Grain Processing Technologies
Class 6 – September 12th, 2017

Crackers, biscuits and cookies – processing and factors that affect quality parameters and consumer's acceptability

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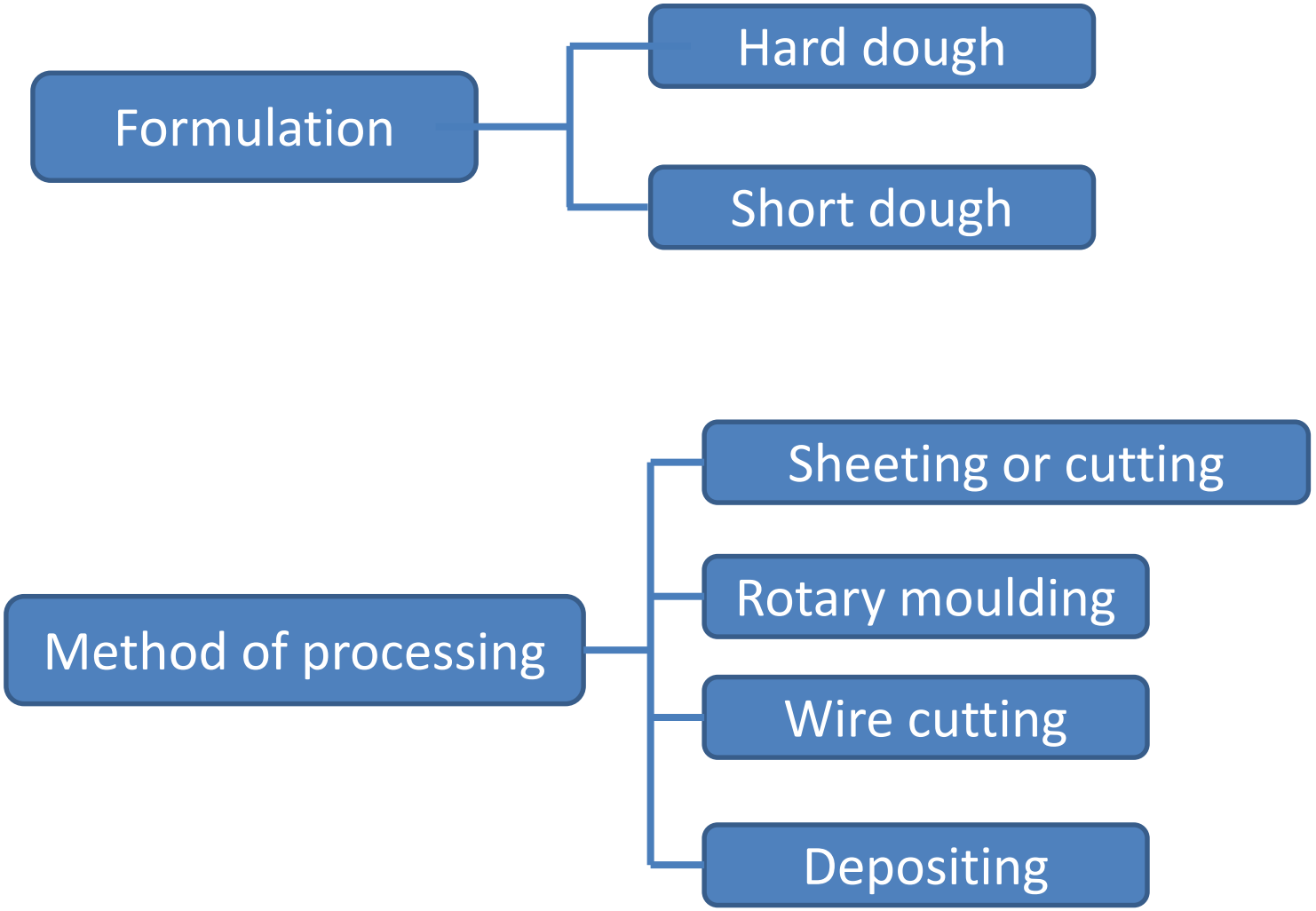
CLASSIFICATION OF BISCUITS (OR COOKIES)



Source: Wrigley et al., Encyclopedia of Grain Science, Cookies, Biscuits, and Crackers, 2002.

Figure 3.1 Rotary moulding roll engraving.

Figure 1.15 Rotary moulder from Dingson Food Machinery.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

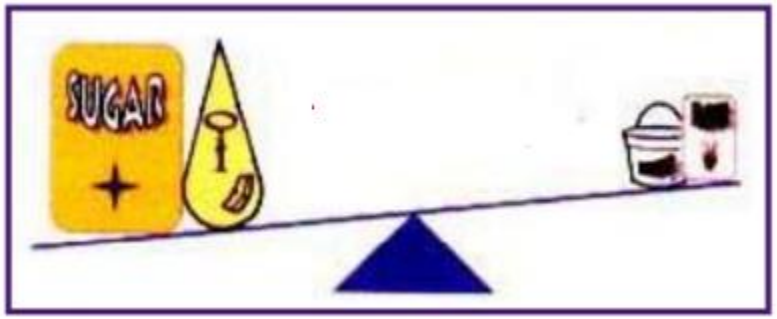
Figure 1.21 Baker Perkins wire-cut machine.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

Products are categorized by the balance of flour, sugar, fat & water

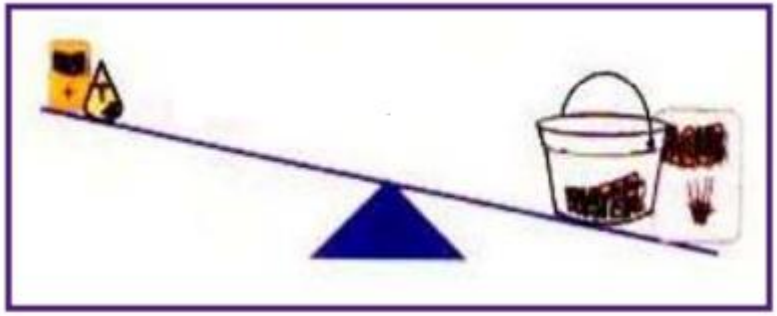
- *High levels of sugar & fat, relative to flour*

– Dough remains more fluid & less structure is developed



- *High levels of water & flour, low levels of sugar & fat*

– Dough develops a firm structure by gluten development



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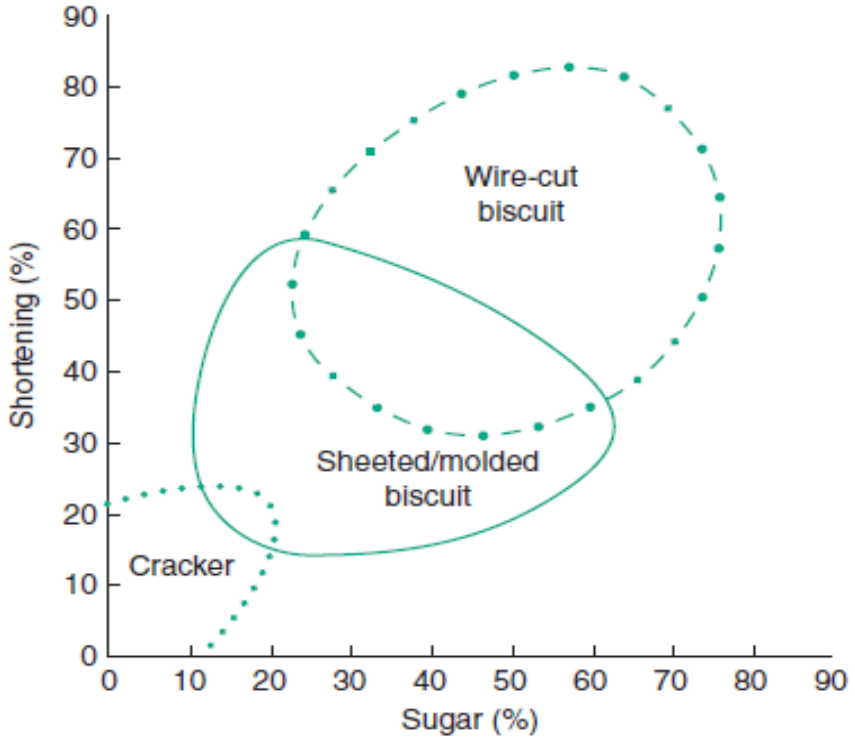
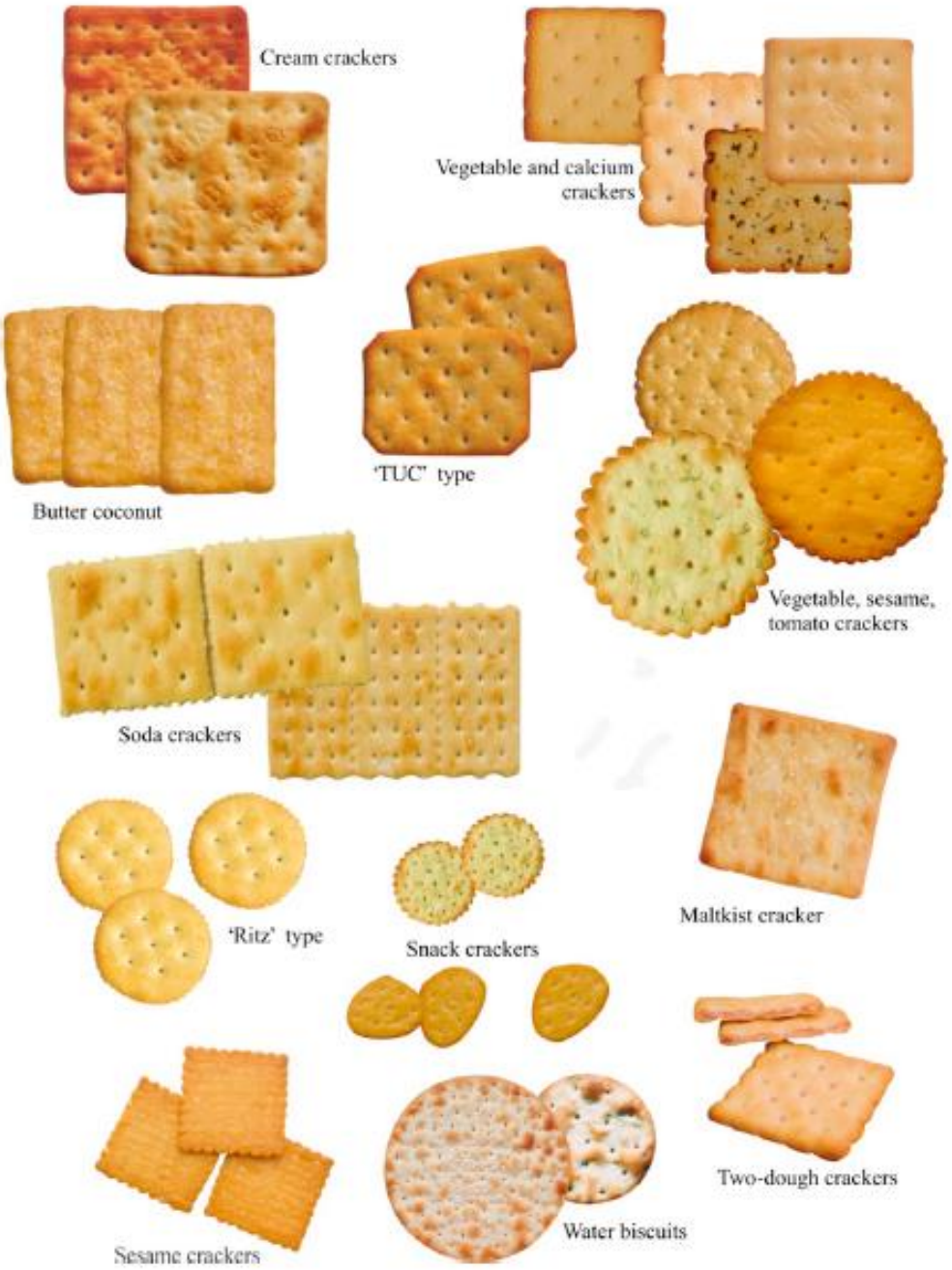


