Summary & PowerPoint

Getting Smart with Lipases in Baked Goods

Bread (dough) Improvers are commonly added to overcome deficiencies in bread making quality of flour. Exogenous lipases modify the natural flour lipids so they become better at stabilizing the dough. This ensures more stability when the dough is over-fermented, larger loaf volume, and significantly improved crumb structure. Lipases that have specificity towards non-polar lipids can break down dairy derived fats, releasing sharp smelling, short-chain fatty acids. While this may be desirable for cheese production, it is undesirable in baked goods. If the baked good contains a significant amount of butter or milk fat, it can take on a putrid odor if such lipases are used in the recipe. This presentation will cover chemistry of different types of lipases and how they will affect the flavor and amount of short chain fatty acid during storage. The attendees will learn how to match a lipase to a baked good to obtain dough strength and bread volume without undesirable off-flavor.

Learning Objectives

- Lipase chemistry, how they work
- How to match a lipase to a baked good
- A new lipase can overcome off-flavor

Presenter
Austin Dilek, Novozymes

Presentation Time
Monday, February 25, 2019
2:50 pm - 3:25 pm

Session
Breakout 2

GETTING SMART with LIPASES

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Novozymes North America Inc.

ASB19, February 25, 2019, Chicago IL

Rethink Tomorrow

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Agenda

Enzymes 101

Lipases in baking

- Functions

- **An introduction to NEW LIPASE**

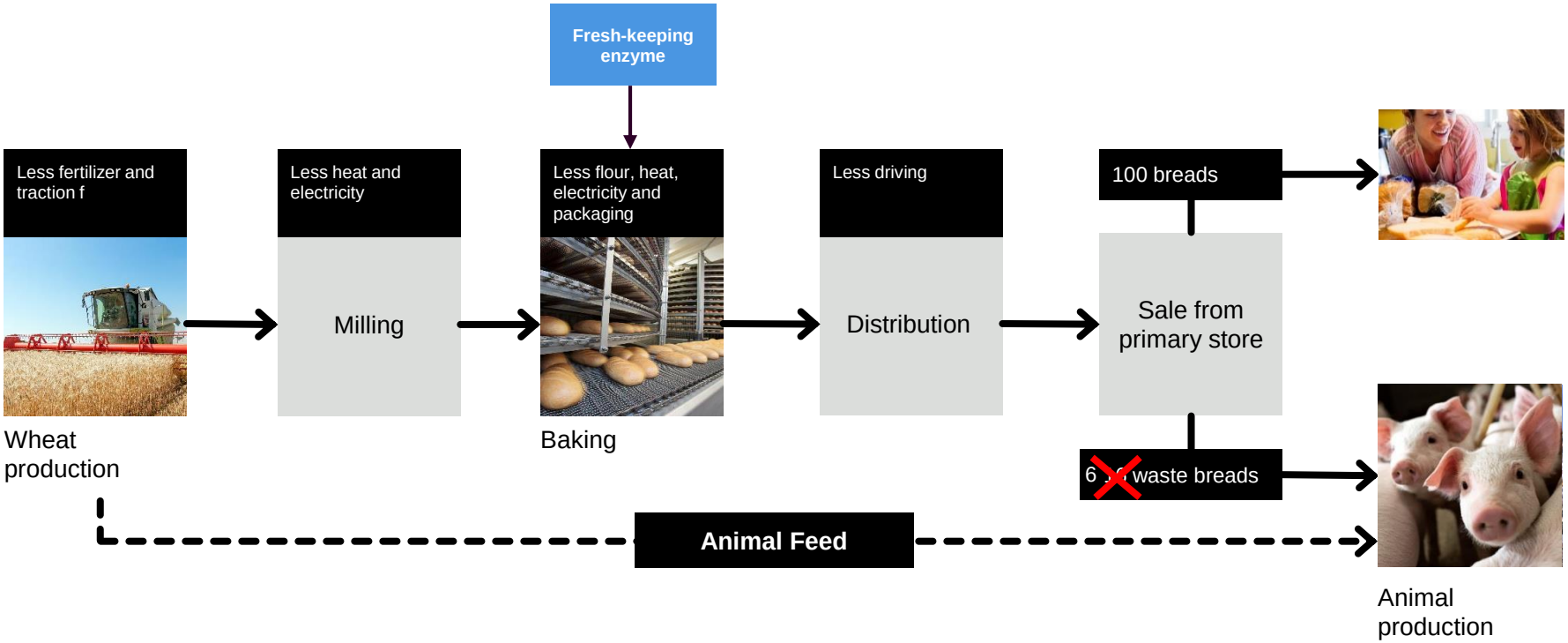
Wrap up

Challenges with growing population

10 Billion

Estimated population by 2050

A fresh keeping enzyme changed the industrial baking



Enzymes are found in nature

Example: Laundry with cold-water wash

A rare microorganism that express enzyme which is active in cold found in stalagmite column

