

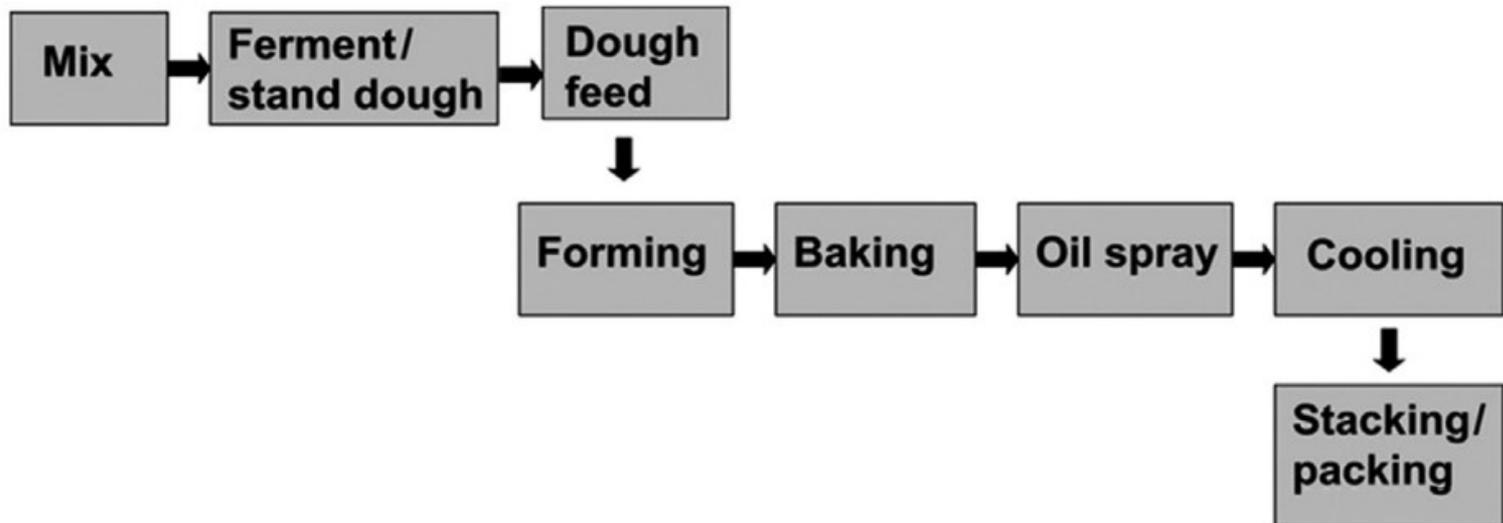
Session 4.6 – Technology of Biscuit Making

BISCUITS

- Biscuits are the snack food – have a long shelf life, are nutritious and available in many functional forms.
- Biscuits broadly fall into four categories, distinguished by their recipes and process: **crackers, hard sweet and semi-sweet biscuits, short dough biscuits and cookies** (including filled cookies).
- Each category and each product type requires a particular **mixing, forming and baking process**

Biscuit making process

- In general the biscuit-making process follows the main steps shown below.



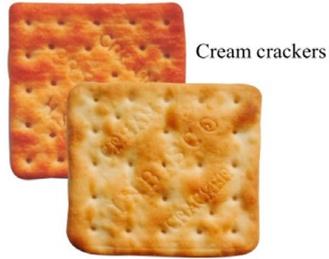
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- Mixing and fermentation or dough standing time, is usually a batch process. The forming, baking, oil spraying and cooling are continuous operations with a high degree of automation. Packing is generally offline, unless the line is dedicated to a single product

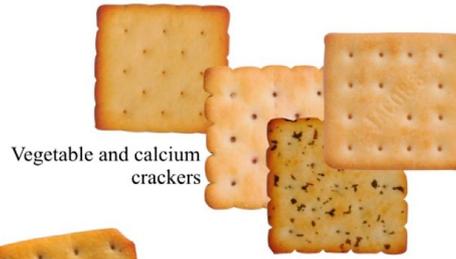
CRACKERS

- Crackers are a wide range of products characterised by **crispy, open texture and savoury flavours**. Crackers include soda and saltine crackers, cream crackers, snack crackers, water biscuits, puff biscuits, 'Maltkist' (sugar-topped crackers), 'TUC' type, 'Ritz' type, vegetable and calcium crackers