Figure 1 Biscuit composition in relation to sugar and shortening, based on 100 parts flour. (Each dough is processed according to its consistency or water content.) (Reproduced from Encyclopedia of Food Sciences and Nutrition, 2nd Edition (2003), p. 534, Elsevier Ltd.)

Source: Wrigley et al., Encyclopedia of Grain Science, Cookies, Biscuits, and Crackers, 2002.

Crackers


Cream crackers
Vegetable and calcium crackers
'TUC' type
Butter coconut
Vegetable, sesame, tomato crackers
Soda crackers
'Ritz' type
Snack crackers
Maltkist cracker
Two-dough crackers
Water biscuits
Sesame crackers

CRACKERS

- Crackers are a wide range of products characterised by crispy, open texture and savoury flavours.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

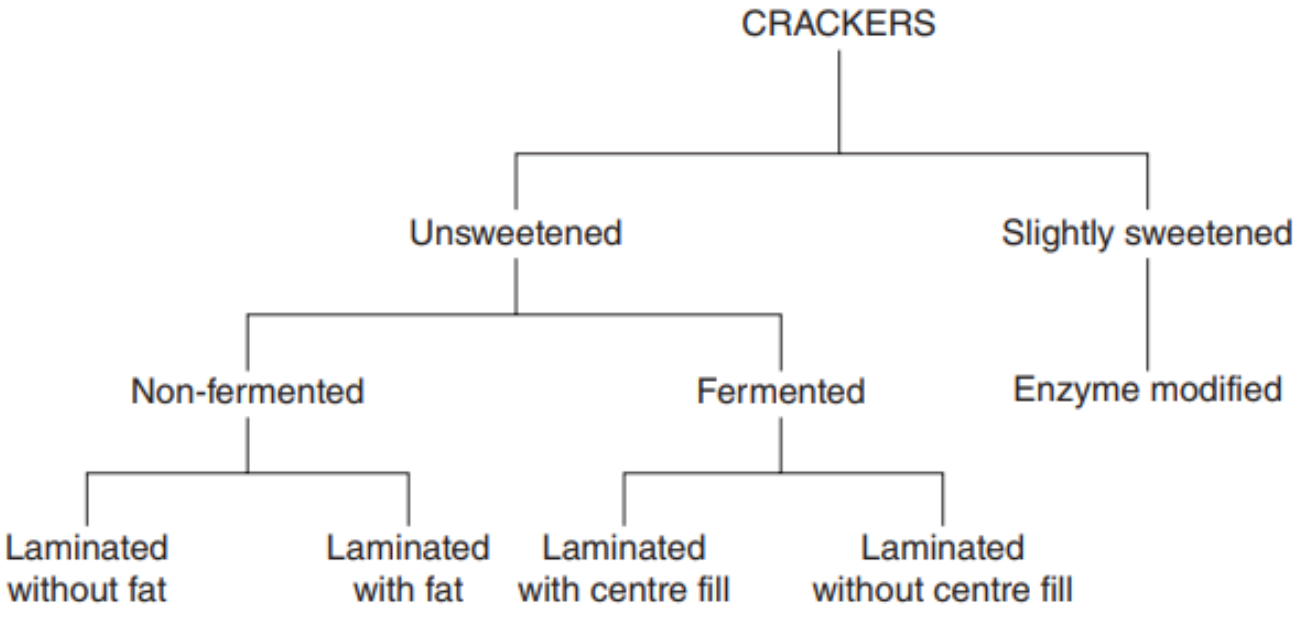
Products are categorized by the balance of flour, sugar, fat & water

Formulation

The ‘Major Ingredients’ used are:

		WATER	sugar	FLOUR	oil
Crackers		Very High	Very Low	Strong	Low
		High	Medium	Medium	Medium
		Medium	Slightly Higher	Medium	Medium

Products are categorized by the balance of flour, sugar, fat & water



Percentage of fat in the dough:	6%	19%	11%	10%	7–9%

Fig. 22.2 Relationship of cream crackers to other crackers.

TYPICAL PROCESS FLOW FOR CRACKERS

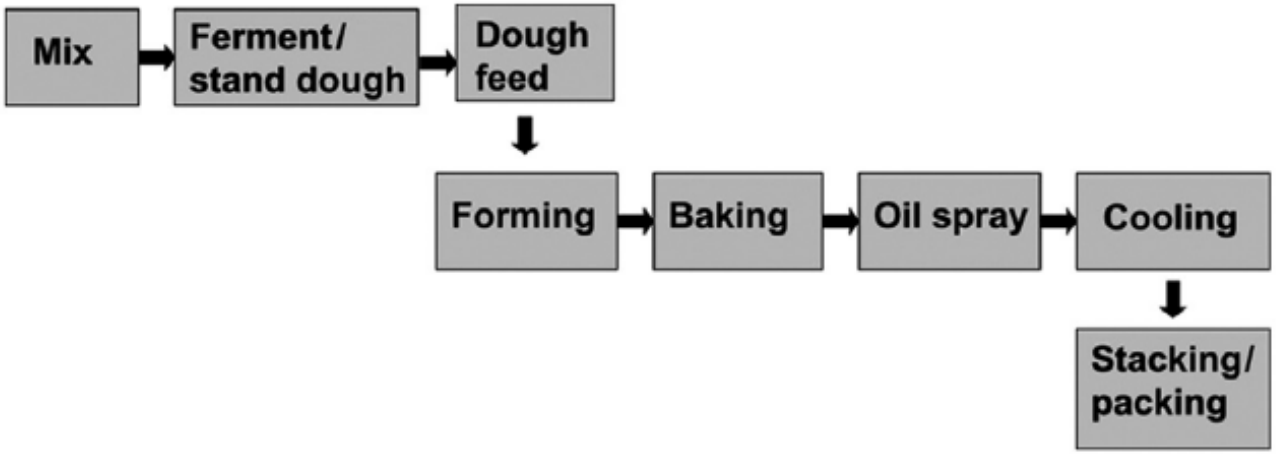


Figure 1.1 Typical process flow for crackers. Mixing and fermentation are usually batch processes, forming, baking, oil spray and cooling are continuous in-line processes.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

FEATURES WHICH INFLUENCE THE BAKING PROCESS

In general, crackers may have some of the following features which influence the baking process:

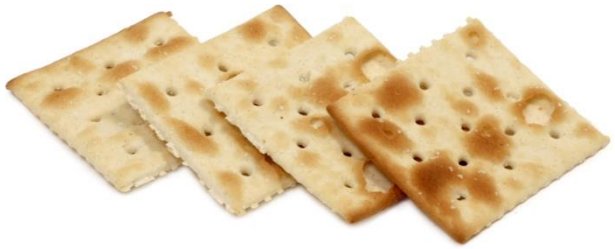
- Doughs which are leavened and fermented with ingredients such as yeast, ammonia and sodium bicarbonate.
- Doughs generally have a high water content (15–25%).
- Cracker doughs are laminated (the dough sheet is made up from multiple thin layers).

