# FOOD INDUSTRIES MANUAL

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20th Edition

edited by

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CHEMICAL PUBLISHING CO., INC.
200 PARK AVENUE SOUTH, NEW YORK, N.Y.

# Food Industries Manual, 20th Edition



ISBN: 978-0-8206-0128-1

Chemical Publishing Company:
www.chemical-publishing.com
www.chemicalpublishing.net

First American Edition - Chemical Publishing New York 1970

Printed in the United States of America

# Preface to Twentieth Edition

Techniques of food manufacturing, handling and packaging have advanced significantly in the seven years since the last edition of FOOD INDUSTRIES MANUAL. These advances are reflected in this, the twentieth edition, which has been largely written from scratch.

The basic arrangement of previous editions, which has satisfactorily stood the test of time, has been retained. Some of the contents of previous editions have been rearranged into more logical sequence. Jams and jellies have been taken out of the section on Confectionery and incorporated in a new section on Preserves. The section on Fish Processing has been considerably enlarged. Storage, Refrigeration and Handling have been combined into one section. A new section on Nutrition makes its appearance, incorporating in more readable form the tables at the end of the previous edition devoted to Vitamins and Composition of Foods, and providing additional information on this important subject.

It is considered that these and other changes improve the overall balance. The result is an encyclopaedia of practical food technology compiled by specialists of international repute, each of whom is a practitioner in close touch with current developments in his field.

My thanks are due to the contributors who have given without stint their knowledge and time; and acknowledgment is made of the work of the late T. Crosbie-Walsh, F.R.I.C., originator of the MANUAL and Editor of earlier editions.

ANTHONY WOOLLEN

23 January 1969

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# Baking

*Compiled by*

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## ACETIC ACID

A 12 per cent aqueous solution of acetic acid is used as a preventative of the bacteriological disease of bread known as 'rope'. It is used in a proportion of 1 pint per sack (280 lb) of flour.

Kirby, Atkin and Frey[1,2] reported that acetic acid is very toxic to bread moulds at low *p*H values; at *p*H values 5·5 to 6·0 the initial growth is retarded but the effect upon the ultimate growth is slight.

## ACIDITY

The relatively rapid increase which occurs in the acidity of a yeasted dough is due to carbon dioxide dissolving in the aqueous phase. Factors which have a slower effect upon the acidity are the production of acid phosphates by the action of phytase on phytin, and the production of organic acids by the yeast. Amos[8] investigated the possibility of bacteria contributing to the march of acidity in fermenting doughs and concluded that the microflora of wheat flour plays no significant part in straight dough systems of panary fermentations but that one member of it, *S. lactis*, produces some acid in long sponge systems.

## AERATION

The aeration of baked goods is achieved in three ways: by yeast fermentation; by chemical action; by the entrapment of air. (*See* ALBUMEN; BAKING POWDER; EGGS; FERMENTATION; AMMONIUM CARBONATE.)

## ALBUMEN

Albumen is the clear jelly-like material surrounding the yolk of a fresh egg. It represents about 58 per cent of the weight of the whole egg. It is mainly water in which is dissolved a complex mixture of proteins and a small proportion of mineral salts.

When albumen is whisked, it entraps air to form a stable and stiff foam, and egg whites are, therefore, used as an aerating agent by the confectioner. They are used in the production of meringues, macaroons, and royal icing.

Dried albumen is available. It may be produced by a fermentation process or by straight drying. The latter does not usually form such a good foam as the fermentation product nor does it keep so well.

## AMMONIUM CARBONATE

Commercial ammonium carbonate, which is a mixture of ammonium bicarbonate and ammonium carbamate, is known as 'Vol' in the confectionery trade. Under the action of heat it decomposes into carbon dioxide, ammonia, and steam and thus acts as an aerating agent. A disadvantage of Vol is that freshly baked goods made with it have a smell of ammonia.

## AMMONIUM CHLORIDE

Ammonium chloride is a yeast food, being a readily available source of nitrogen for the organism. It is an ingredient of some bread improvers.

## BAKING POWDER

Baking powder is a mixture containing chemicals used for the aeration of various types of confectionery. The active ingredients are sodium bicarbonate and an acid substance, which in the presence of water will react with the bicarbonate to produce carbon dioxide. The relative proportions of bicarbonate and acid body must be such that the bicarbonate is fully neutralized but the residue of acid is not excessive. In addition to these two chemicals, a baking powder contains an inert filler, such as a starch. The acid bodies mainly used in baking powder are acid sodium pyrophosphate, acid calcium phosphate, and cream of tartar. The amount of acid calcium phosphate or acid sodium pyrophosphate needed in a baking powder is about 1·3 times the proportion of sodium bicarbonate that is present, and the amount of cream of tartar required is about 2·2 times the bicarbonate content of the mixture.

The aerating powers of baking powders are fixed by a Statutory Instrument, S.R. & O. 1946 No. 157. According to these regulations, baking powder must yield not less than 8 per cent of available carbon dioxide and not more than 1·5 per cent of residual carbon dioxide, the available and residual carbon dioxide being determined as specified in the schedule to the Order. Golden raising powder must yield not less than 6 per cent of available carbon dioxide and not more than 1·5 per cent of residual carbon dioxide. The methods of determining the residual and available carbon dioxide prescribed by the Order are:

(1) A sample of 2 g of baking powder or Golden raising powder, as the case may be, shall be treated with 25 ml of water and evaporated to dryness on a boiling-water bath and subsequently treated with a further 25 ml of water and evaporated in like manner. The residual carbon dioxide is the weight evolved thereby when the sample so treated is further treated with excess of dilute sulphuric acid at room temperature, the evolution being completed either by boiling or by means of reduced pressure.

(2) The available carbon dioxide shall be determined by ascertaining the difference between the total carbon dioxide and the residual carbon dioxide; and the total carbon dioxide shall be determined by ascertaining the

weight evolved when the baking powder or golden raising powder, as the case may be, is treated with excess of dilute sulphuric acid at room temperature, the evolution being completed either by boiling for 5 min or by means of reduced pressure.

## BISCUITS

Most types of biscuits call for the use of a weak flour of low protein content. The gluten should be rather distensible in nature. Good biscuit flours can be obtained from English wheat, if the weak varieties are chosen and they are milled in sound condition. If the gluten is elastic instead of being distensible, the biscuit doughs may 'creep'. The distensibility of the gluten in a biscuit flour can be increased by treatment with sulphur dioxide (the final amount present must not exceed 200 ppm) or with a proteolytic enzyme.

The main ingredients in most types of biscuit are flour, sugar, fat, and water or milk, but the relative proportions in which these ingredients are used differ according to the variety of biscuits being made. In most instances the aeration is accomplished by means of baking powder.

The dough ingredients and the doughing liquor are mixed together mechanically to give a uniform but stiff dough. This dough is passed between rolls until it has acquired a uniform texture and thickness. After passage through further rolls for a final control of the thickness, the dough sheet passes under a cutter which stamps out the biscuit shapes. These are then baked in a travelling oven. The moisture content of the finished biscuit is in the region of 3 per cent.