These novel enzymes enable…

… cold-water wash

… significant savings of energy, CO_2 and money

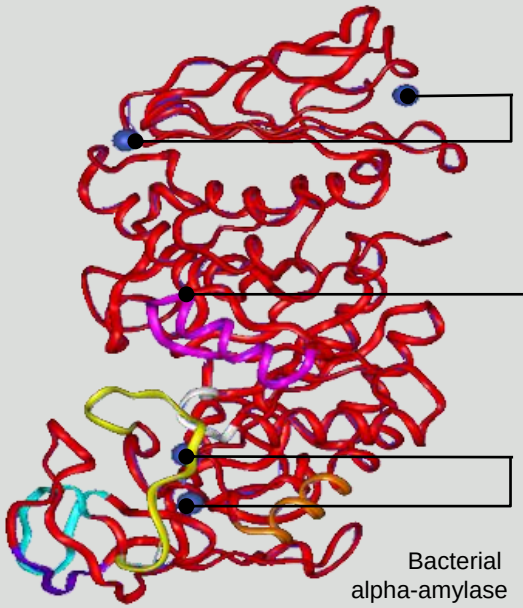
Underwater stalagmite columns

Ikka Bay region of Greenland

novozymes

Structure and functionality

Most enzymes are globular proteins



Calcium ions

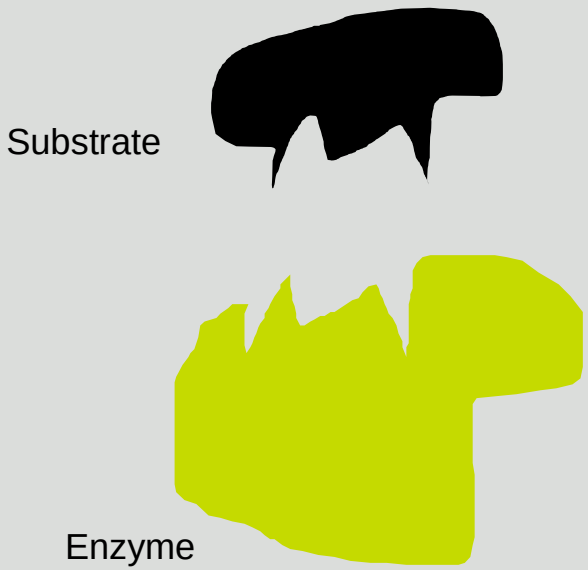
Active site

Region that contains catalytic residues

Calcium ions

Bacterial alpha-amylase

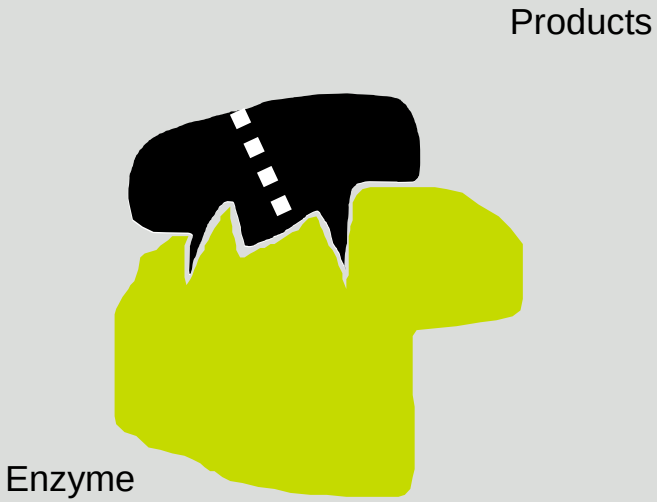