Crackers



Cream crackers



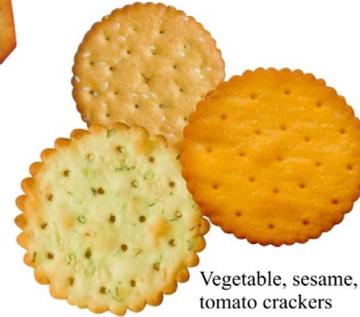
Vegetable and calcium crackers



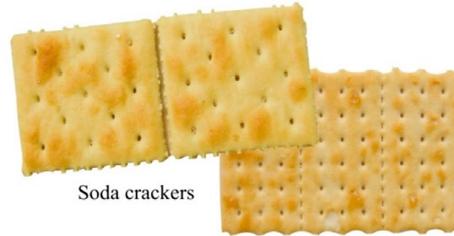
Butter coconut



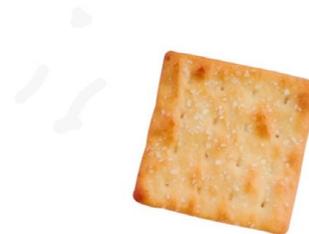
'TUC' type



Vegetable, sesame, tomato crackers



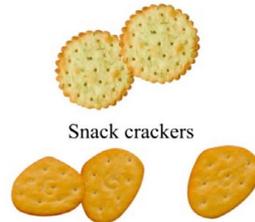
Soda crackers



Maltkist cracker



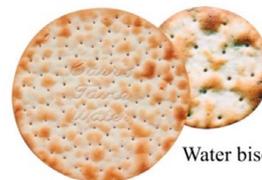
'Ritz' type



Snack crackers



Sesame crackers



Water biscuits

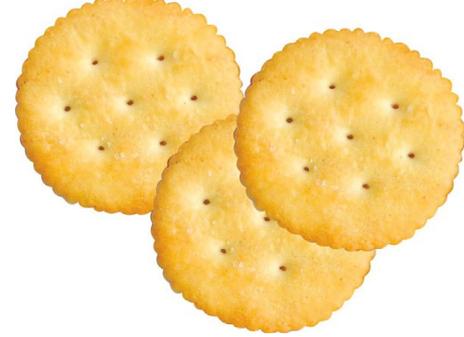


Two-dough crackers

Cracker features

- Doughs which are leavened and fermented with ingredients such as yeast, ammonia and sodium bicarbonate.
- Doughs generally have a high water content (15–25%).
- Cracker doughs are laminated (the dough sheet is made up from multiple thin layers).
- Cracker doughs spring or lift in the first part of the oven to achieve an open, flaky texture; this requires humidity and high heat input.
- Some crackers are cut and baked in strips or complete sheets and broken into individual biscuits after baking.
- Some crackers require a colour contrast between dark blisters and a pale background colour.
- Traditional English crackers, such as cream crackers and water biscuits, are normally baked on light wire-mesh bands.
- Crackers are baked to low moisture contents (1.5–2.5%), which requires a high energy input.

Snack Crackers



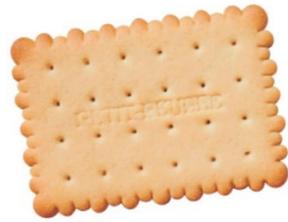
- Snack crackers are light and crispy with oil spray.
- Critical Ingredients
 - Flour should be weak with a **protein content of 8–9%**
 - Proteolytic enzyme.
- Mixing: Temperature of about 33°C for enzyme doughs
- Standing time: the standing time is about 2.0–2.5 hours at 35°C.
- Forming: The dough is laminated with four laminations, approximately 4 mm thick

• Baking:	Baking time	5.0 minutes
	Zone temperatures	220/220/230/230/180°C
	Band preheated to	180–200°C

Hard Sweet Biscuits

- Examples of hard sweet biscuits are Marie, Petit Buerre, Rich Tea, Arrowroot and Morning Coffee. They are characterised by an even, attractive colour and texture and good volume
- Doughs have strong, developed gluten which gives an elastic dough, which is sheeted and cut. It often shrinks in the first stage of baking
- Doughs have low sugar and fat
- Doughs have water contents typically of around 12%
- Biscuits are normally baked on a wire-mesh band (except for Marie which is traditionally baked on a steel band)
- Humidity in the first part of the baking is important to achieve good volume and a smooth surface sheen
- Biscuits are baked to low moisture contents, around 1.5–3.0%.

Hard sweet biscuits



Petit Buerre



Rich Tea Finger



Breakfast biscuits



Marie



'Dorada'



Rich Tea



Arrowroot

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- Marie biscuits are made with medium protein flour and containsodium metabisulphate (SMS) to develop a soft extensible dough. The doughs are mixed on horizontal mixers to a temperature of 40–42°C.
- The dough is sheeted and cut and is traditionally baked on a steel band.
- Critical Ingredients
 - Flour should not exceed 9.0% protein. Higher protein will result in a hard biscuit.
 - Cornflour and maize flour are used to reduce the total gluten content and make a more tender eating biscuit SMS will modify the protein to make a soft extensible dough.
- Mixing

Mixing is critical to developing the soft extensible dough. A mixing action which kneads the dough without too much tearing and extruding is ideal. Mixing time on a typical highspeed mixer will be 20–25 minutes. Marie doughs are mixed until the required temperature is achieved. The dough should reach 40–42°C.