The wide spread between the compositions of different types of biscuit dough is reflected in the range of analytical data for the various kinds of biscuit. Macaroons and ginger nuts may contain from 45 to 50 per cent of sugar, whereas water biscuits and cream crackers will contain less than 1 per cent. Golden puff and short cake biscuits may contain from 25 to 30 per cent of fat compared with less than 10 per cent in Abernethies and water biscuits.

## BREAD

Bread is a baked aerated dough, the primary ingredients of which are flour, yeast, salt, and water. Often fat is also included in the dough mix. The yeast ferments the sugars natural to the flour and those produced by diastatic activity and thereby evolves carbon dioxide, which aerates the dough.

The majority of the bread produced in Britain is made from white flour but wholemeal and wheatmeals are also used for bread production. Speciality breads, such as malt, germ and protein-enriched breads are also available, usually under proprietary names. The composition of breads of all types is controlled by the Bread and Flour Regulations, 1963.

## BREADMAKING

Bread is produced by making a dough from wheat flour and aerating this with carbon dioxide produced by yeast fermentation. Salt is included in the dough because it regulates the rate of fermentation, toughens the gluten, and prevents the bread from being insipid in taste.

The proportion of water needed to make the dough varies with the nature of the flour but usually it is in the region of 15 gal per 280 lb of flour.

The proportion of salt used also varies but it is common practice to use about 5 lb per 280 lb of flour.

The proportion of yeast needed depends upon the proposed duration of the fermentation and can be calculated approximately by dividing 12 by the number of hours that will elapse between the mixing of the dough and the placing of the dough in the oven.

The water used to make the dough is brought to a temperature that will give the finished dough a temperature of 24 to 27° C (75 to 80° F), the exact temperature required depending upon the proposed length of the fermentation. The necessary water temperature can be arrived at by subtracting the temperature of the flour from twice the desired dough temperature.

When bread is to be made by what is known as the straight dough system, the required proportions of flour, yeast, salt, water, and any other dough ingredients, such as fat, sugar, bread improvers, are mixed together until a homogeneous dough is obtained and this is then covered over and allowed to ferment in bulk. When about three-quarters of the proposed bulk fermentation time has passed, the dough is very thoroughly kneaded or 'knocked-back', so as to expel much of the gas and to tighten up the dough. It is then covered once more and allowed to complete its bulk fermentation.

At the completion of the bulk fermentation, the dough is divided into pieces of the required weight, an operation known as 'scaling', and each of these pieces is moulded into a ball. After a short period in which they can recover from the action of the scaling and rounding up, the dough pieces are moulded into the shape required for the type of bread that is to be made.

These finally moulded dough pieces are placed in baking tins and allowed a fermentation period, which is known as the 'final proof', so that they can become once more inflated with gas, since much of the old gas will have been expelled during the moulding operation. The proving period normally occupies from 25 to 40 min, according to the type of bread being made.

At the end of this final proof the tins containing the dough pieces are placed in the oven and baked. The baking temperature is 232 to 260° C (450 to 500° F), and the baking time from 40 to 55 min.

Bread is also made on what is known as the sponge system. In this type of method some of the flour, part of the water, and the yeast are mixed together and allowed to ferment for perhaps 12 to 16 hr. The dough is then broken down with the remainder of the water, the salt is added and the remainder of the flour used to re-form a dough. This is allowed to ferment for $1\frac{1}{2}$ to 2 hr and is then scaled, moulded, proved, and baked. A long sponge process calls for the use of less yeast than is required for a straight dough system.

A method known as the flying sponge system involves making a slack batter with almost all the water and an equal weight of flour and including in this all the yeast but very little salt. After a fermentation period of 1 to $1\frac{1}{2}$ hr the remainder of the flour and the salt are incorporated and fermentation continued for 2 to $2\frac{1}{2}$ hr.

On the 'delayed salt' method, the salt is omitted from the initial dough mix and, on a three hour system, is added and thoroughly mixed in about one hour before the end of the bulk fermentation.

Modern developments in the technology of breadmaking are particularly concerned with the elimination of bulk fermentation. In the most important of these, ripening of the dough, which can only be reached slowly by fermentation, is attained very rapidly by the expenditure of intense mechanical work during mixing.

Continuous breadmaking is exemplified by the 'Do-Maker' process.[3] The ingredients of the dough are automatically fed in correct proportions into a continuous dough mixer, the yeast being metered in the form of a suspension in a nutrient medium. The yeast suspension is prepared several hours in advance of its delivery to the mixer and is accordingly in a very active state when incorporated in the dough. The dough being continuously extruded from the mixer passes to a 'dough developer', which it is subjected to intense mechanical treatment, which fully ripens it. The continuous cylinder of dough emerging from the developer is automatically cut into lengths, each of which drops into a baking pan *en route* to the oven.

The Chorleywood Bread Process[4] is a batch method and requires less specialized plant. A dough is prepared that differs from traditional formulations in that (i) more yeast is employed, (ii) fat must be present, (iii) 75 ppm of ascorbic acid or a combination of ascorbic acid and potassium bromate is used as oxidizing improver and, (iv) an extra gallon of water per sack (280 lb) of flour is added. The dough is then subjected to intense mechanical mixing, the work expended being 5 Wh per lb of dough over a period of 5 min. The dough is then divided, allowed an intermediate proof of 10 min, and the baking process completed in the normal way.

More recently, processes are being developed in which rapid ripening of the dough is achieved by chemical means alone.[5] For example, the use of suitable combinations of ascorbic acid, potassium bromate, and fat will produce good quality bread on a very short system and such processes have been used on a large scale in Australia for some time. Probably the best combination is one of *l*-cysteine and potassium bromate, but at the time of writing, cysteine is not permitted as an additive in bread.

## BREADMAKING PLANT

In most bakeries the flour is not run directly into the mixer but first passes through a sifter as a safeguard against foreign bodies, such as pieces of string or labels, being found in the bread. A widely used flour sifter consists of a spiral brush operating inside a semi-circular sieve.

### Tempering tank

The tempering tank is fed with cold water and hot water and is fitted with a thermometer and a stirrer; it is used to prepare the doughing liquor at the required temperature. It is fitted with a gauge, which enables a known volume to be discharged from the machine.

### Dough mixer

An older type of machine is the rotary drum mixer. It consists of a slowly revolving horizontal cylinder which tumbles the dough through a grid of horizontal steel bars. A disadvantage of this machine is that the progress of the mixing cannot be assessed visually without stopping the machine and removing the watertight cover.

The machine most widely used at the present time is the open pan mixer. It consists of a steel bowl in which one or more metal arms perform a kneading action, and usually the pan revolves while the mixing operation is in progress. Open pan mixers with removable bowls avoid the necessity for taking the mixed dough out of the bowl, since the latter can be wheeled away from the mixing arms and used as a fermenting vessel. The bowl is wheeled back under the mixing arms when the knocking-back operation has to be performed.

High-speed mixers resemble the old rotary drum mixers, but the container remains stationary while the internal grid revolves at high speed. Because of the heat produced during the mixing operation these mixers are often fitted with a cooling jacket.

