Breadmaking 1 – The Science of Breadmaking

BAKING INDUSTRY RESEARCH TRUST

> INFORMATION SHEET

The main breadmaking processes used in New Zealand are mechanical dough development (MDD), bulk fermentation (BF) and no-time doughs.

Dough made by any process must be:

- extensible enough for it to relax and to expand while it is rising
- elastic enough to have the strength to hold the gases produced while rising
- stable enough to hold its shape and cell structure.

INGREDIENTS

INGREDIENT	**FUNCTION & SPECIFICATIONS** (*based on flour content)
Flour	Flour is needed for structure. Two proteins present in flour, gliadin and glutenin, form gluten when mixed with water. Gluten is necessary for bread making and influences the mixing, kneading and baking properties of dough. Wheat starch also plays an important role in providing structure when it gelatinises during baking in the oven. Bread making flour is made from a semi-hard wheat with a medium to high protein content.
Water	Water hydrates the dry ingredients. It combines with flour to form gluten and it also acts as a solvent or dispersing agent for other ingredients such as salt and sugar. Water is needed for the gelatinisation of starch during the baking process. The proportion of water used in relation to flour, called water absorption, controls the rheological properties of the dough, for example, extensibility and stickiness. Water also controls the finished dough temperature.
Yeast	Leavens the dough by producing carbon dioxide gas. Alcohol, acids and energy generation are other by products of yeast fermentation and these condition the flour and add flavour to the final product. Average level of yeast in bread is 2–5%*.
Salt	Aids flavour, helps to control fermentation, toughens gluten. Usually added 1.75–2.25%*.
Conditioning agents	For example, dough conditioners such as ascorbic acid (an oxidising agent) to strengthen gluten proteins.
Sugar	In New Zealand, sugar is added purely to be used in the fermentation process, with residual sugars left to enhance flavour. Only traces of sugars (1–3%) are left in the finished product.
Vegetable oil	Canola oil is the usual choice and its purpose is to act as a lubricant for cell expansion in the dough, making a finer crumb structure, smoother texture and greater volume in the finished product. Dependent on the bread type, it is used at 2–3%*.
Milk solids	Various types including non-fat dry milk, whey and soy/whey blends. Assist with crust colour, flavour, improved dough handling.
Mould inhibitors	Slow mould growth and extend the shelf life of the bread. Examples include calcium propionate and vinegar.

Examples of other ingredients that may be included dependent on the type of bread include vital wheat gluten, malt, enzymes and soy flour.

PROCESSING

PROCESS	**DETAILS**
Mixing	There are two main functions. Firstly, to evenly distribute the ingredients and secondly, to allow the gluten to develop, providing the structure for the bread. Each dough has an optimum mixing time, depending on the flour and mixing method used. Over-mixing produces a dough that is very extensible with reduced elastic properties, while undermixing will produce a loaf of bread with poor crumb texture.
Fermentation	After mixing the bread is left to rise, known as fermentation, and a number of things happen: • The dough changes from a rough dense mass lacking extensibility with poor gas holding properties, into a smooth, extensible dough with good gas holding properties. • The yeast cells grow. • The gluten protein pieces form networks. • Alcohol and carbon dioxide are formed from the breakdown of carbohydrates (starch, sugars) that are found naturally in the flour. • Yeast breaks sugar down into carbon dioxide and water. Enzymes in yeast and flour also help to speed up this reaction. The energy which is released is used by the yeast for growth and activity.

	• In a bread dough where the oxygen supply is limited, the yeast can only partially break down the sugar. Alcohol and carbon dioxide are produced in this process known as alcoholic fermentation. The carbon dioxide produced in these reactions causes the dough to rise (ferment or prove), and the alcohol produced mostly evaporates from the dough during the baking process. During fermentation each yeast cell forms a centre around which carbon dioxide bubbles form. Thousands of tiny bubbles, each surrounded by a thin film of gluten, form cells inside the dough piece. The increase in dough size occurs as these cells fill with gas. Examples of other ingredients that may be included dependent on the type of bread include vital wheat gluten, malt, enzymes and soy flour.
Kneading	Any large gas holes that may have formed during rising are released by kneading and both gas bubbles and temperature become more even. The dough is then allowed to rise again and is kneaded if required by the particular production process being used.
Rising	During the final rising the dough again fills with more bubbles of gas, and then the dough is baked in the oven. Before being left to rise, the internal structure is made up of large gas holes lined with gluten with smaller holes and ingredients in between these. After 2 hours rising gluten strands form a lattice as the dough reaches the required size.
Baking	The baking process transforms an unpalatable dough into a light, easily digestible, porous flavourful product. As the intense oven heat penetrates the dough the gases inside the dough expand, rapidly increasing the size of the dough. This is called “ovenspring” and is caused by a series of reactions: Gas + heat = increased volume or increased pressure. Gas pressure inside the thousands of tiny gas cells increases with the heat and the cells become bigger. 1. Carbon dioxide produced by the yeast is present in solution in the dough. As the dough temperature rises to 40°C, this carbon dioxide turns into a gas, and moves into existing gas cells to expand them. 2. The oven heat changes liquids into gases by the process of evaporation and so the alcohol evaporates. Heat also has an effect on the rate of yeast activity. As the temperature rises the rate of fermentation increases, and so does the production of gas cells, until the dough reaches the temperature at which yeast dies (approximately 46°C). The extra sugars produced between 46–75°C are then available to sweeten the breadcrumb and produce the attractive brown crust colour. Stabilisation of the crumb begins as the starch granules swell at about 60°C, and in the presence of water are released from the gluten. The outer wall of the starch granule cell bursts and the starch inside forms a thick gel-like paste that helps form the structure of the dough. From 74°C upwards the gluten strands surrounding the individual gas cells are transformed into the semi-rigid structure associated with bread crumb strength. The natural enzymes present in the dough die at different temperatures during baking. One important enzyme, alphaamylase, continues to break starch into sugars until the temperature reaches 75°C. The loaf is not completely baked until an internal temperature of 98°C is reached. Steam is produced because the loaf surface reaches 100°C+ and as the moisture is driven off, the crust heats up and eventually reaches the same temperature as the oven. Sugars and other products, some formed by breakdown of proteins, blend to form the attractive colour of the crust, through “browning” reactions which occur very quickly above 160°C.
Cooling - slicing & wrapping	In bakeries bread is cooled quickly when it leaves the oven. The crust temperature is over 200°C with an internal crumb temperature of approximately 98°C. The loaf is full of steam which also must be given time to evaporate. The whole loaf is cooled to approximately 35°C before slicing and wrapping can occur without damaging the loaf.

REFERENCES

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