Enzymatic catalysis



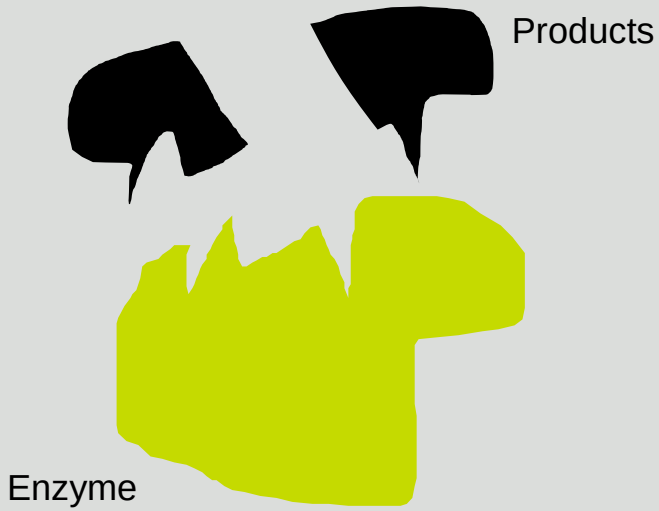
Enzymatic catalysis

Enzyme-substrate complex
(transition state)

Enzymatic catalysis

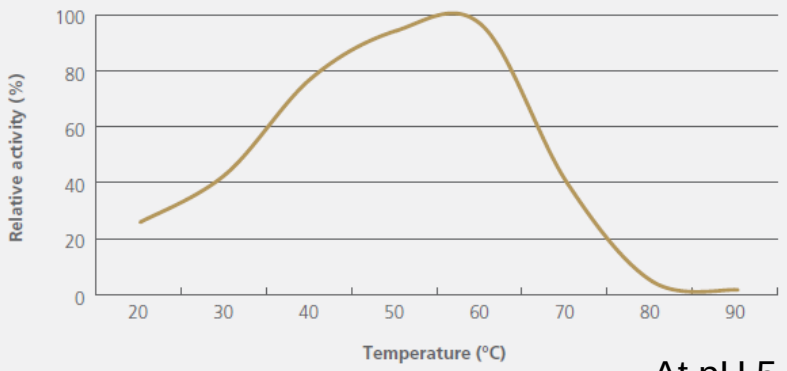


Enzymatic catalysis



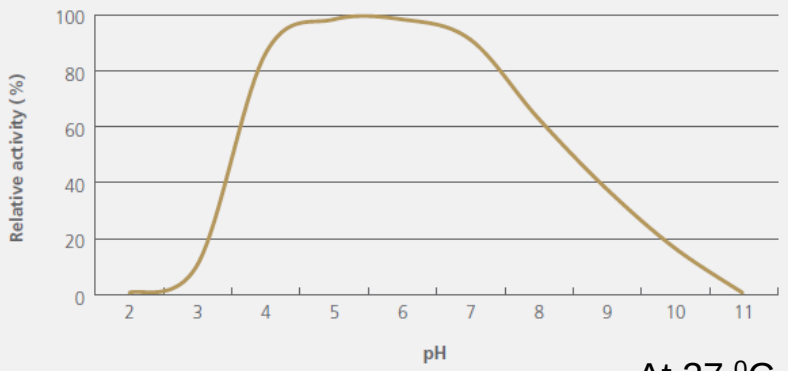
Enzymes work in a range

Temperature effect on the enzyme activity



At pH 5.0

pH effect on the enzyme activity



At 37 ^{0}C

Enzyme dosage, Substrate availability, Inhibitors also important

What are the wants?