### Dough divider

Dough dividers are machines that perform automatically the operation of 'Scaling', that is, dividing the dough mass into pieces of equal weight. The ideal arrangement would be a machine that divides by weight but all existing machines divide by volume. The machines carry a number of boxes or pockets and these are filled with dough by means of a plunger and their contents are then discharged. Such machines furnish dough pieces of constant weight only as long as the density of the dough remains unchanged. It is necessary, therefore, for the weights of the discharged pieces to be periodically checked while the machine is in operation.

### Handing-up machine

This is a machine for moulding dough pieces into round shapes as they leave the divider. The best known type consists of a hemispherical shaped tunnel that spirals around a finely corrugated cone. This cone revolves and in so doing carries the dough pieces through the tunnel and discharges them at the top in a nicely rounded condition.

### Final moulder

The handing-up machine can be employed as a final moulder for those types of bread where a rounded shape is required. Another type of final moulder, of which there are numerous modifications, consists of two moving bands, one of which travels faster than the other. A piece of dough fed into one of these machines leaves it in the form of a cylinder.

The type of final moulder used in the plant bakery where tin bread is being produced is the spindle moulder. The machine contains two or more rapidly revolving spindles each of which rotates a piece of dough against a band or a roller until it forms a tight roll. The roll is then discharged between two moving canvas bands, which give it a final shaping.

### Prover

A prover is an enclosed space in which the temperature and relative humidity of the air are controlled and in which the finally moulded dough pieces are allowed to re-inflate themselves with gas before being baked. In some bakeries the proving space is essentially a cupboard fitted with shelves or boxes carried by endless belts, while in others it takes the form of a room into

which the dough pieces are brought on wheeled racks.

In plant bakeries automatic provers are used. The doughs in canvas slings or in tins move slowly in a series of horizontal or vertical paths through an enclosure, the air in which is controlled for temperature and humidity.

### Oven

Ovens used in bakeries are shallow, rectangular chambers capable of being heated to and maintained at an appropriate temperature. The smaller ovens are usually peel ovens, i.e. ovens in which the bread is set and removed by long-handled spades known as peels. A larger type of oven is the drawplate, the sole of which is mounted on runners and can be withdrawn from the oven when loading and unloading is to be performed. In plant bakeries the ovens are automatic. They may be fitted with swinging tins, which traverse the ovens slowly in a series of vertical paths or with a travelling sole, which consists of an endless flexible metal band.

Ovens may be fired with coal or coke, with oil, or with electricity. An older type of coke- or coal-fired oven is the side flue oven in which flames and hot gases of combustion pass through the baking chamber. These ovens must be brought to a solid heat before baking commences because flames cannot be drawn through the oven while it contains bread.

One form of externally heated oven is constructed so that the hot products of combustion are led into flues that surround the oven but do not enter the baking chamber. In another form the heat is applied externally to the ends of steam tubes, the major portions of which are inside the oven. Automatic travelling ovens are usually oil- or gas-fired and the heating may be by hot air or by steam tubes.

## BUNS

Buns are usually made by preparing a ferment preparatory to dough making. A breadmaking flour is more suitable for the production of buns than is a cake flour. A suitable method would be to make a ferment with the following ingredients:

| | |
|---|---|
| water | 1 quart |
| milk powder | 2 oz |
| sugar | 2 oz |
| yeast | 3 oz |
| flour | 8 oz |

This ferment should have a temperature of 32° C (90° F) and should be left for half an hour. It should then be doughed up by adding to it:

| | |
|---|---|
| flour | 4 lb |
| salt | ½ oz |
| fat | 12 oz |
| sugar | 10 oz |
| currants | 1 lb |

The resulting dough should be allowed to ferment for 90 min at a temperature of from 27 to 29° C (80 to 82° F). A lower temperature with a higher proportion of yeast is preferable to the use of a higher temperature. In the early stages of fermentation the dough should be knocked-back in order to prevent chilling and it is advisable to perform this operation once every 20 min. The final proving is performed in steam at about 31° C (88° F). The buns are baked at a temperature of from 211 to 220° C (420 to 460° F).

## CAKE

The basic ingredients of cakes are flour, shortening, eggs, sugar and milk. Eggs will aerate approximately their own weight of flour and consequently if more flour than eggs is used in a cake recipe, baking powder must be added to aerate the surplus flour.

Twenty-five years ago a typical recipe for good quality cake was:

| | |
|---|---|
| flour | 100 parts |
| shortening | 35 ,, |
| eggs | 40 ,, |
| sugar | 95 ,, |
| baking powder | 2·5 ,, |
| milk | 60 ,, |

but modern formulae call for the use of more shortening and eggs and less milk and baking powder. An example is:

| | |
|---|---|
| flour | 100 parts |
| shortening | 65 ,, |
| eggs | 90 ,, |
| sugar | 95 ,, |
| baking powder | 0·6 ,, |
| milk | 30 ,, |

Cake batters are prepared usually by either the sugar batter or the flour batter method. The former procedure, which is known also as the creaming method, is preferable when high-class cakes are being made but the flour batter method is more suitable for the production of cheap cakes with a low egg content.

The sugar batter method is performed by creaming together the fat and the sugar at medium speed for about 10 min, adding the egg in stages while the mixing is continued, and finally making several alternate additions of flour and milk. The egg should be brought to a temperature of about 21° C (70° F) before being added to the mix or the batter may curdle.

In the flour batter method the shortening and the flour are creamed together until a fluffy mass is obtained. The eggs and sugar are whipped together and the resulting foam is then carefully blended into the creamed fat and flour. The milk is then added in small portions.

Cake batters are baked at temperatures between 149 and 208° C (300 and 425° F) depending upon their richness, their weight and their moisture content. Richer batters of high sugar content require less heat than those made on leaner formulae.

## CAKE FLOUR

Cake flours are usually medium to weak in strength; the use of strong flours would result in a tough product. Medium strength flours are used for the heavier cakes such as most fruit cakes; the weaker flours are better for layer cakes and the like. For many purposes, so-called 'high-ratio' cake flour is demanded. This is specifically intended for cakes with a high ratio of sugar plus liquid to flour, the extreme example being 'angel food'. Such a flour is obtained by taking the finest fraction of a

patent flour milled from a weak grist and treating it with gaseous chlorine, a process which modifies both the gluten and the starch. Alternatively, a suitable cut from an air-classification plant may be chlorinated.

## CAKE PREMIXES

The retail sale of cake premixes has not made much headway in the U.K., but bulk sales for catering purposes have been reasonably successful. Most types require the addition of water only, and therefore contain flour, fat, sugar, milk powder, dried egg, baking powder, flavourings, and colour. Provided that the baking qualities of the dried egg are satisfactory, the critical ingredients are the fat and the flour. The fat must have the correct plasticity and must not be susceptible to rancidity. So-called '100-hour' fat (fat which is free from rancidity after aeration for 100 hr at 100° C (212° F)) is usually specified, and this stability is usually achieved by the addition of permitted antioxidants. As the premixes are normally used for the lighter type of cakes, high-ratio flour is commonly used. To ensure freedom from infestation, the flour or the complete mix is entoleted.