- Forming: The dough may be laminated, but doughs made with SMS are usually sheeted without lamination.

Baking time	5.0–6.5 minutes
Temperatures	200/220/180°C
Moisture	1.5%

A ratio of cooling to baking time should be at least 1.5:1. This will help to avoid checking (cracking of the biscuits after packaging due to an internal moisture gradient).

Short doughs: rotary moulded biscuits



Caramelised biscuit



Printed biscuits



Digestives



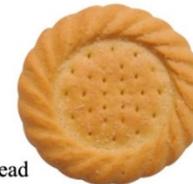
Moulded cookie



Star cookie



Shortbread



Italian frollini



Short Doughs (Moulded Biscuits)

- This is another wide biscuit category with many designs. **The doughs are short with higher fat and sugar contents than the crackers and hard sweet biscuits** This is the simplest category for the dough piece forming process (rotary moulding) and so these products are very widely produced, often in very high volumes.
- Malted milk, Glucose, Lincoln, Digestive, Nice, Shortbread, custard cream from Britain, Italian frollini, Dutch speculaas, caramelised biscuits, and Glucose and Tiger from India.
- Critical parameters
 - Doughs have a low water content, but more fat and sugar than the hard sweet biscuits. High humidity in the first part of the baking process allows the biscuit structure to form. Relatively slow baking at comparatively low temperatures.
 - Flour should not exceed 8.0–9.0% protein. Higher protein will result in a tough biscuit, particularly if it is overmixed.
 - The vitamin and mineral mix should be developed to suit the local requirement.
- Mixing

The mixing process must not develop the gluten in the flour, as this will result in a tough biscuit. **Mixing is therefore done in two stages.** In the **first stage, all the ingredients are mixed except the flour and soda.** The mixing continues until a consistent, homogenous cream is produced. It is important to keep the temperature of the dough low and chilled water is required for the mixer jacket. **For the second stage, the flour and soda are added and mixed for 1 minute at slow speed and 1–2 minutes at high speed.** The final dough temperature should be 18–22°C.

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- Baking: Steam may be used at the oven entry to achieve a high humidity. This will allow the biscuit to expand in the first zone and achieve good volume.
- Sufficient cooling is required to set the biscuit, which will be soft as it leaves the oven, usually 1:1.5 baking to cooling time.

Baking time	5.0–5.5 minutes
Temperatures	180/200/220/200/180°C
Moisture	<3.0%

Baking process of biscuits

- Our focus is on the baking of good-quality biscuits.
- There are three main changes which we will see as all biscuits are baked. They are the **development of the biscuit structure and texture, the reduction in the moisture content and the development of the colour.**
- Formation of the structure and texture of the biscuit will take place in the first half of the oven, the reduction in the moisture mainly in the middle of the oven and the development of the colour in the final third of the oven

Biscuit structure

- Texture – open, flaky, short, depending on the product, etc.
- Density/volume – low density gives more volume and a lighter bite
- Bite/mouth feel – crispiness, softness, smoothness, crunchiness, etc.
- Flavour – many flavours and fillings are heat susceptible and the protection of the flavours and texture of the fillings needs consideration for the baking process. For example, for a variety of soft doughs and cookies, a preference will be given for radiant heat, a longer baking time at a lower temperature

Moisture content

- An important factor in baking doughs with high water content, such as crackers and water biscuits.
- Low moisture content enhances the keeping qualities of the biscuit.
- Evenness of the moisture content from the centre to the outside of the biscuit requires penetrative heat and adequate time for baking and cooling to avoid 'checking' (cracks in the biscuits after packing).

Colour

- Consistency of colour with time and across the width of the oven band.
- Some products such as Marie require a very even bland colour; others such as cream crackers and some rotary moulded designs require colour contrasts and highlights. These features require different baking systems to enhance the appearance of the product



Ingredients

- The structure and texture of the biscuit is determined by the ingredients, mixing and forming and the baking process.
- Wheat flour: Typical biscuit flour is milled to a yield or extraction of 70–75%.
- The percentage of protein determines the flour strength. A dough made from strong flour with a high protein content is extensible and can be machined into a continuous sheet for crackers and hard biscuits. A weak flour with a low protein content produces a soft dough, which may be moulded or deposited on the baking band and when baked, gives a short texture.