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

FEATURES WHICH INFLUENCE THE BAKING PROCESS

- 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.



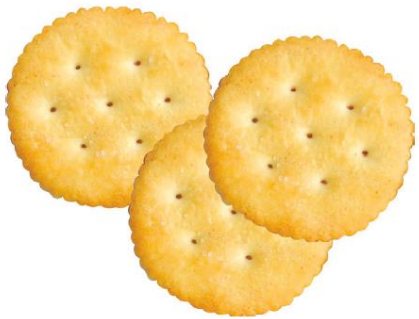
Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

Figure 3.4 Crackers cut in strips.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR SNACK CRACKERS

Snack crackers are successful in every market: light and crispy with oil spray.



Flour	100.00
Sugar	8.02
High-fructose corn syrup	2.85
Vegetable oil (soya bean)	11.66
Lecithin	0.20
Ammonium bicarbonate	1.84
Sodium bicarbonate	1.08
Acid calcium phosphate	1.08
Salt	0.77
Enzyme	0.01
Water	29.47

Critical Ingredients

1. Flour should be weak with a protein content of 8–9%

2. Proteolytic enzyme.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR SNACK CRACKERS

Mixing

An ‘all in’ mix on a horizontal mixer

Temperature of about 33°C for enzyme doughs.

⇩

Standing Time

⇩

Forming

Figure 1.4 Baker Perkins horizontal high-speed mixer with shaft-less blade.

The dough is laminated with four laminations, approximately 4 mm thick

No fat/flour filling is used

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR SNACK CRACKERS

⇩

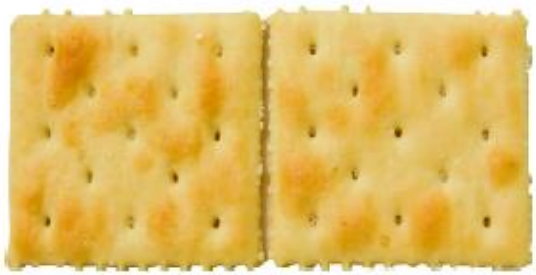
Baking

Figure 1.5 Baker Perkins forming line: (right to left) laminator, three gauge roll units, relaxation conveyor, rotary cutter, scrap lift and return conveyors.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR SODA CRACKERS

Soda crackers are a traditional product in the United States, where they are made in very large volumes. Similar crackers are the Biscuits 'Saltine' or 'Premium' crackers.



Important characteristics:

- A two-stage mixing process known as 'sponge and dough'
- A long fermentation, usually 24 hours
- Fast baking time, around 2.5 minutes, on a heavy mesh preheated oven band

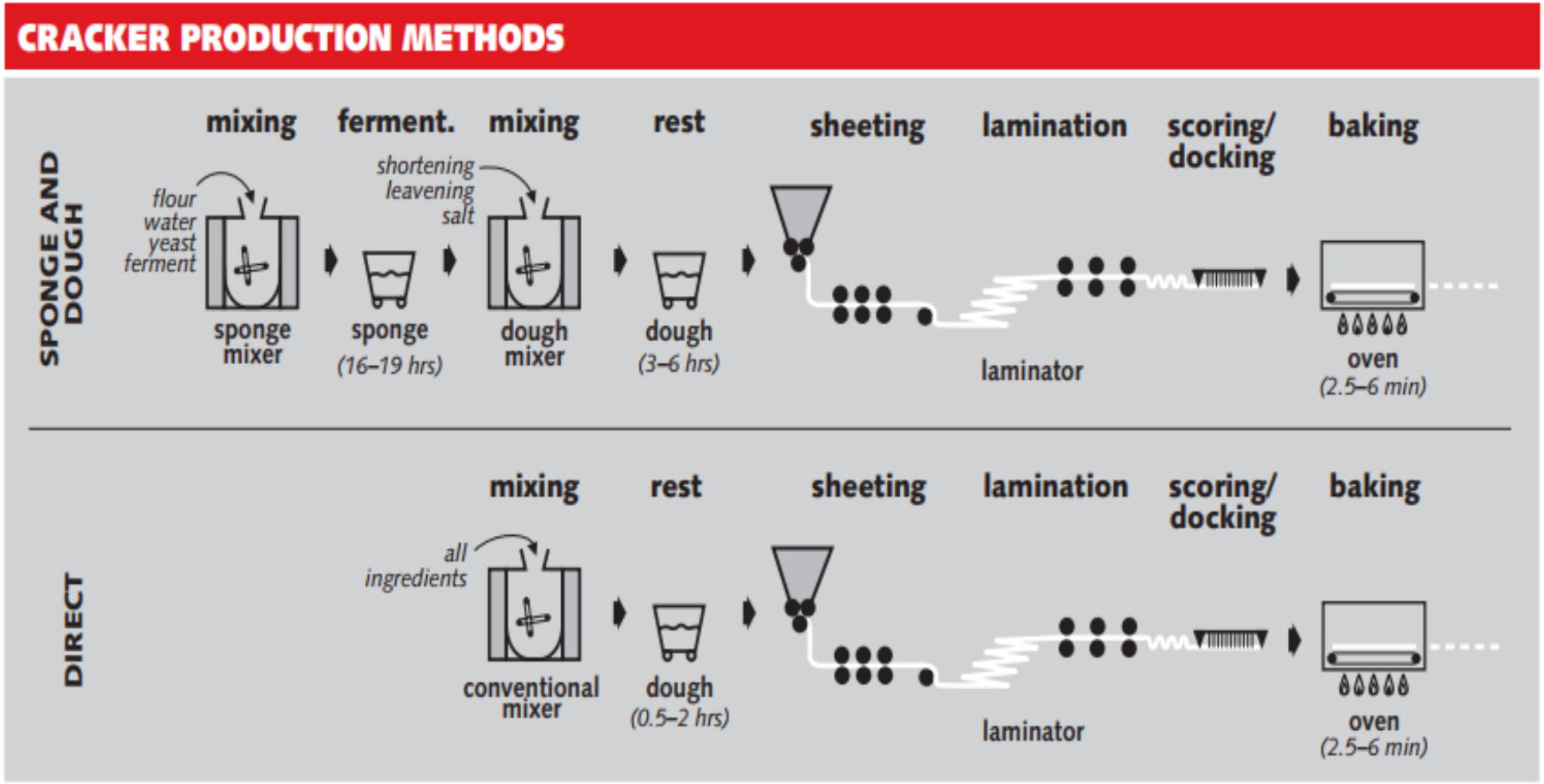
Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR SODA CRACKERS

- ***Critical Ingredients***
- A strong flour will give an open cracker texture.
- The flour used in the sponge must be 10–11% protein.
- Stronger flour gives a harder cracker. A weaker flour (8.0–9.0% protein) is usually used for the dough and will give a product with a softer bite.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR SODA CRACKERS

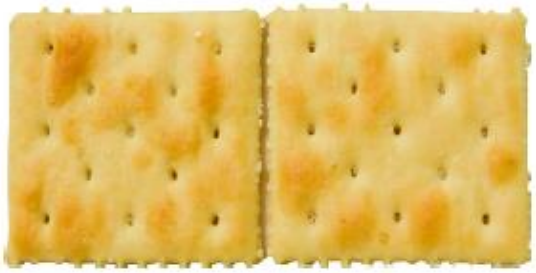


PROCESS FOR SODA CRACKERS

1.3.3 Formulation

1.3.3.1 Sponge

Flour (strong)	66.7
Fresh yeast	0.17
Dough fat	5.00
Lecithin	0.53
Malt extract 80%	0.95
Water	28.0



1.3.3.2 Dough

Sponge (follow the formulation as described in Section 1.3.3.1)