## CARAMEL

Caramel is produced by the controlled heating of cane-sugar (or glucose) to about 190° C (352° F). It may be added principally as a flavouring agent or as a colouring agent and is used for both purposes in flour confectionery. It is the only colouring matter that is permitted in bread.

## CORNFLOUR

This is maize starch and it is used for the manufacture of custard powders (which are coloured and flavoured cornflours) and also as an ingredient of some proprietary sponge mixtures and cake flours.

## CREAM OF TARTAR

Cream of tartar, i.e. acid potassium tartrate, is used as the acid ingredient in some baking powders. The salt is only slightly soluble in cold water but dissolves readily in hot water and, therefore, when it is used in conjunction with sodium bicarbonate as an aerating agent, the bulk of the gas evolution is delayed until the goods reach the oven.

One hundred parts of cream of tartar will neutralize 45 parts of sodium bicarbonate.

## CREAM POWDER

A cream powder is a preparation containing an acid phosphate intended for use as an acid ingredient of aerating mixtures. The neutralizing values of such preparations are often adjusted to be equal to that of cream of tartar.

## CRUMB SOFTENERS

A number of substances have been recommended as dough ingredients for the purpose of enhancing the softness of the crumb of bread. The best known of these are of the emulsifier type and as such are included in the Emulsifiers and Stabilizers in Food Regulations, 1962. Those permitted in bread are stearyl tartrate and partial glycerol esters, e.g. glyceryl monostearate (G.M.S.).

## CRUMPETS

A suitable recipe for crumpets is:

| | |
|---|---|
| flour of medium strength | $4\frac{1}{2}$ lb |
| water | 2 quarts |
| milk powder | 3 oz |
| salt | $1\frac{1}{2}$ oz |
| yeast | 2 oz |

The water is used at about 38° C (100° F) and the batter sponge is allowed to ferment for $1\frac{3}{4}$ hr. One pint of warm water containing $\frac{1}{8}$ oz of sodium bicarbonate is then well mixed throughout the sponge, after which it is allowed to recover for 10 min. The batter is then poured into hoops that have just been placed onto a well-polished hot plate. When the shiny wetness disappears from the top of the crumpets, the hoops are turned over so that the surfaces of the crumpets initially at the top become cooked. The baking time required is about 4 min.

## CRUST COLOUR

The colour of the crust of bread is due in part to a reaction between sugar and protein or protein degradation products. It is, therefore, related to the amount of sugar remaining in the dough at the completion of the fermentation. If the maltose figure of a flour is high, the residual sugar will be high and the colour of the crust of the bread made from the flour will accordingly be pronounced. If, however, the maltose figure is low, the crust will be pale.

Any factor which affects the amount of sugar remaining in a dough when the dough goes to the oven will affect the crust colour of the bread; under-fermentation leaves an excess of sugar and thus gives rise to a high crust colour, while over-fermentation will use up more than the normal amount of sugar and will produce a pale crust.

## DIASTATIC ACTIVITY

The diastatic activity of a flour is its ability to convert some of its starch into sugar. It is a factor of considerable importance in breadmaking, where aeration depends upon the fermentation of sugar by yeast, but sugar-forming power is of no importance in processes depending upon chemical action or the incorporation of air for aeration. Dextrin-forming power, which is related to the activity of alpha-amylase is, however, significant even when the aeration is chemical, if the goods are boiled and not baked. A high dextrin-forming power can in these circumstances cause doughy streaks and stickiness in the goods.

*See* DIASTATIC ACTIVITY *in section on* FLOUR AND FLOUR MILLING.

## DOUGHS

The two main proteins of wheat flour, gliadin and glutenin, have the power of uniting in the presence of

water to form a complex which has elastic properties. This complex is termed gluten. This property of gluten formation is not possessed by any other cereal flour and hence wheat flour is the only one which gives an elastic dough capable of holding gas and expanding under its pressure.

When wheat flour is mixed with water the gluten that is formed takes the shape of a network of interwoven strands, and these serve as the girderwork of the dough. The strength and elasticity of the dough will depend upon the number of gluten strands that are present and upon their physical properties. Hence, the dough properties are to a large extent determined by the proportion of protein in the original flour and the nature of that protein.

A wheat-flour dough can be inflated if gas is produced within it. Such gas can be produced either by incorporating yeast in the dough, which will ferment the sugars naturally present and evolve carbon dioxide, or by including in the dough chemical substances that will react together to liberate carbon dioxide.

If a dough that has been suitably aerated in either of these ways is baked, it will become 'set' and the outcome will be a light, well-aerated product. If the dough contains little more than yeast, flour, salt, and water, the resulting product will be bread, whereas if the dough contains fat, sugar, eggs, and spices, it will be confectionery.

## DOUGHNUTS

Doughnuts fall within the category of buns, but they are cooked by being roasted in fat instead of being baked in an oven. A plain bun dough is prepared (*see* page 4) and the scaled pieces flattened. Jam is placed in the middle of each flattened piece and the dough folded over so that the jam is enclosed. The pieces are then proved in the absence of steam, after which they are fried to a light golden colour in hot fat.

The doughnuts are drained and then rolled in caster sugar. Ring doughnuts are made by flattening out each scaled piece and cutting a ring from the centre with a cutter.

The fat must be hot enough to form a crust on the doughnut almost immediately; if it is not hot enough the doughnut will be greasy.

## EGGS

Eggs are used as aerating agents in confectionery work because they have the power of entrapping air when they are whisked, thereby forming a stiff and stable foam.

A fresh egg consists of about 12 per cent shell, about 58 per cent egg white or albumen, and about 30 per cent yolk. The average compositions of the whites and yolks are:

| | *Whites* *per cent* | *Yolks* *per cent* |
|---|---|---|
| moisture | 87·0 | 50·0 |
| protein | 12·5 | 16·0 |
| fat | 0·3 | 32·0 |
| mineral salts | 0·6 | 0·8 |

The foaming property of eggs is due mainly to the albumen, or white; yolks alone cannot be beaten into a stiff foam because of their high fat content. The value of the egg yolks lies in their ability to colour, flavour, and shorten the goods in which they are used. Whole eggs are able to aerate their own weight of flour and if a smaller proportion of egg than this is used, the additional aerating power required can be provided by baking powder.

Shell eggs are seldom used except on the small scale; the labour and loss of material involved makes their use generally uneconomic. Frozen whole eggs, i.e. shelled eggs preserved by freezing, have been used for many years. With the advent of compulsory pasteurization, doubts were expressed as to the baking qualities of pasteurized egg; but it has been shown that pasteurization has little if any deleterious effect. Provided that the egg is not stored for long periods in the frozen state, and thawing is carried out carefully, frozen egg will behave satisfactorily in a wide range of baked goods. Only in products where the performance of the egg is very critical, e.g. in baked custards and eclair cases, are difficulties likely to be encountered. In many of the larger plants, *liquid* whole egg is delivered in bulk from refrigerated tankers.

Dried egg has the advantage of requiring very little storage space, but it varies considerably in its aerating power. A.F.D. (accelerated freeze-dried) egg is of very good quality and as it is usually gas-packed it stores well without refrigeration.