Consumers want a bread with

- nice and even bloom
- good shape and volume
- less additives

The industry wants a dough that is

- robust
- easy to handle
- good machinability
- right balance between elasticity and extensibility

Benefits of lipases

Optimal dough strengthening effects

Higher mixing and fermentation tolerance

Appealing bread appearance and size

Improved volume as well as a finer and more regular crumb appearance, sliceability

Clean label

1 kg can replace 100 to 1,000 kg of traditional emulsifiers which leads to a cleaner label and an improved carbon footprint

A NEW LIPASE

Highest tolerance towards short fatty acid chains which leads to a broader usage in application including recipes containing butter

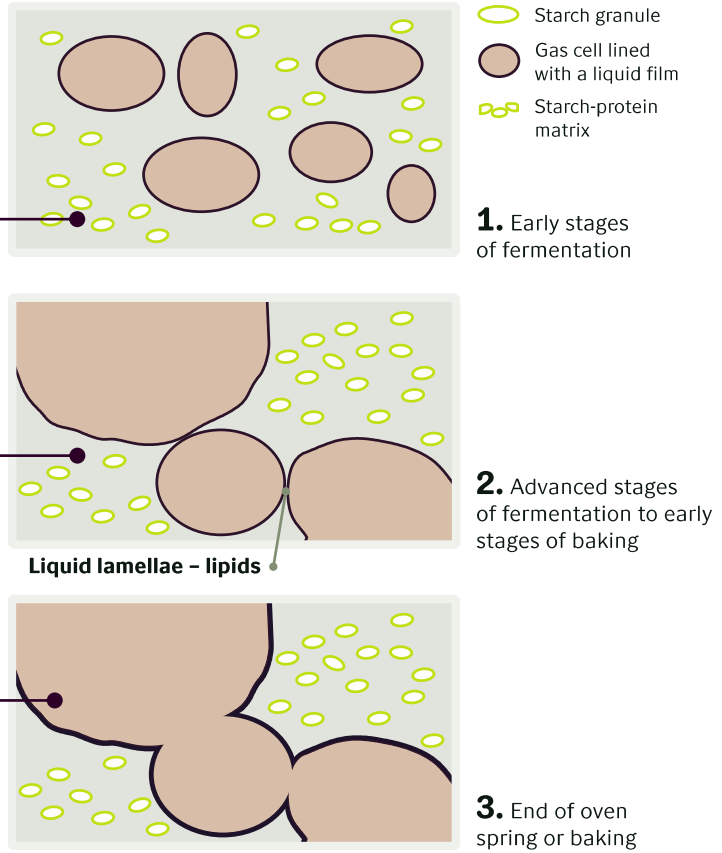
Volume increase during baking
Stages of gas cells

Dough consists of discrete gas cells lined with liquid films, embedded in starch-protein matrix

After fermentation, matrix does not completely enclose gas cells, leaving only liquid films