Flour (weak)	33.3
Dough fat	5.00
Soda	0.60
Salt	1.50

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

BISCUITS

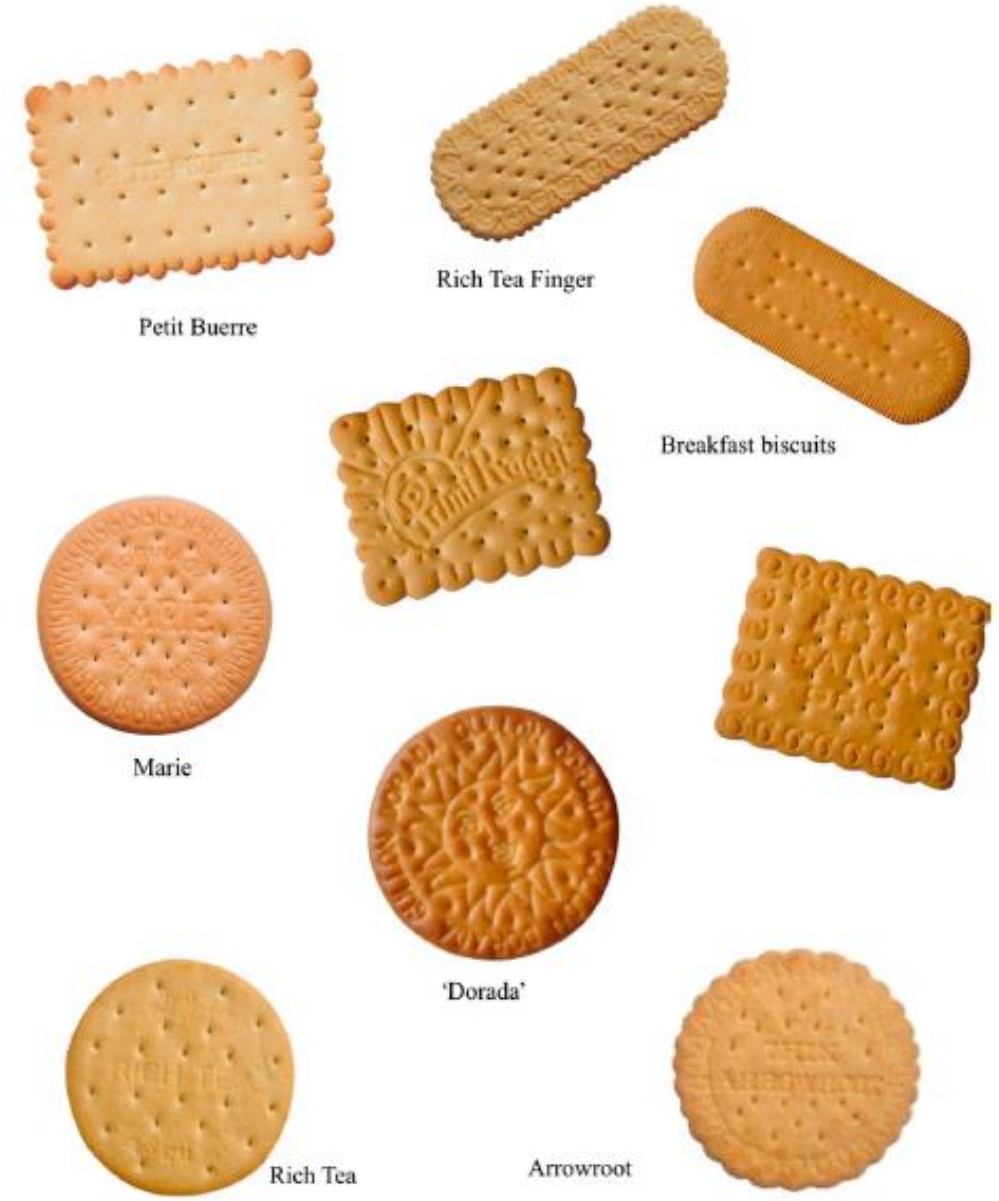


Figure 1.9

HARD SWEET BISCUITS

Doughs for hard sweet biscuits have the following features:

- 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%
-

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

HARD SWEET BISCUITS

- 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%.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR HARD SWEET BISCUITS

Marie is a classic biscuit made throughout Europe and Asia. It has a light, crisp, delicate texture, with pale colour and clear smooth surface.

1.5.3 Formulation

Flour	100.00
Cornflour	4.41
Maize flour	14.70
Granulated sugar	25.59
Invert syrup 80%	7.94
Shortening	11.03
Lecithin	0.57
Salt	0.88
Soda	0.67
Acid calcium phosphate	0.08
Protease	0.02
SMS 10% solution	0.02
Ammonium bicarbonate	0.73
Water	26.47

- Medium protein flour
- Medium protein flour and contain sodium metabisulphate (SMS) to develop a soft extensible dough.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR HARD SWEET BISCUITS

Critical Ingredients

1. Flour should not exceed 9.0% protein. Higher protein will result in a hard biscuit;

2. Corn flour are used to reduce the total gluten content and make a more tender eating biscuit

3. SMS will modify the protein to make a soft extensible dough.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

Cookies

Ginger Crunch

Nut and raisin cookie

Wire-cut cookie

Fruit cookie

Chocolate chip cookie

Egg cookie

Chocolate and nut cookie

Chocolate chip cookies

Oat cookie

Iced cookie

Fruit cookie

COOKIES

- Very soft doughs which are deposited directly onto the oven band;
- High fat and sugar recipes;
- Long baking times with relatively low baking temperatures
- High humidity is required in the first oven zones to allow the dough to spread on the oven band.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

PROCESS FOR A CHOCOLATE CHIP COOKIE

Short cookies with inclusions of chocolate chips or nuts.

1.10.3 Formulation

Flour	100.00
Shortening	55.98
Granulated sugar	50.05
Brown sugar	0.76
Whole egg powder	1.24
Vanillin	0.10
Invert syrup	1.24
Salt	0.96
Ammonium bicarbonate	0.29
Sodium bicarbonate	0.67
Chocolate chips	30.00
Water	19.14

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

INGREDIENTS

- **Wheat Flour**

Wheat Gluten

% of protein determines the flour strength

↓

2.2.2 Wheat Flours: Typical Specifications

Table 2.1

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

Protein content:

- Strength and elasticity
- Crackers are made with strong flour

Starch

- Rigidity and texture of the biscuit
- Dextrinisation = Colouring of the biscuit

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

INGREDIENTS

Sugar

- Sweetness
- Texture
- Inhibit starch Gelatinisation and gluten formation

Leavening Agents

- Yeast is normally used Used in the production of cream crackers
- The yeast is most active at temperatures of 30–35°C during
- *Sodium bicarbonate*
- *Ammonium bicarbonate*

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

INGREDIENTS

Fats

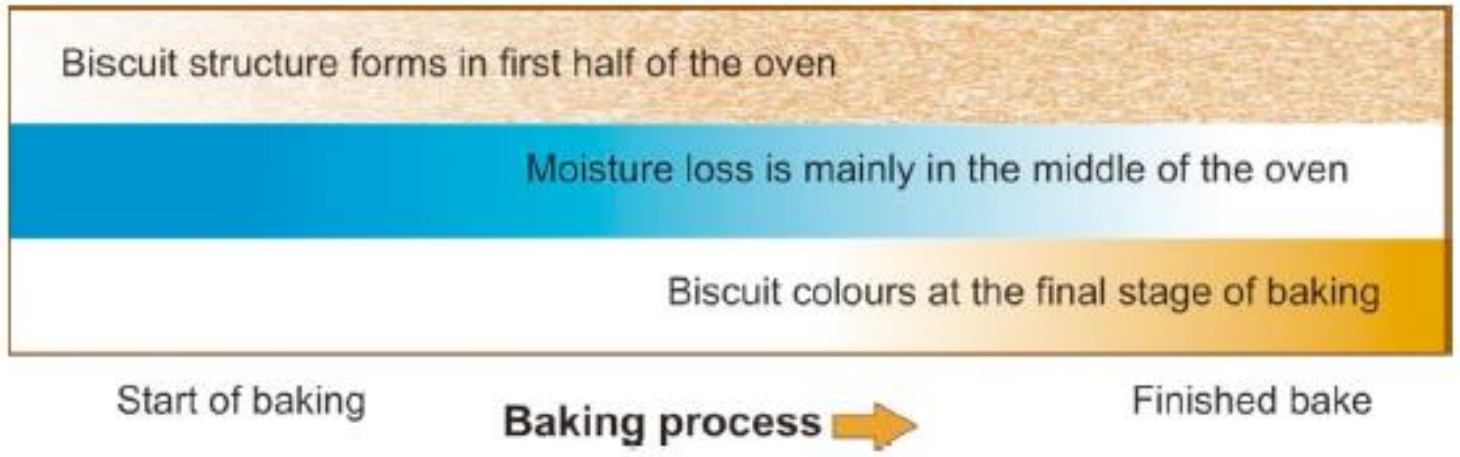
- Act as lubricants
- Tendetizant agent
- Provides texture/structure to the product
- Act as aerating agents
- Eating quality (palability)
- Moisture-barrier in finished products

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

Is Water an Ingredient?