## ENZYMES

An enzyme is a substance which has been derived from living matter and which, when present in only a minute proportion, can initiate or accelerate a given chemical action without undergoing chemical change itself. Enzymes have been called organic catalysts.

Enzymes are markedly specific in their action. Thus, an enzyme which can effect the breakdown of protein will have no effect upon starch, and conversely a starch-degrading enzyme does not act upon protein.

Wheat flour contains a starch-splitting enzyme which is known as *beta*-amylase. This enzyme splits off units of the sugar maltose from the outer chains of the starch molecule, leaving behind a compound known as erythrodextrin, which has many starch-like properties. The reaction does not proceed in dry flour, but as soon as flour is made into a dough the *beta*-amylase initiates the production of maltose from starch. Hence, when the yeast has utilized the sugars pre-existing in the flour, it has a reserve supply to which it can turn and is thus enabled to go on producing gas.

*Beta*-amylase is unable to act upon normal sound starch and the extent to which it can produce maltose from a flour is dependent, therefore, upon the proportion of damaged starch granules in that flour. All commercial flours contain damaged starch granules because some degree of damage is unavoidable during the milling process, but the extent of the starch damage varies with the mill making the flour.

Flour that is made from sprouted wheat contains in addition to *beta*-amylase a significant proportion of another diastatic enzyme known as *alpha*-amylase. *Alpha*-amylase is present to only a small extent in the flour from sound wheat. *Alpha*-amylase can cause the degradation of the residual erythrodextrin left behind

when *beta*-amylase has chopped maltose units off the outer surfaces of the starch molecule. The degradation products that result from this action can be acted upon by *beta*-amylase. Hence, the joint action of *alpha*- and *beta*-amylase will lead to a greater production of sugar than the action of *beta*-amylase alone.

If sufficient sprouted wheat is used in a blend to give flour of a high *alpha*-amylase activity, the results may be disastrous. The low molecular weight dextrins produced by the action of the *alpha*-amylase on the starch can give rise to a marked stickiness in the crumb of the final loaf and in severe cases may lead to the loaf collapsing on leaving the oven. *Alpha*-amylase is very active at a temperature as high as 60° C (140° F) and hence the detrimental effect of this enzyme is mainly exercised after the dough reaches the oven. For this reason a flour high in *alpha*-amylase will suffer more severely when baked in a slack oven for a long time than when baked quickly in a hot oven. This influence of baking conditions upon the severity of damage from *alpha*-amylase activity explains why trouble from an excess of this enzyme has been encountered to a much greater degree in Irish soda bread than in yeast bread. Soda bread is baked at a lower temperature than yeast bread, from 200 to 220° C (390° to 430° F) instead of from 230 to 260° C (450° to 500° F), and for a considerably longer time (from $1\frac{1}{4}$ to $1\frac{1}{2}$ hr instead of from 45 to 55 min), thereby offering much more scope for the *alpha*-amylase to produce the gummy dextrins which give rise to stickiness in the crumb.

Wheat also contains proteolytic enzymes. A protein-degrading enzyme isolated by Bales and Hale[6] and Hale[7] proved to be of the papain type. Opinions have differed on the question of whether proteolytic action plays any part in dough ripening. It has been shown by Amos[8] and Samuels[9] that there is a slow but progressive liberation of amino acid in a dough and Amos has emphasized that although the quantity of amino nitrogen set free is small, it does not follow that the physical changes which accompany this rupture of the protein molecule are also small.

Oxidizing enzymes also exist in flour and these enzymes are responsible for the darkening of the colour that occurs when wetted flour is exposed to the air. They cause atmospheric oxygen to unite with complex constituents of the flour to produce dark-coloured oxidation products. These oxidases are concentrated in the bran and the germ, and hence the lower the grade of a flour the greater the rate at which darkening proceeds after it has been wetted.

## FLAVOURINGS

Probably the most widely used flavour of the confectioner is vanilla; this may be added as vanilla essence (an alcoholic extract of the vanilla bean) or as a solution of synthetic vanillin. Cocoa and chocolate are also used frequently and primarily for the flavour they impart, but they differ from most other flavouring in that they also contribute substance, food value and colour to the finished product.

Most of the other flavourings added are spices and seasonings, essences and oils, or synthetics. The most common of the spices used are; allspice, angelica, caraway seed, cinnamon, cloves, ginger, mace and nutmeg, and poppy seed; others like anise are used only occasionally or like saffron are used only in certain parts of the country. Many of the spices are also available as oils and essences; other important flavourings in this group include the oils of almond, orange, lemon, lime, and peppermint.

Advances in the technology of synthetic flavourings suggest that they will gradually supplant almost all 'natural' flavourings, including those of substances added in larger quantities for other reasons, e.g. butter and honey.

## FONDANT

Fondant is a mixture of invert sugars prepared by heating sugar and water to a temperature of from 115 to 120° C (240 to 245° F) and adding glucose or a weak acid to accelerate the inversion. A suitable procedure would be to boil 12 lb of sugar and 3 pints of water and to add to this 2 lb of glucose or $\frac{1}{4}$ oz of cream of tartar.

## GLUCOSE

Confectioners' 'glucose' is manufactured by the acid or enzymic hydrolysis of starch; the resulting product is not pure glucose but this sugar mixed with maltose and dextrins.

A high grade 'glucose' should give a clear bright solution when mixed with water and should yield no sediment. It should contain no unaltered starch.

## GLYCERINE

Glycerine is used in confectionery as a sweetening agent and also as a means of keeping cheap cakes moist. It would be used in the proportion of about 1 oz per lb of fat in the formula.

## GLYCERYL MONOSTEARATE (G.M.S.)

Glycerol is a tri-hydric alcohol and when each molecule of glycerol is combined with three molecules of fatty acid, whether the same or different acids, the result is a fat. Glyceryl monostearate in which one molecule of glycerol is combined with only one molecule of the fatty acid, stearic acid, has, therefore, been described as a 'super glycerinated fat'. It is used as an ingredient of bread doughs, because it has a softening effect upon the crumb and tends to delay staling. (*See* CRUMB SOFTENERS.)

## HUMIDITY

The humidity of the atmosphere is the weight of water vapour contained in unit weight of the air. If this weight is expressed as a percentage of the maximum weight of water vapour that the unit weight of the air can retain at the temperature in question, the resulting figure is known as the relative humidity. Whether any material tends to dry out or to absorb moisture depends upon the relative humidity of the atmosphere to which it is exposed, and for each substance there is a relative humidity with which it is in equilibrium. Packeted flour will tend to lose moisture, and hence lose weight, when stored in very dry air, but will pick up moisture, and

therefore gain weight, if exposed to air of high relative humidity.

The water content of a dough is relatively high and hence a dough will tend to lose moisture from the surface and to form a skin, unless the air to which it is exposed has a high relative humidity. This is a matter that requires attention when a dough is being proved.

## ICING

Water icing is used for covering cheap cakes. It can be made by mixing into boiling water sufficient icing sugar to give a consistency similar to that of fondant, such as is used for piping. Water icing can be coloured with liquid colouring matter as desired.