Wheat flour types

Property	Soft flour (%)	Medium flour (%)	Strong flour (%)
Protein	8.0	10.3	13.2
Wet gluten	25.0	26.0	31.0
Fat	0.0	1.0	2.4
Carbohydrate	80.0	76.3	66.9
Ash	0.3	0.5	0.5
Water absorption	53.0	58.0	60.0

Role of wheat gluten

- Wheat flour contains proteins including gliadin and glutenin. In the presence of water, these proteins combine to form gluten.
- As the dough is mixed the protein molecules form long strands of gluten, which have strength and elasticity. The gluten forms an elastic web, which gives the dough strength and allows it to be machined into a thin sheet for crackers and hard sweet biscuits.
- The gluten web is also important in trapping air and gas bubbles formed by yeast fermentation and by leavening agents such as sodium bicarbonate (soda) or ammonium bicarbonate (vol).

Starch

- Starch is insoluble in water; however, the starch granules do absorb a limited amount of water in the dough and swell. **Above temperatures of 60–70°C, the swelling is irreversible and gelatinisation begins.** The gelatinisation may continue until the starch granules are fully swollen, but it is normal in baked products that only partial gelatinisation occurs.
- The gelatinisation of the starch contributes to the rigidity and texture of the biscuit.
- As the starch gel is heated further, **dextrinisation** occurs. This contributes to the **colouring of the biscuit.**

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- In soft dough products, the **high sugar and fat content of the dough inhibits starch gelatinisation**. The presence of sugar delays the gelatinisation of the starch, which may be due to the competition for the water. The fat, composed of triglycerides and surfactants, also tends to inhibit gelatinisation. **With high sugar and fat recipes, the dough has a low gel viscosity and strength, and produces short and soft biscuits and cookies.**

Sugar

- Common sugar (sucrose) is a carbohydrate derived from sugarcane or sugar beet. It is a disaccharide composed of two monosaccharides, a molecule of glucose joined to a molecule of fructose.
- Sugar gives sweetness, but it is also important in developing the texture of the biscuit. Dissolved sugar tends to inhibit starch gelatinisation and gluten formation and creates a biscuit with a more tender texture.

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- Sugar gives sweetness, but it is also important in developing the texture of the biscuit. Dissolved sugar tends to inhibit starch gelatinisation and gluten formation and creates a biscuit with a more tender texture.
- Undissolved sugar crystals give a crunchy, crisp texture. Sugar crystals, which melt during baking, cool to a noncrystalline glasslike state giving a crispy, crunchy texture, particularly on sugartopped biscuits.
- Dry sucrose melts at 160–186°C. Biscuits with sugar toppings which are melted to a smooth, shiny surface require high-intensity flash heat at the end of the oven to fully melt the sugar.
- Invert sugar syrup is a mixture of glucose and fructose. The sucrose is split into its component monosaccharides by hydrolysis. The sucrose in solution is heated with a small quantity of acid such as citric acid. After inversion the solution is neutralised by the addition of soda. The invert syrup is sweeter than sugar and it contributes to a moist, tender texture in the biscuit.

Leavening Agents

- Yeast is normally used in the production of cream crackers. The yeast is most active at temperatures of 30–35°C during dough fermentation. At temperatures above 40°C, the yeast activity stops and it is therefore inactive during the baking process.
- Sodium bicarbonate (soda): Soda is readily soluble and it reacts with acidulants in the dough in the presence of water, producing carbon dioxide and decomposing to salt and water. The leavening of the dough takes place during mixing and fermentation of the dough
- Ammonium bicarbonate (vol): This leavening agent decomposes completely when heated, producing carbon dioxide, ammonia and water. The reaction is rapid at around 60°C, and therefore the expansion of the dough takes place during the initial stages of baking.

Fats

- Fats are a vitally important ingredient in achieving the texture, mouth feel and the bite of the biscuit. Crackers and hard biscuits have relatively low percentages of fats in the recipes, while soft cookies have high amounts of fat.
- Recipes with high fat contents require little water for producing a cohesive dough and produce soft, short doughs. During mixing, the fat coats the flour particles and this inhibits hydration and interrupts the formation of the gluten.
- Where both fat and sugar amounts in the recipe are high, they combine to make a soft, syrupy, chewy texture.
- Typical blended vegetable dough fats are solid at ambient temperature and melt over a wide temperature range. Most fats used in biscuit making melt below blood temperature (36.9°C), and this avoids a waxy mouth feel.
- Fats are specified with a Solid Fat Index (SFI), which indicates the percentage of solid fat present in the total fat. A dough fat typically has an SFI of around 18 at 25°C and 12 at 30°C