BAKING: THE DEVELOPMENT OF THE BISCUIT STRUCTURE AND TEXTURE

Changes during the baking process



Biscuit Structure ***Moisture Content*** ***Color***

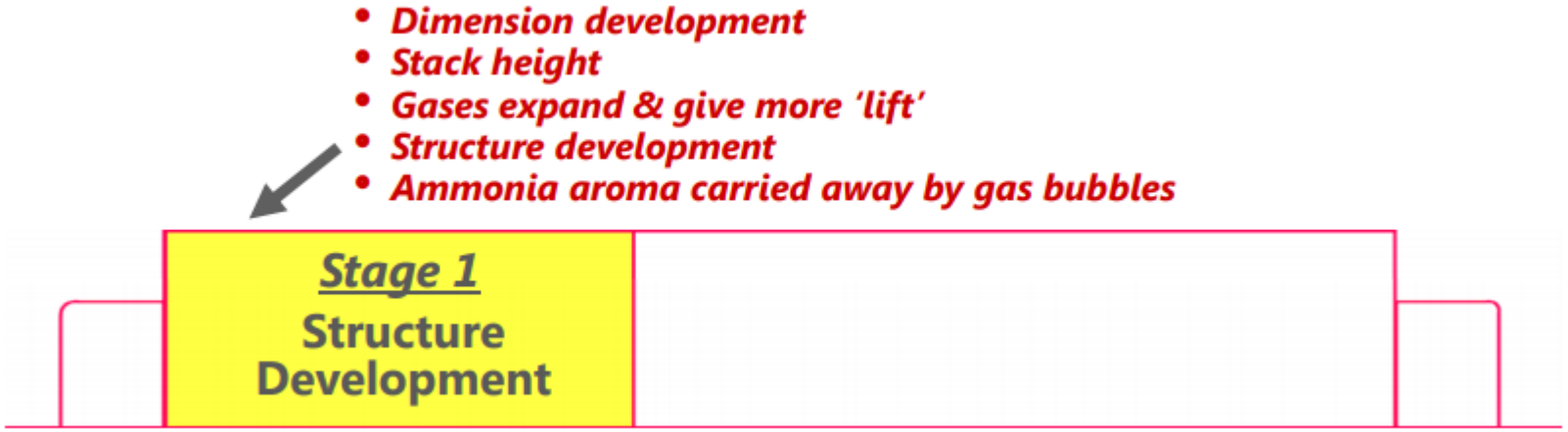
- *Textura*
- *Density/volume*
- *Flavour*

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

BAKING: THE DEVELOPMENT OF THE BISCUIT STRUCTURE AND TEXTURE

Stage 1: Structure Development
Front End Heat is Critical

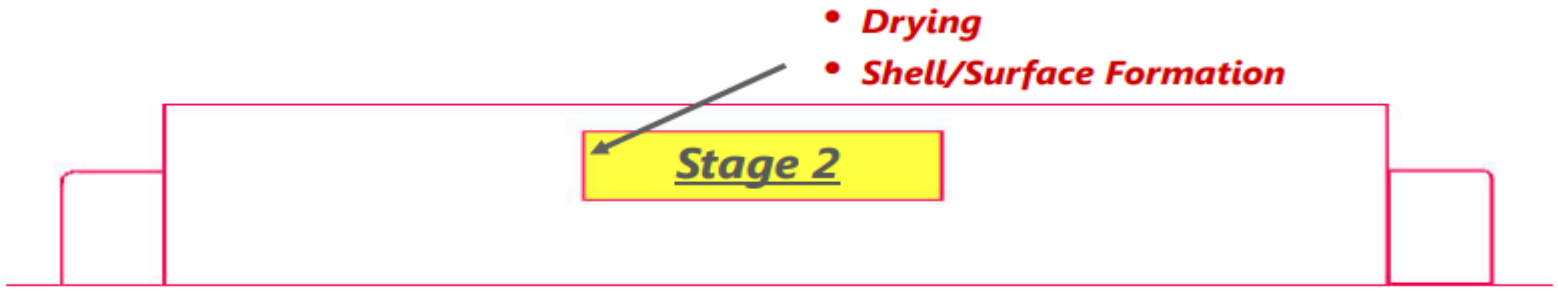
- Ammonia, carbon dioxide gases & water vapor are formed and released. These cause the cracker to 'lift' .



BAKING: THE DEVELOPMENT OF THE BISCUIT STRUCTURE AND TEXTURE

Stage 2: Moisture Removal

- Continues to remove 'free water' from the dough piece
- Maximum gas/dough piece expansion achieved
- Product volume relaxes
- Fixing the product structure: – Starch gelatinização – Gluten proteins change (denaturize)
- Crusting of the product surface begins



- **If crusting of the surface begins too early in the second stage, 'blisters' may result**

BAKING: THE DEVELOPMENT OF THE BISCUIT STRUCTURE AND TEXTURE

Stage 3: Color Development

- Majority of moisture removed during Stages 1 & 2 and coloring now occurs
- Structure is fully set and product is firm
- The color develops due to: – Sugar caramelization – protein reactions (Maillard browning)
- These also develop flavor

BAKING: THE DEVELOPMENT OF THE BISCUIT STRUCTURE AND TEXTURE

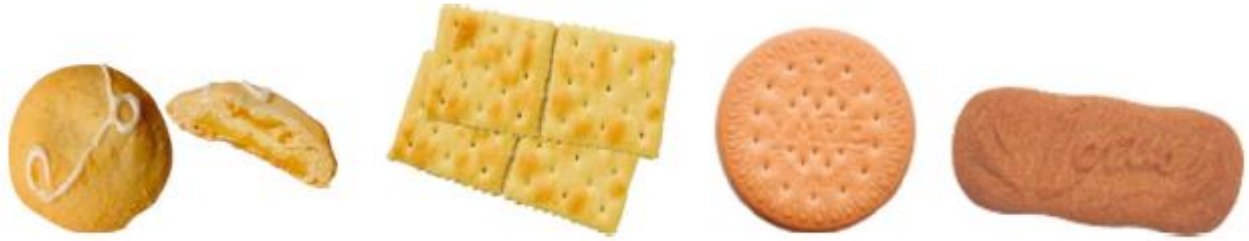


Figure 2.2 Wide variety of biscuit textures, densities, bites and flavours.

Figure 2.3 Variety of biscuit colours and highlighting.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

BAKING: THE DEVELOPMENT OF THE BISCUIT STRUCTURE AND TEXTURE

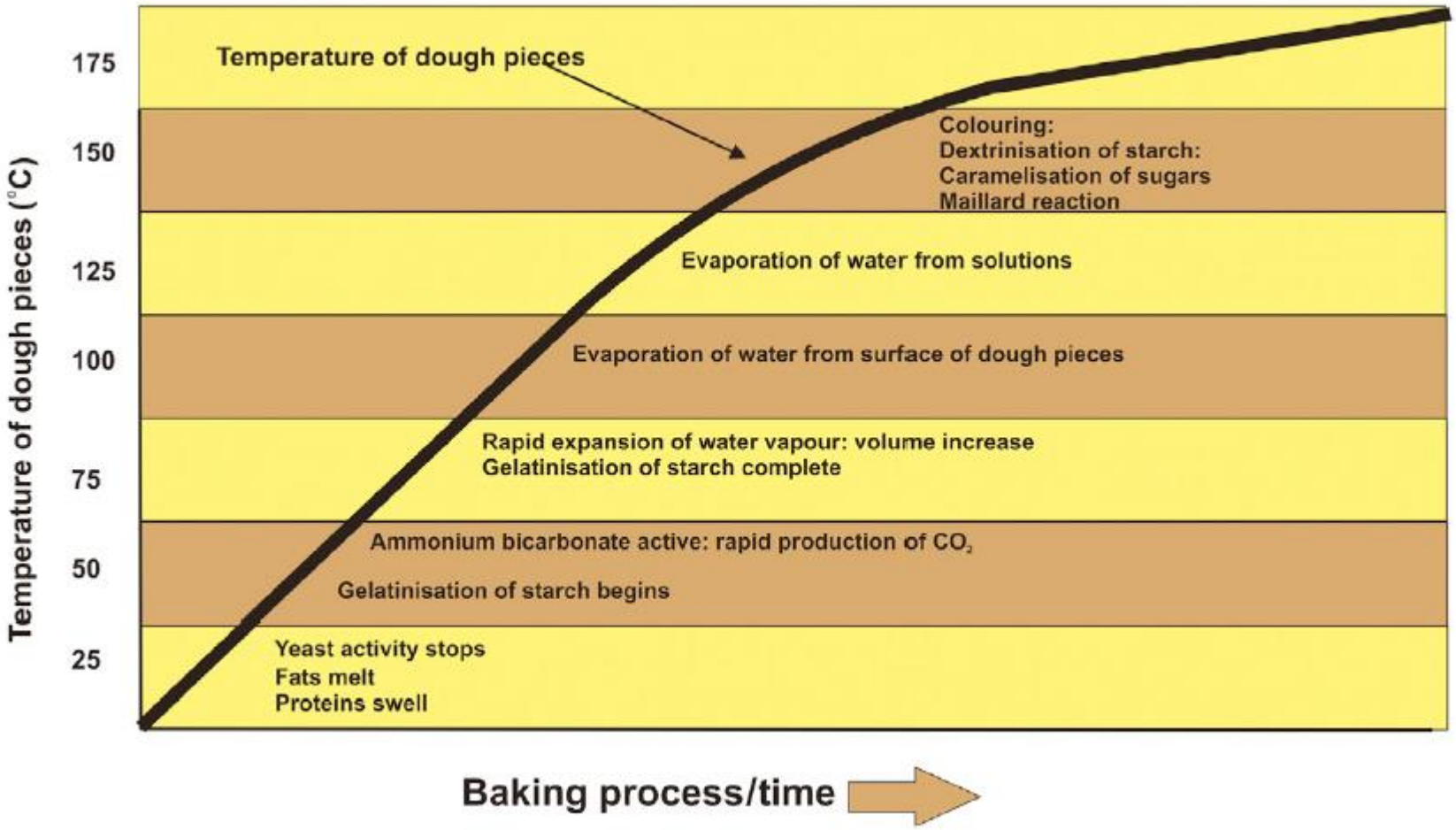


Figure 2.4 After W. Mowbray.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