Royal icing is prepared with icing sugar and egg albumen. About 7 lb of icing sugar are required for each pint of egg albumen. Sometimes a little acetic acid is added to toughen the albumen but this must be used with care or the icing may be hard and bitter.

## INVERT SUGAR

Invert sugar is a mixture of dextrose and laevulose. It occurs naturally in ripe sweet fruit but the commercial article is prepared from sucrose by the action of the enzyme invertase or by acid treatment. It is used, often mixed with glucose, as a sweetening agent in cheap confectionery.

## KNOCK-BACK

When a bread dough has completed about three-quarters of its bulk fermentation, it should be given a very thorough mixing in order to expel the old gas and to stretch the dough and make it more elastic. This operation is known as 'knocking-back' the dough. It is an essential operation if good bread is to be produced.

## LECITHIN

Lecithin belongs to the class of substances known as lipoids, which are combinations of fat with nitrogen-containing substances and phosphorus. Commercial 'lecithin' is extracted from soya bean and is available in an emulsified form for use as a bread improver. Added to a dough at the rate of 1 lb per sack, it causes the dough to feel silkier and produces also a silkier and softer crumb, which has enhanced keeping properties.

## MACAROONS

Confectionery goods made from almonds, sugar, and whites of eggs are called macaroons. Macaroon goods require to be baked in a steady oven at a temperature of from 170 to 175° C (350 to 370° F). Too much heat will cause the goods to flow out.

## MALT BREAD

There are many types of malt bread, which range from lightly malted white bread to heavily malted brown bread with a sticky crumb. Many of these breads contain ingredients additional to the malt or malt flour, such as fat, milk powder, and golden syrup.

Kent-Jones and Mitchell[10] give the following as a typical formula for malted brown bread:

| | |
|---|---|
| wheatmeal | 28 lb |
| brown malt flour | 2 lb |
| salt | 8 oz |
| golden syrup | 8 oz to 1 lb |
| fat | 8 oz to 1 lb |
| yeast | 8 oz |
| water | 7 quarts (approximately) |

The dough, which should have a temperature of from 24 to 26° C (76 to 78° F), is given a bulk fermentation of $1\frac{3}{4}$ hr with a knock-back at the end of 1 hr. The dough is baked for about 50 min in an oven at from 204 to 215° C (400 to 420° F). Some malt breads contain fruit.

## MARZIPAN

*See section on* CONFECTIONERY.

## MERINGUES

Meringues are confections made from a mixture of sugar and white of eggs, which are beaten together to give a very light product. The method used to prepare meringues depends upon the kind of article that is to be made, and there are three main methods. In the cold meringue method the white of egg is beaten and the sugar added cold. Very hot meringue is made by making the sugar very hot and beating it along with the white at the beginning. Italian meringue is made by beating the egg white very stiff and then boiling the sugar before adding it.

## MILK AND MILK BREAD

Milk is used in breadmaking as liquid whole milk, skimmed milk, or as dried products derived from these. Milk is a bread improver and for this purpose liquid milks are added at the rate of 4 to 8 gal and powders at the rate of 5 lb per sack of flour. Apart from some increase in the nutritive value of the bread, the main effects of such additions are the production of a softer dough, improvement in crumb texture, and the production of a thin crust.

Larger additions are required to produce the various milk breads. Milk bread must now contain not less than 6 per cent of *whole* milk solids (dry basis); bread containing not less than 6 per cent (dry basis) of skimmed milk solids should be described as skimmed milk bread, separated milk bread, or lactein bread.

## MUFFINS

Muffins are often associated with crumpets but they are very different from the latter goods, although they are baked, like crumpets, on a hot plate. Muffins are thick but well aerated dough cakes which do not have the toughness of crumpets.

| *Formula* | |
|---|---|
| medium strength flour | 5 lb |
| salt | 1 oz |
| sugar | $\frac{1}{2}$ oz |
| yeast | 2 oz |
| water | 2 pints |
| milk | $1\frac{1}{4}$ pints |

The dough is well mixed and should be moderately warm, e.g. water at 38° C (100° F) should be used. It is allowed to lie for an hour and then it is thoroughly kneaded and allowed to ferment for a further half-hour. At the end of this second period of fermentation, the dough is divided into pieces weighing about 2½ oz each. The scaled pieces are proved for about 30 min and are then baked on a hot plate kept at only a moderate temperature. When the goods have been baked sufficiently on one side they are turned over. If the hot plate is at too high a temperature, the middle of the muffin is liable to be underbaked.

## OAT CAKES

Oat cakes can best be made from a meal of medium particle size. Often about 15 per cent of wheat flour is mixed with the oatmeal to make the dough easier to handle. Sometimes a pinch of bicarbonate is included in the mix.

*Formula*

| | |
|---|---|
| oatmeal (or 3½ lb oatmeal plus ½ lb flour of good strength) | 4 lb |
| lard | 2 oz |
| salt | 1 oz |

The fat is rubbed into the meal which is then made into a bay. Into this is placed the salt, and warm water is then used to make the meal into a dough. The dough should be made fairly soft as it will tighten. It is scaled into pieces weighing about 6 oz, each of which is moulded up round. These are then rolled until they are about ⅛ in thick and about 8 inches in diameter. The use of some dry meal may be required to prevent sticking. The rolled pieces are baked on one side until they are nearly done and are then turned over. They are removed from the plate when they begin to curl during the baking of the second side and are placed on a rack over the plate where they undergo drying and toasting. Alternatively they can be placed on a clean baking sheet and dried for a few minutes in the oven.

## PIKELETS

These are made from a crumpet batter which has been thinned down. It is poured on to a hot plate without hoops and allowed to run out into a thin cake of 5 to 6 inches in diameter. The plate must be really hot. When the shiny wetness from the top of the cake disappears, the pikelets are turned in the same way as crumpets.

## PRESERVATIVES

In bread, the following substances may be added as preservatives: acetic acid, monocalcium phosphate (A.C.P.), and sodium diacetate to prevent the onset of 'rope' (q.v.) propionic acid and certain of its salts to inhibit mould growth. Rope is only likely to be troublesome in the summer months, as is mould formation unless the bread is sliced and wrapped.

The Preservatives in Food Regulations, 1962, permit the presence of up to 1,000 ppm of propionic acid or sorbic acid and certain of their salts in flour confectionery other than biscuits. All these materials inhibit mould growth, but in cakes sorbic acid is the most effective. Wrapped cakes are particularly vulnerable to mould growth, and the judicious use of sorbic acid can extend the time required for the onset of visible mould growth by about 50 per cent.

## PROTEIN-ENRICHED BREADS

The addition of say 14 lb of dry gluten per sack of flour in a normal breadmaking process produces a loaf containing about 16 per cent of protein (dry basis). The physical effects of the addition are an increased specific volume and improved crumb characteristics. Such breads, provided they contain not less than 16 per cent of protein (dry basis) are termed gluten breads. By making greater additions of gluten and by modifying the breadmaking formula, high-protein breads, which must contain not less than 22 per cent of protein (dry basis), can be produced; these have a still higher specific volume.

Breads of these types are manufactured particularly for the slimming market. Their calorific value per unit weight is virtually the same as for ordinary bread, but their calorific value per unit volume is much less and bread is normally eaten by volume.