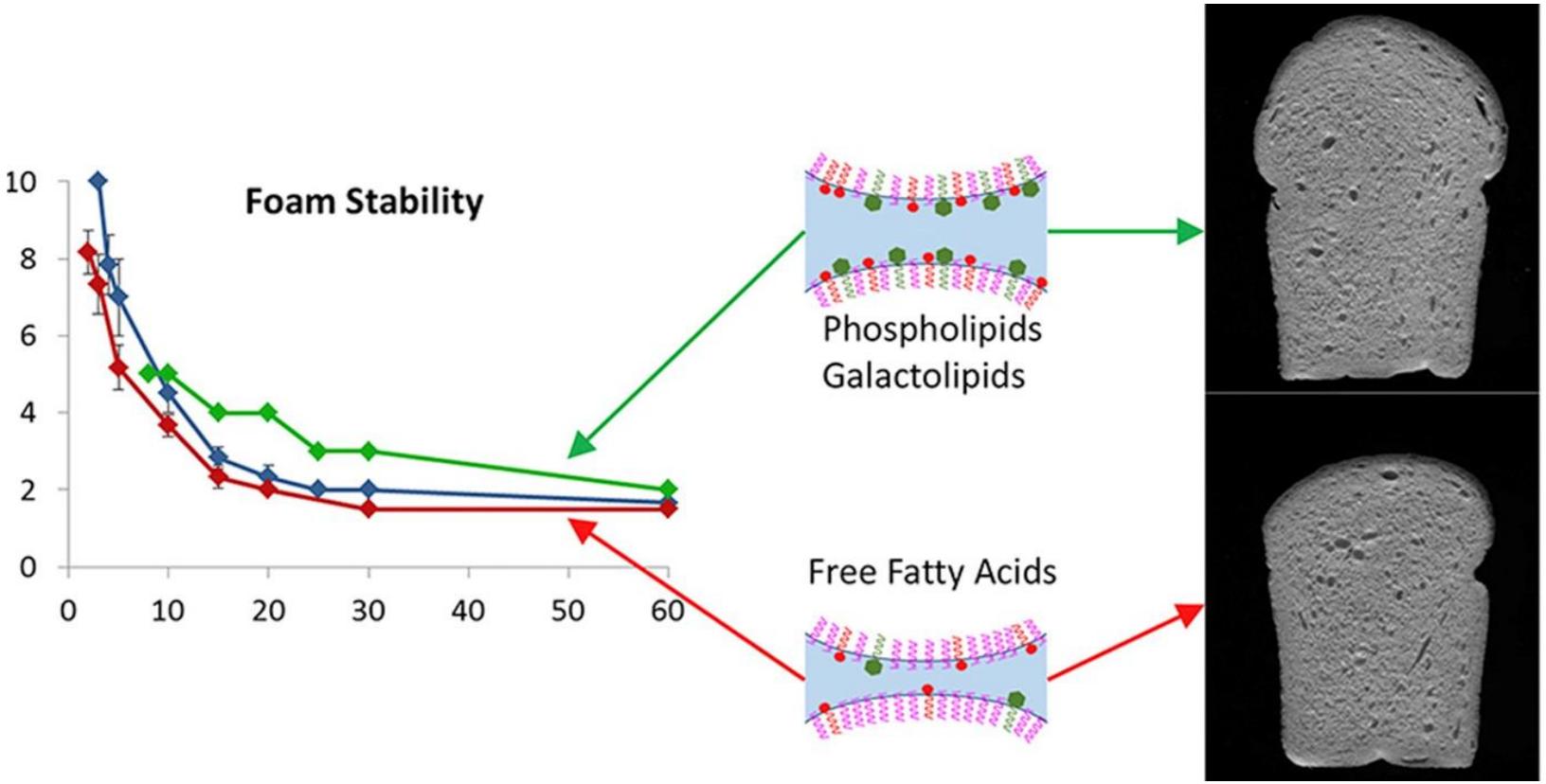
Baking increases expansion, film cannot meet demand of increased surface area – conversion to open sponge

Weaker film leads to more open bubbles and greater loss of gas retention



Modified from Gan, Z., Ellis, P.R. and Schofield, J.D. (1995)

During proving, gas bubble stability depends on the types of lipids adsorbed at the air-water interface



- Both proteins and lipids are active at the air-water interface, but is dominated by lipids.
- **FFAs are detrimental to foam stability therefore loaf volume, while polar lipids improve foam stability and the volume.**

- **Lipases modify naturally occurring nonpolar and polar lipids** in wheat flour, such as triglycerides, lecithin, and digalactocyl diglycerides (DGDG).

  The resulting lipids have improved emulsifying properties

- They can also work in synergy when combined with other enzymes.

Lipase fact sheet

Lipases catalyzes the hydrolysis of fats and oils in the presence of water.