BAKING: THE DEVELOPMENT OF THE BISCUIT STRUCTURE AND TEXTURE

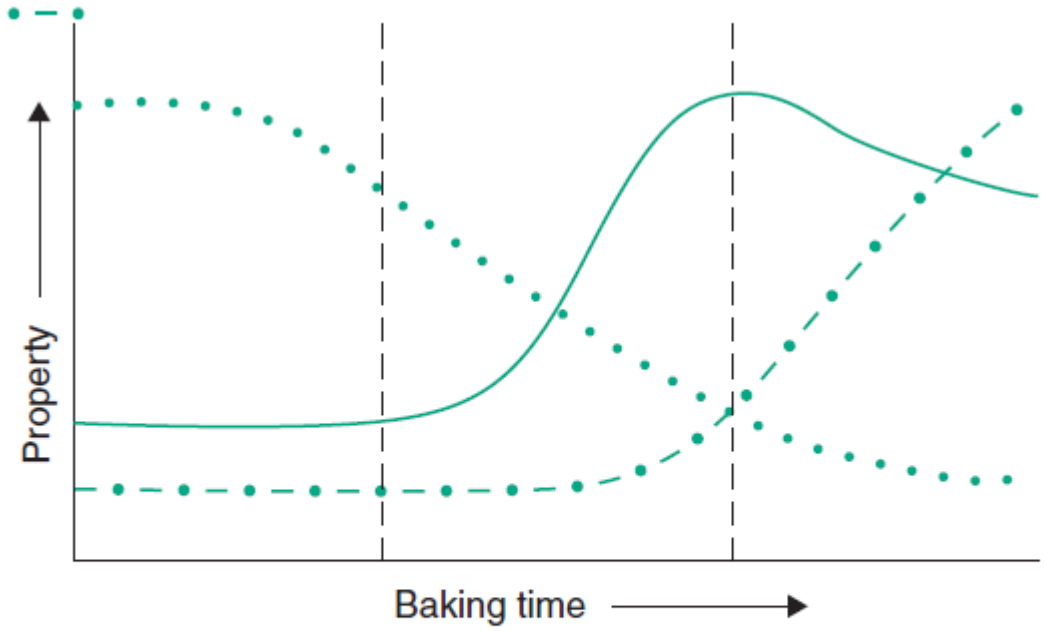


Figure 2 Physical changes in biscuits during baking. Key: • – •, color; ——, thickness; • • •, weight. (Reproduced from Encyclopedia of Food Sciences and Nutrition, 2nd Edition (2003), p. 537, Elsevier Ltd.)

MODES OF HEAT TRANSFER

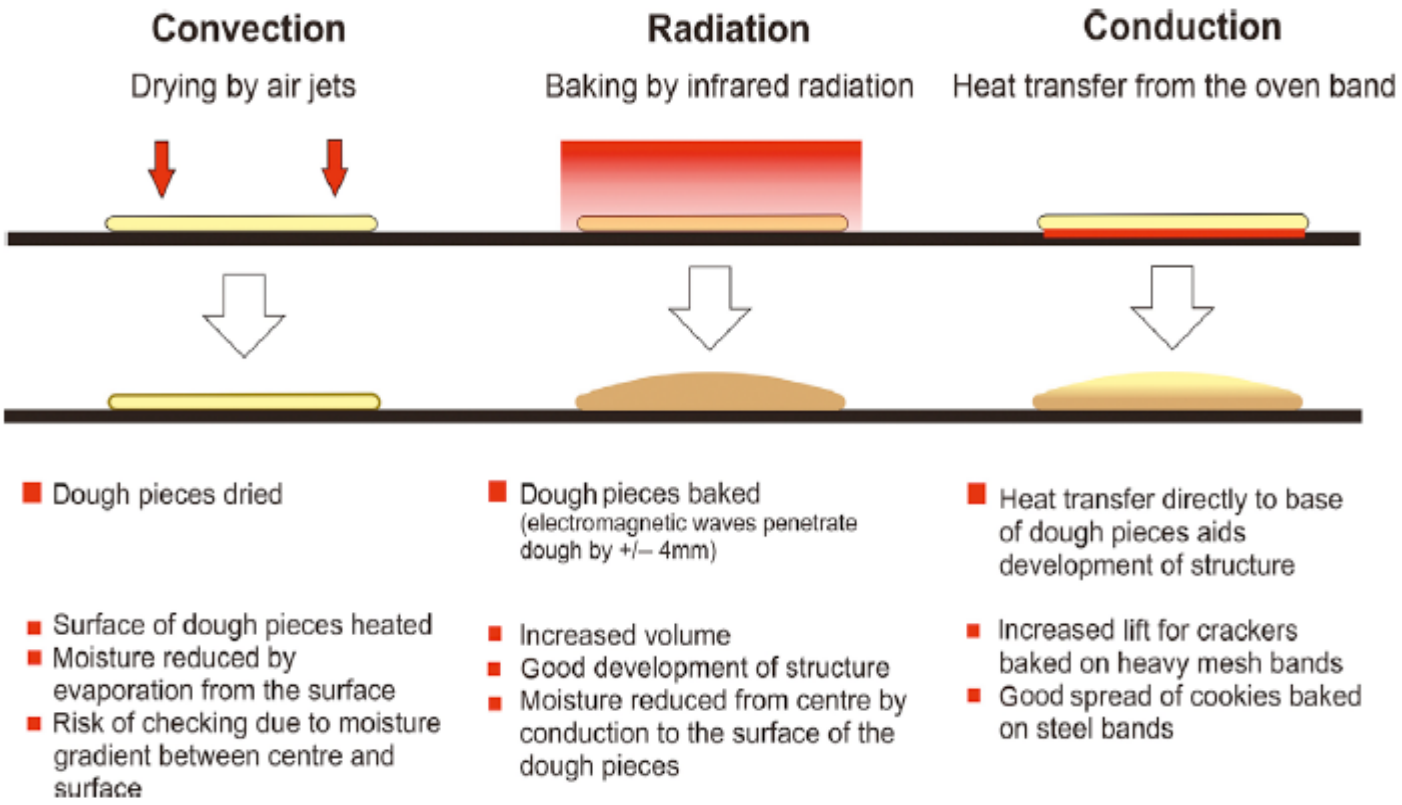


Figure 4.12 Summary of the effects of the modes of heat transfer.

Source: DAVIDSON, I. Biscuit Baking Technology. 2nd Edition, 2016.