In a somewhat different class are the starch-reduced breads, rolls etc. To qualify for this description, the carbohydrate content to dry basis must be less than 50 per cent. This is normally achieved by fairly massive additions of dry gluten, and above average additions of skimmed milk powder and of fat. The specific volume of the products varies, but on a weight basis the calorific value is generally higher than that of ordinary bread because of the increased fat content.

## PUFF PASTE

If properly made, puff paste will consist of alternate layers of flour and butter. Some margarines are particularly suitable for use in the preparation of puff paste, but a mixture of margarine and butter is often preferred. A flour of only moderate strength is needed but it should give a dough possessing good distensibility.

The amount of butter used should lie between 12 and 16 oz for each 1 lb of flour, while the amount of water employed should be such that the consistency of the dough is approximately the same as that of butter after it has been handled. The paste should be made with cold water and should be handled on a cold slab and kept covered with a damp cloth between manipulations.

One method of preparing the paste is to make a dough from the flour using about one-quarter of the total butter in its preparation. After the dough has lain for about 10 min, it is rolled out and the remaining butter, in the form of small lumps, is distributed over about two-thirds of it. The unbuttered third is folded over half the buttered portion and the folded portion then turned over on top of the remaining buttered third. The folded dough is rolled out again and refolded as before. The dough can be left to lie for 20 to 30 min, being covered with a damp cloth during this period, and it is then given two more foldings. In some instances a total of six folds, or turns, are given to the dough, but a good recovery period should always be allowed between each pair of foldings.

## ROPE

Bacteria of the *B. mesentericus* group are common to soil and thus found on wheat. Despite the rigorous cleaning processes performed in a mill, some of these bacteria are transmitted to flour during the milling operation. These bacteria form spores, which are a resting stage, and these spores are to be found in all flour, although usually the contamination is not high. Unfortunately, the spores of the mesentericus organism are very resistant to heat and survive the temperature of the baking process with the result that some, if only a few, rope spores are to be found in any loaf of bread. If bread is kept warm and under conditions which preclude marked loss of moisture, the spores of the mesentericus organism will turn into vegetative bacteria and these will multiply. As the organisms increase in number, the crumb of the bread will assume a yellowish-brown tint, become very sticky, and acquire a smell of decaying fruit. These are the signs of the bread disease 'rope'.

In Britain rope occurs only during the summer months and only then in bread that has been kept for several days in an atmosphere of fairly high humidity.

The tendency for bread to become ropy when submitted to conditions favourable to the development of the organism is influenced by the conditions under which the bread has been fermented, baked, and cooled. Bread made on a short fermentation system is less liable to become ropy than bread made on a long, slow fermentation process.

Bread that has been thoroughly baked out is less liable to become ropy than bread that has received only a moderate baking in a slacker oven. Rapid cooling of the bread will diminish the likelihood of its becoming ropy. Protracted cooling is tantamount to giving the organisms in the bread a preliminary incubation.

The rope bacteria cannot thrive if the medium in which they are present is sufficiently acid to have a *p*H of 5·0. An inimical *p*H can be obtained in bread by incorporating in the dough 1 pint of 12 per cent acetic acid or 1½ lb of 80 per cent acid calcium phosphate per sack.

## RUSKS

If an attractive rusk is to be made the dough should be richer than an ordinary bread dough. A suitable formula is:

| | |
|---|---|
| flour | 7 lb |
| fat | 1 lb |
| sugar | 6 oz |
| malt | 2 oz |
| whole-milk powder | 8 oz |
| salt | 1 oz |
| yeast | 3½ oz |
| water | 4 lb |

The dough should be allowed to ferment for 1¼ hr, given a good knock-back, and allowed to lie for a further ¼ hr. It should be baked in sandwich tins but less dough should be put in the tins than is used with ordinary bread doughs and a longer proof should be given. After being baked, the loaves should be kept for 2 days, cut into slices of about ½ inch in thickness, and baked to a light-brown colour in a cool oven.

## SCONES

*Formula for fruit scones*:

| | |
|---|---|
| soft flour | 4 lb |
| baking powder | 4 oz |
| fat | 12 oz |
| sugar | 12 oz |
| salt | ¾ oz |
| eggs | 4 |
| fruit | 10 oz |
| milk | About 1¾ pints |

If plain scones are required they may be made on a rather richer (*A*) or a cheaper (*B*) formula:

| | *A* | *B* |
|---|---|---|
| flour | 4 lb | 4 lb |
| baking powder | 3 oz | 4½ oz |
| fat | 16 oz | 8 oz |
| salt | ¾ oz | ¾ oz |
| sugar | 14 oz | 8 oz |
| eggs | 4 | nil |
| milk | about 1½ pints | about 2 pints |

The fat is creamed up with the sugar and the eggs then worked in. The remaining ingredients are added and the whole worked up into a dough of medium consistency. The dough is scaled and the pieces moulded up round. They are then flattened into pieces about 6 inches in diameter and 1 in thick and placed on a greased baking tin. Each round is divided into four pieces by making two cuts through the dough at right-angles. The pieces are washed with egg wash and baked at a temperature of 230° C (450° F).

## SHORT PASTE

For the best type of short paste work good butter was always used but good short paste can be made with a good margarine. Various formulae for short paste are available. The richest formulae contain a good proportion of egg, while a cheap short paste contains none.

| | *Rich formula* | *Cheap formula* |
|---|---|---|
| flour | 4 lb | 3 lb |
| butter | 2 lb | — |
| fat | — | ½ lb |
| caster sugar | — | ½ lb |
| egg yolks | 10 | — |
| baking powder | — | 1 oz |
| water | About 4 gills | About 3½ gills |

The fat is rubbed into the flour and the mixture made into a bay. The eggs and the water are added and the ingredients mixed together. The paste is stored in a cool place for an hour or two or preferably overnight.

## SHORTBREAD

A formula for good shortbread is:

| | |
|---|---|
| flour | 4 lb |
| butter | 2 lb |
| sugar | 1 lb |
| salt | 1¼ oz |
| eggs | 3 |

The eggs should be mixed with the sugar, then the butter rubbed in and the flour by degrees. The baking temperature should depend upon the size of the pieces which are being baked, the temperature lying between 195 and 225° C (380 and 440° F).

## SHORTENING

'Shortenings' are hydrogenated fats. They can be 'tailor made' for specific purposes in confectionery work.

## SODA BREAD

In Eire a large proportion of the flour is used for the production of soda bread which is a chemically aerated bread. The aeration is accomplished by adding sodium bicarbonate to the flour and making the mixture into a dough with butter milk. The acid of the butter milk and the bicarbonate react to release carbon dioxide. The dough is baked in an iron pot, often in a peat fire when the bread is made domestically.

A weak flour sufficiently highly treated to reduce the elasticity of the gluten gives the best results.

## SODIUM BICARBONATE

Sodium bicarbonate is widely used in the confectionery trade. It is the ingredient with which an acid body is mixed in baking powders and in self-raising flour. It reacts with acid to liberate carbon dioxide and this gas produces the desired aeration in the goods. Sodium bicarbonate will release carbon dioxide if heated on its own but it then leaves an alkaline residue of sodium carbonate in the goods, which gives them an objectionable taste and causes the flour to assume a deep yellow colour.

