrus origin.
added water	Total amount of added water. The amount may have to be varied to suit the consistency of the dough.

Appendix 2
Conversion tables

Weight		Weight		Temperature		Length		Volume					
Kilograms	lbs	lbs	ounces (oz)	°C	°F	mm	inches	litres	UK fluid oz	UK pints	UK gallons	US fluid oz	US pints
0.1	0.22	0.1	1.60	1	34	1	0.039	0.1	3.52	0.18	0.02	3.38	0.21
0.2	0.44	0.2	3.20	2	36	2	0.079	0.2	7.04	0.35	0.04	6.76	0.42
0.3	0.66	0.3	4.80	3	37	3	0.12	0.3	10.56	0.53	0.07	10.15	0.63
0.4	0.88	0.4	6.40	4	39	4	0.16	0.4	14.08	0.70	0.09	13.53	0.85
0.5	1.10	0.5	8.00	5	41	5	0.20	0.5	17.60	0.88	0.11	16.91	1.06
1	2.20	1	16.00	6	43	6	0.24	1	35.20	1.76	0.22	33.82	2.11
2	4.41	2	32.00	7	45	7	0.28	2	70.40	3.52	0.44	67.64	4.23
3	6.61	3	48.00	8	46	8	0.31	3	105.60	5.28	0.66	101.45	6.34
4	8.82	4	64.00	9	48	9	0.35	4	140.80	7.04	0.88	135.27	8.45
5	11.02	5	80.00	10	50	10	0.39	5	176.00	8.80	1.10	169.09	10.57
6	13.23	6	96.00	20	68	20	0.79	6	211.20	10.56	1.32	202.91	12.68
7	15.43	7	112.00	30	86	30	1.18	7	246.40	12.32	1.54	236.72	14.80
8	17.64	8	128.00	40	104	40	1.57	8	281.60	14.08	1.76	270.54	16.91
9	19.84	9	144.00	50	122	50	1.97	9	316.80	15.84	1.98	304.36	19.02
10	22.05	10	160.00			100	3.94	10	352.00	17.60	2.20	338.18	21.14
20	44.09	20	320.00	180	356	1000	39.37	20	704.00	35.20	4.40	676.35	42.27
30	66.14	30	480.00	200	392			30	1056.00	52.80	6.60	1014.53	63.41
40	88.18	40	640.00	220	428			40	1408.00	70.40	8.80	1352.70	84.54
50	110.23	50	800.00	240	464			50	1760.00	88.00	11.00	1690.88	105.68
100	220.46	100	1600.00	260	500			100	3520.00	176.00	22.00	3381.76	211.36
				280	536								
				300	572								
				350	662								

Appendix 3
Calculations of nutritional information

Setting up a spreadsheet

It is commonly the case that not only a list of ingredients must be shown on the packaging for biscuits but also details of basic nutritional analysis.

It is convenient and relatively simple to calculate the nutritional values using ingredient analyses and the biscuit recipe. The accompanying spreadsheet gives an example for a digestive biscuit made from the recipe number 60 given in section 6.2.1. Such a spreadsheet is constructed in the following way:

- The ingredients are listed in column A.
- The recipe weights are entered in column B.
- In column C are entered the moisture contents of the ingredients or, in the case of chemicals, the loss in weight to be expected during baking.
- In column D the computer is set to calculate the 'dry' weights of each ingredient using data from columns B and C.
- In columns J, K, L, M analytical data about each ingredient is entered from ingredient suppliers' information or from tables, for example, from McCance and Widdowson.[1]
- In columns F, G, H, I the computer is set to calculate the total quantities of each component in each ingredient in the mix.
- All the columns of values are totalled.
- An estimate is made of the baked biscuit moisture content (in this case 2.5%) and using this and the weight of 'dry' ingredients (148.8) a value for the yield of biscuits from the mix can be calculated.
- In a separate table below, calculations for the values of energy, protein, carbohydrate and fat per 100 g of biscuit may be made. For example, the energy value is found by taking the value in I19 and dividing by B23 × 10.

Clearly, by using more detailed analyses of each ingredient such values as dietary fibre, saturated fatty acid and vitamins per 100 g of biscuit can also be calculated.

Another use of this analytical table

Using a spreadsheet set up to make the calculations as shown the product developer can play 'what happens if' games to match recipes to the desired requirements, such as those of product fat and energy. This could be a very useful approach when the aim is to match a competitor's product. The competitor's product probably shows a list of ingredients (and these should be in descending order of magnitude) plus a compositional analysis of the product. By filling in a likely recipe, from experience or with the aid of recipes given in this book, the calculations of the composition can be compared with what is required. It is very easy to adjust the recipe until a near match of the composition is reached.

Reference

[1] HOLLAND, B et al (1991) McCance and Widdowson *The Composition of Foods, 5th edition.* Royal Society of Chemistry and MAFF, London.

	A	B	C	D	E	F	G	H	I	J	K	L	M
	Ingredients Recipe	Wt per mix (kg) 60 Digestive	Moisture content (%) and loss during baking	'Dry' wt (kg)		Ingredient nutritional values in mix				Ingredient nutritional values, g/100 g from tables			
						Carbohydrate	Protein	Fat	Energy (kcal)	Carbohydrate	Protein	Fat	Energy (kcal)
7	Fat	34.52	0	34.520		0.0	0.0	34 520.0	310 680	0	0	100	900
8	Lecithin	0.70	0	0.700		0.0	0.0	700.0	6 300	0	0	100	900
9	Sugar	22.00	0	22.000		22 000.0	0.0	0.0	88 000	100	0	0	400
10	Cane syrup	3.18	20	2.544		2 512.2	9.5	0.0	9 476	79	0.3	0	298
11	Amm. bicarbonate	0.47	100	0.000		0.0	0.0	0.0	0	0	0	0	0
12	Sod. bicarbonate	1.69	50	0.845		0.0	0.0	0.0	0	0	0	0	0
13	Tartaric acid	0.71	0	0.710		0.0	0.0	0.0	0	0	0	0	0
14	Salt	1.29	0	1.290		0.0	0.0	0.0	0	0	0	0	0
15	Water	9.00	100	0.000		0.0	0.0	0.0	0	0	0	0	0
16				0.000		0.0	0.0	0.0	0				
17	White flour	81.57	14	70.150		63 379.9	7 667.6	1 060.4	285 495	77.7	9.4	1.3	350
18	Wholemeal	18.67	14	16.056		11 930.1	2 371.1	410.7	57 877	63.9	12.7	2.2	310
19					Totals	99 822.2	10 048.2	36 691.2	757 828				
20	Total wt of mix	173.80											
21	'Dry' wt			148.815									
22	Moisture of biscuits		2.5										
23	Yield of biscuits	152.54											
24													
25	*Nutritional values of biscuit per 100 g*												
26	Energy (kcal)	496.8											
27	Protein (g)	6.6											
28	Carbohydrate (g)	65.4											
29	Fat (g)	24.1											

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