QUALITY PARAMETERS AND CONSUMER'S ACCEPTABILITY

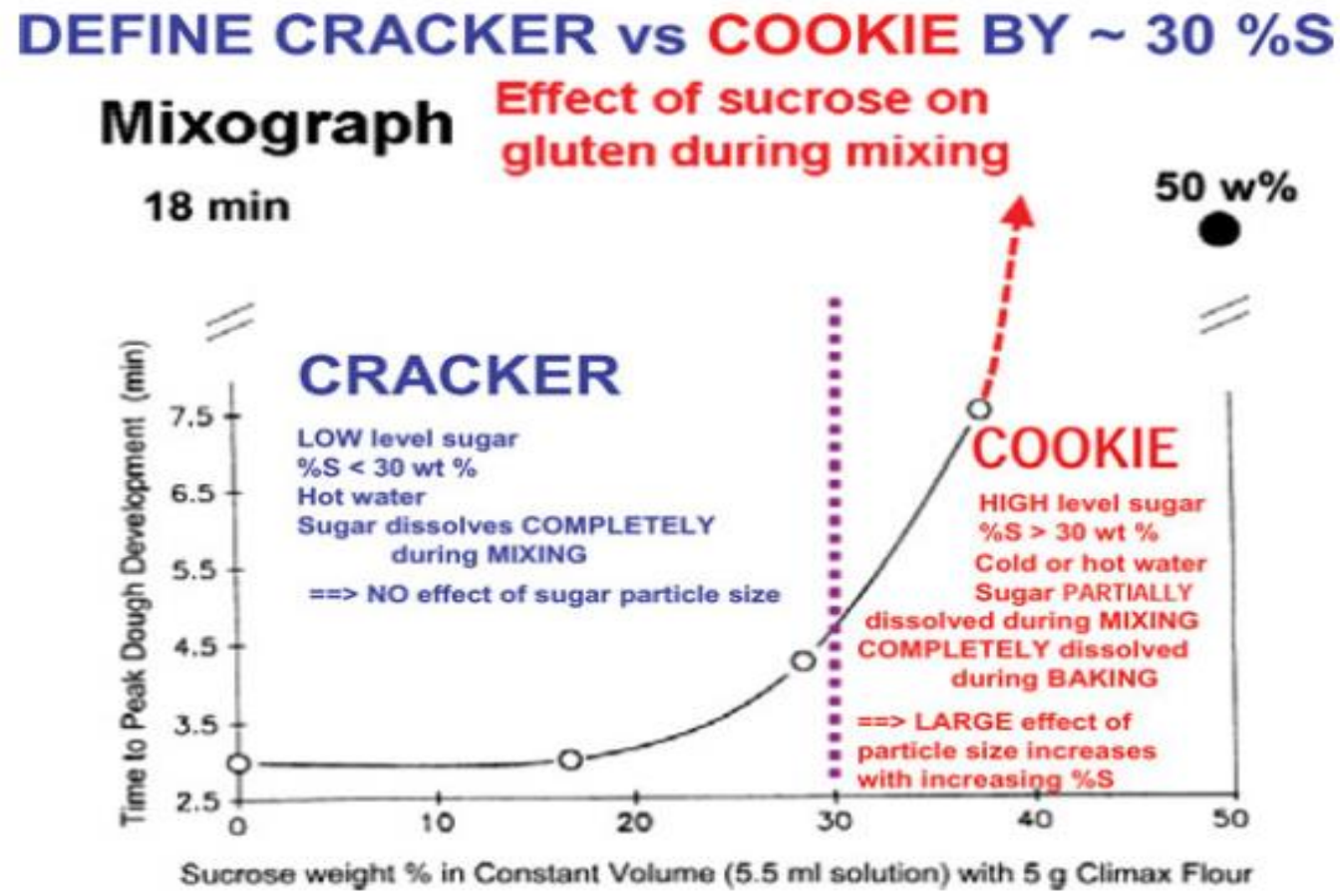
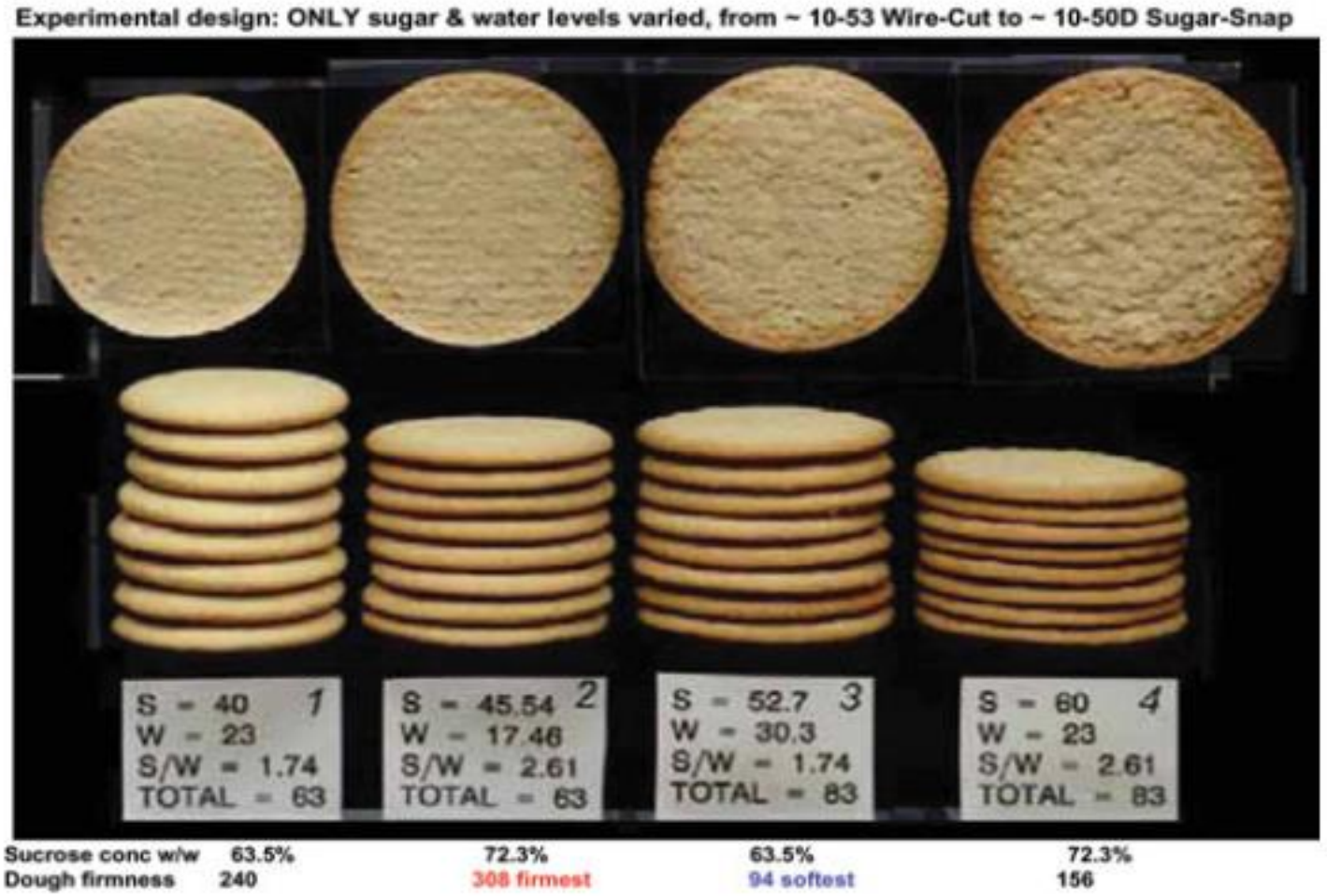


Figure 5 Mixograph results, as a function of sucrose concentration in model doughs, revealing distinctions between cracker- versus cookie-making (Slade et al., 2006). (Color figure available online.)

QUALITY PARAMETERS AND CONSUMER'S ACCEPTABILITY

(A)



QUALITY PARAMETERS AND CONSUMER'S ACCEPTABILITY

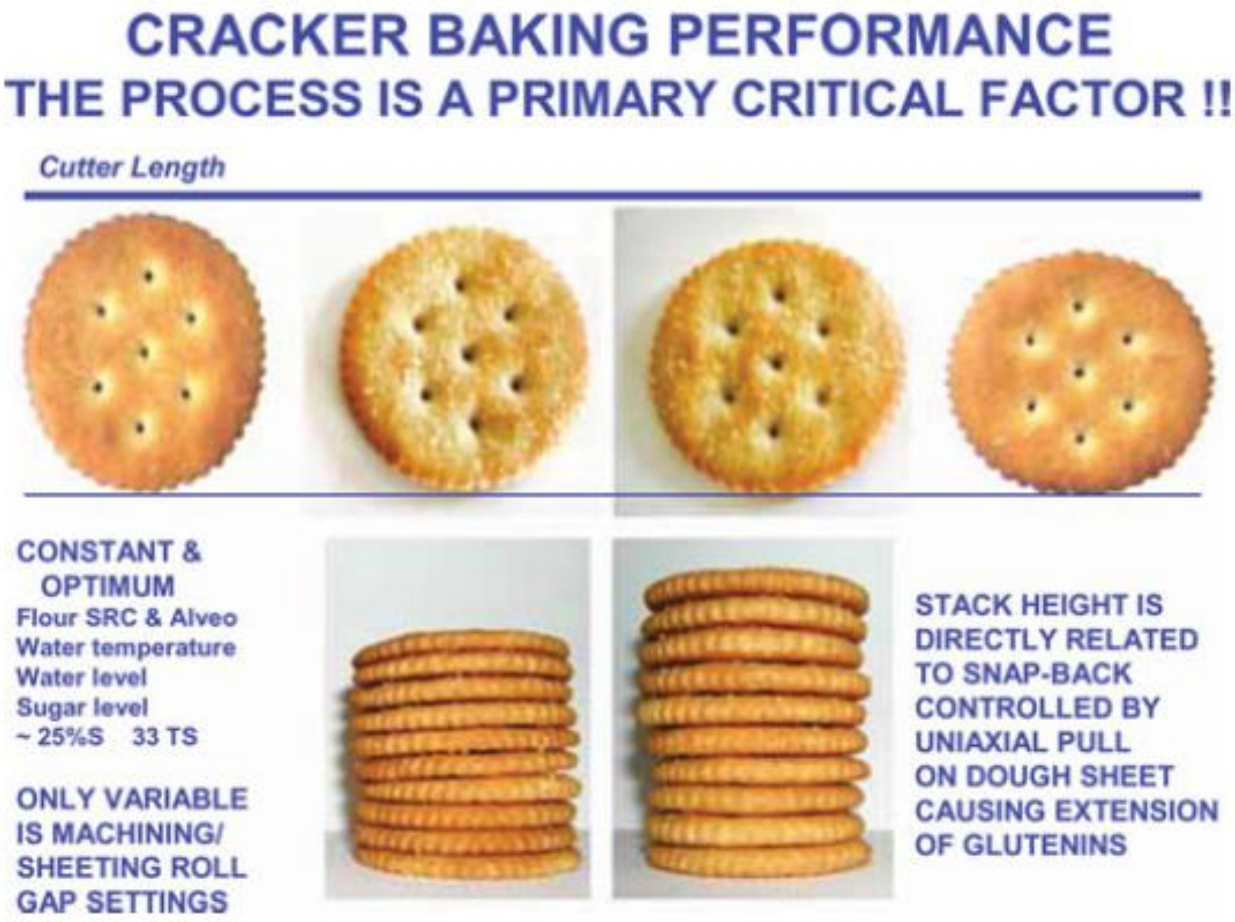
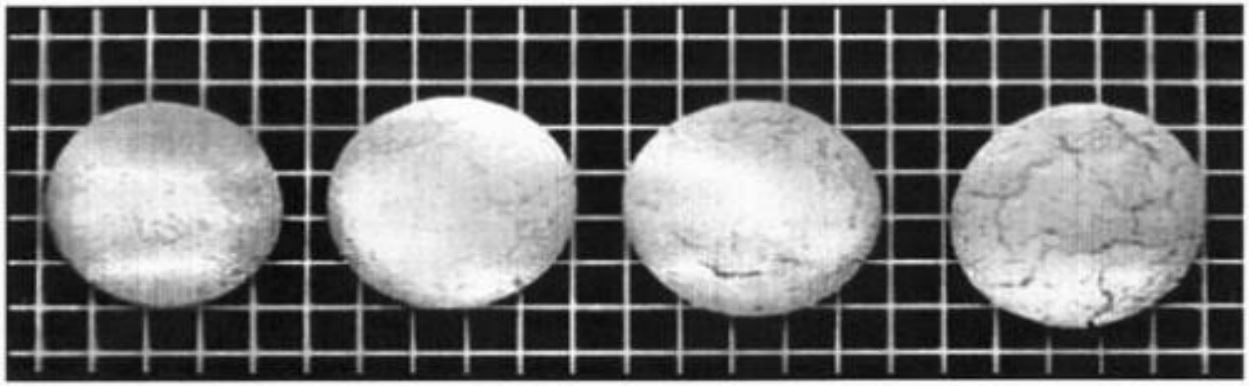


Figure 9 Cracker-baking results illustrating the primary importance of processing (in particular, dough-machining) on baking performance (Slade et al., 2006). (Color figure available online.)