## SOYA FLOUR

Soya flour is milled from the soya bean, a legume which is widely grown in the Far East. It has a protein content in the region of 45 per cent, an oil content of about 25 per cent, and contains about 2 per cent of lipoids. Two disadvantages attaching to unprocessed soya flour as an ingredient of food preparations are the rapidity with which rancidity may develop because of the high oil content, and the beany and rather bitter taste. These two defects can be dealt with by suitable steam treatment, which removes the taste and diminishes the tendency for rancidity to develop. Trouble from rancidity can also be avoided by removal of the oil.

Soya flour has been advocated as an ingredient of bread doughs on the grounds that it helps to maintain moistness and freshness in the bread. It has a deadening effect on the dough, however, and this restricts the proportion in which it can be employed in ordinary white bread to about 2 lb per sack. Special breads are, however, made which contain much higher quantities of soya flour, but they are characterized by a loaf of small volume that shows a close texture in the crumb.

## SPONGE GOODS

Well-made sponge goods are a profitable line for the confectioner. The ingredients required are: a hard grained sugar, a soft weak flour, and eggs. Plain sponges can be made by beating together 3 lb of eggs and 2 lb 10 oz of sugar until the mixture is firm and then mixing lightly into 2 lb 6 oz of flour. The mixture is filled into moulds and baked in a solid oven at 204° C (400° F). If sponge fingers are to be made the sugar should be reduced to 2 lb and the flour increased to $2\frac{1}{2}$ lb.

## STALING

As bread ages it loses flavour and aroma and becomes harsh and crumbly. At one time it was thought that this staling was due to loss of moisture from the loaf but it has been shown that bread will stale even when stored under conditions that prevent loss of moisture.

The basic cause of bread staling is a change in the nature of the starch. In fresh bread the starch exists in what is known as the *alpha* form. At temperatures below 55° C (131° F) *alpha* starch is unstable and some of it changes into a *beta* form until an equilibrium mixture is attained. The composition of the equilibrium mixture is determined by the temperature, the lower the temperature the greater the proportion of *beta* starch in the equilibrium mixture.

*Alpha* starch has a greater water-holding capacity than *beta* starch, and hence the change from *alpha* to *beta* starch is accompanied by an extrusion of water from the starch. This water may be taken up by the gluten.

Above 55° C (131° F), *alpha* starch is stable and does not change to *beta* starch, and hence bread stored at this temperature will not stale. This is not a practical solution to the problem, since bread kept at this temperature will be very prone to develop rope.

Staling can be delayed also by storing bread at −20° C (−4° F). The reason is not that the equilibrium is distubed but that the rate of transformation at this temperature is so extremely slow that it is of no practical significance.

## SUGAR

Different types of sucrose are used for different purposes.

Sugar nibs—a very coarse sugar—are used to sprinkle on the top of bath buns.

Granulated sugar, which has a hard grain, is employed in the making of macaroon goods but it should not be used in other goods where eggs are the only moistening agents.

For most purposes fine caster sugar is used, and particularly for working with eggs or creaming with butter.

Icing sugar is used for making water icing or royal icing.

Dark sugars, such as demerara, are useful in dark-coloured cakes because they aid the colour while they also add to the flavour.

## VIENNA BREAD

Whether or not a loaf is a Vienna loaf is not determined by its ingredients or by the technique by which it has been produced, but by its characteristics. The most distinctive characteristic of a Vienna loaf is its very crisp, thin, and highly glazed crust, of a light golden brown colour. Another feature of a Vienna loaf or roll is that it does not have an unbroken surface; the loaf or roll

is either cut on the upper surface or is moulded into such a shape that the upper surface is not continuous. The vesiculation of the crumb of Vienna bread is coarser than that of ordinary bread, and gas holes are present. In order that the crust characteristics may be obtained, the dough must be baked in an ample supply of steam and it is usual to effect the baking on the sole of the oven.

## VIENNA OVEN

A Vienna oven has less depth than an ordinary bread oven and it has a sole which slopes up from the front to the back of the oven. The reason for this is that it ensures that steam is retained in the oven even when the door is opened, as an ample supply of steam is essential for the production of good Vienna bread.

## VOL

*See* AMMONIUM CARBONATE.

## WHEATMEAL

Meals (wheatmeals and wholemeals) need to be treated differently from white flours in the bakery. They usually require two or more gallons of water per sack over the proportion needed for white flour and are best suited by a bulk fermentation of $1\frac{1}{4}$ to $1\frac{1}{2}$ hr. Ample salt is required and the inclusion of fat may enhance crumb consistency. The dough temperature must be well below that employed for white flour doughs and a temperature of 22 to 23° C (72 to 74° F) is recommended. A suitable formula would be:

| | |
|---|---|
| meal | 70 lb |
| salt | $1\frac{1}{2}$ lb |
| yeast | $1\frac{1}{4}$ lb |
| water | $4\frac{1}{4}$–$4\frac{1}{2}$ gal |

The dough should be finished at a temperature of 23° C (74° F) and should be allowed to ferment for 1 hr. It should then be given a thorough knock-back and allowed to ferment for a further 15 min. The dough should then be scaled, moulded, and proved. It is important that full proof should not be given; meal doughs should always go to the oven on a rising proof. The dough should be well baked.

Speciality meals, that is meals that contain additional ingredients such as germ or diastatic malt, may require special treatment, but the recommended procedure will be supplied by the proprietors of the meal.

## YEAST

Yeasts are unicellular plants, the cells of baker's yeast (*Saccharomyces cerevisiae*) being about $\frac{1}{3,600}$ inch in diameter. They normally reproduce by 'budding', in which process a daughter cell grows from the parent cell and eventually assumes an independent existence, although it may remain attached to the parent cell. Yeasts are able to utilize sugar for their energy requirements and in so doing they produce carbon dioxide and alcohol as waste products. It is upon this property of yeast that its use as an aerating agent depends.

Yeast is most active at a temperature of 22 to 29° C (72 to 85° F). Its activity is impaired at a temperature of about 40° C (110° F), and at a temperature of 50 to 60° C (125 to 130° F) yeast is killed. If yeast is to be maintained in good condition it should be wrapped in a damp cloth and kept in a cool place or preferably stored in a refrigerator at 4° C (40° F).

A rough check upon the relative activities of samples of yeast can be made by incorporating them in a series of doughs made under identical conditions, i.e. same flour, same amount of water, etc., placing these doughs in graduated cylinders, and noting the height to which they rise in a given time. For more accurate work the Zymotachygraphe can be used.

## YIELD

The yield of bread obtained from a flour is determined by the amount of water used in the dough and the losses which occur during fermentation and baking. If the latter two factors are reasonably constant in a bakery, then yield is determined by the water absorption of the flour being used. This is naturally influenced by the moisture content of the flour but, in the absence of wide fluctuations in moisture content between different consignments of flour, water absorption is governed by the wheat blend, the amount of damaged starch, and the chemical treatment that a flour has received.

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