QUALITY PARAMETERS AND CONSUMER'S ACCEPTABILITY

COLLAPSE AND SURFACE CRACK



Comparison of cookies with different levels of sodium bicarbonate (lb per flour cwt) using a constant level of acid in the formula to generate corresponding extents of vertical expansion during baking, in order to demonstrate that the cause of cookie surface crack is COLLAPSE, not sugar recrystallization nor surface drying.

Figure 12 Leavening agents such as sodium bicarbonate contribute to cookie collapse and surface-crack formation during baking (Slade et al., 2006). (Color figure available online.)

QUALITY PARAMETERS AND CONSUMER'S ACCEPTABILITY

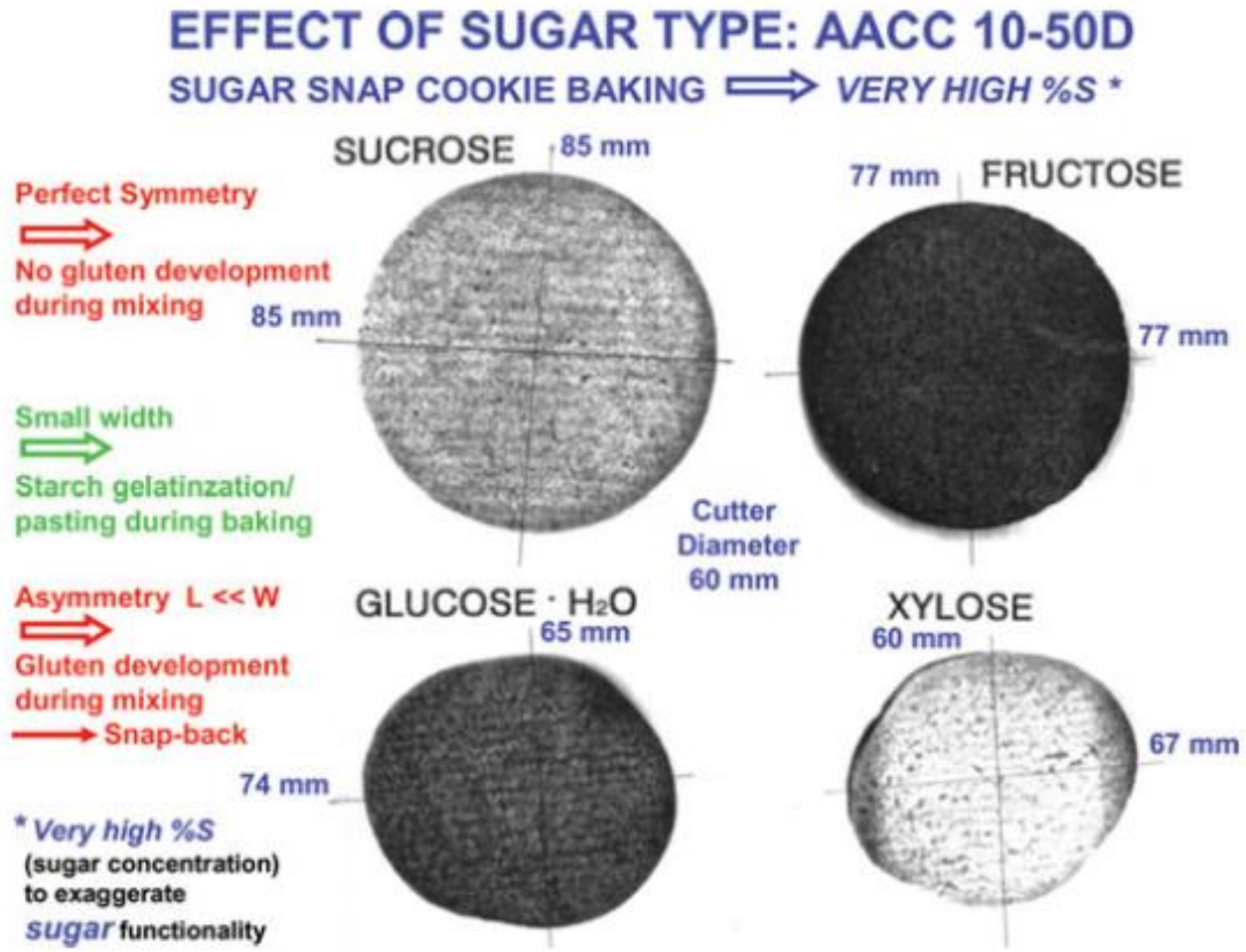


Figure 13 Effects of sugar type on sugar-snap cookie baking (Slade et al., 2006). (Color figure available online.)

QUALITY PARAMETERS AND CONSUMER'S ACCEPTABILITY

Figure 15 Effect of sucrose particle size on cookie-baking performance (Slade et al., 2006). (Color figure available online.)

QUALITY PARAMETERS AND CONSUMER'S ACCEPTABILITY

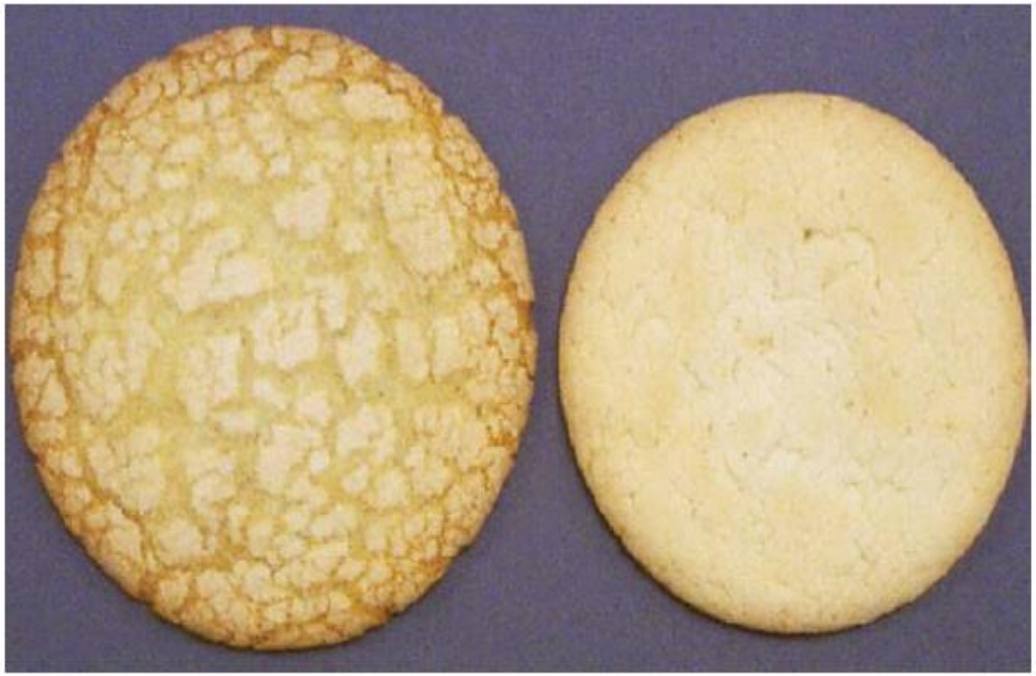


Figure 4 Cookies baked from soft (left) and hard (right) wheats which differ only in their *Hardness* gene. Near-isogenic soft (*Ha*) and hard (*ha*) wheat lines were milled and their flours baked using a standard AACC cookie formula.

QUALITY PARAMETERS AND CONSUMER'S ACCEPTABILITY

Taking the biscuit: Consumers more sensitive to sugar reductions than fat

By Nicola Cottam, 03-Jun-2014
Last updated on 05-Jun-2014 at 08:42 GMT

Fat perception is more complex than sweetness, say researchers

ELSEVIER

Food Quality and Preference
Volume 35, July 2014, Pages 41-47

The impact of sugar and fat reduction on perception and liking of biscuits

Coralie Biguzzi, Pascal Schlich, Christine Lange

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Highlights

- In commercial biscuits, fat reduction is less noticeable than sugar reduction.
- Fat reduction may induce a reduction in sweetness perception.
- Fat or sugar-reduced biscuits perceived as less sweet are less liked than normal ones.
- Fat-reduced biscuits only perceived as less fatty are equally liked as normal ones.