Acts on wheat flour lipids, egg lipids, fats and oils in baked goods

Specificity against polar and non-polar lipids: polar and non-polar lipases

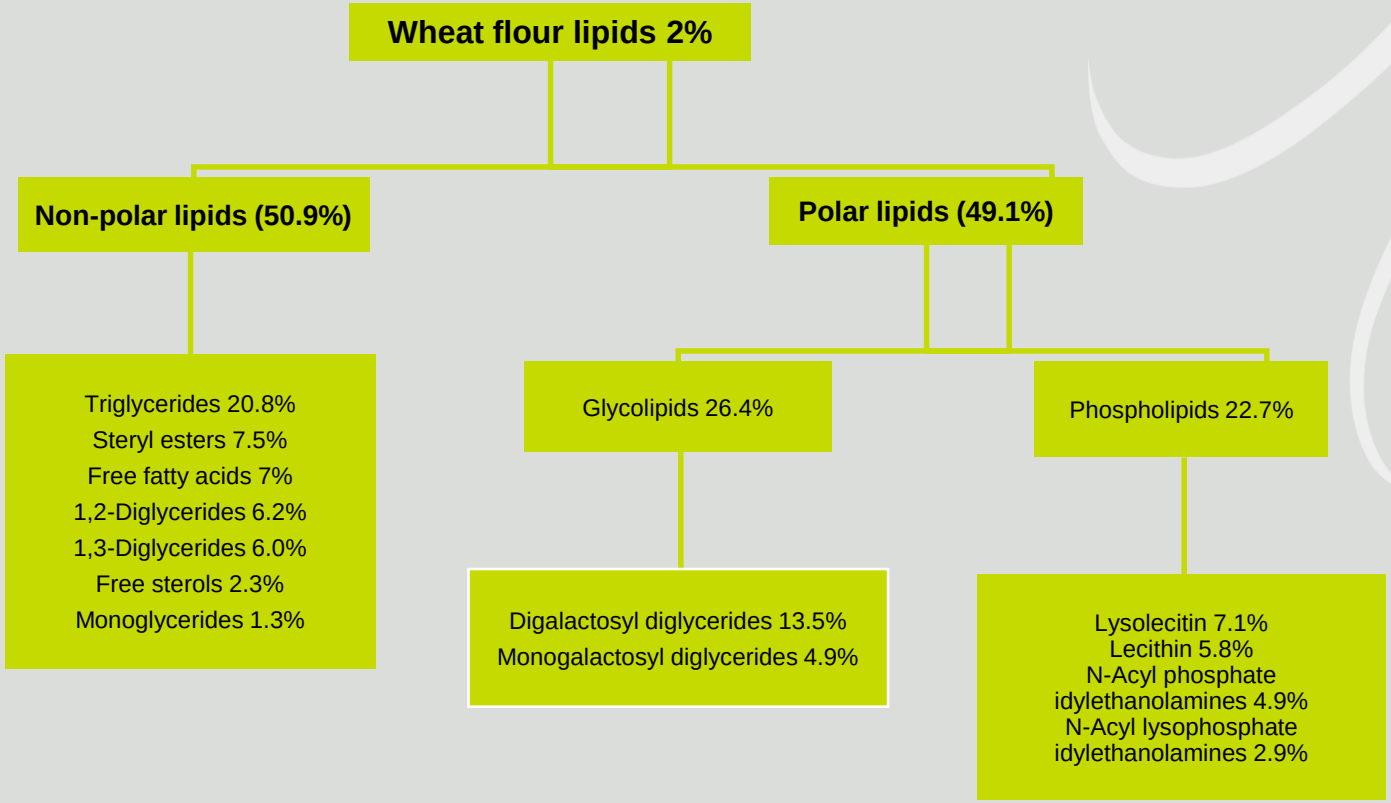
Works in the bowl, inactivated in the oven

Dough strengthening: ↑ loaf volume, apperance, crumb structure

↓ loss during slicing

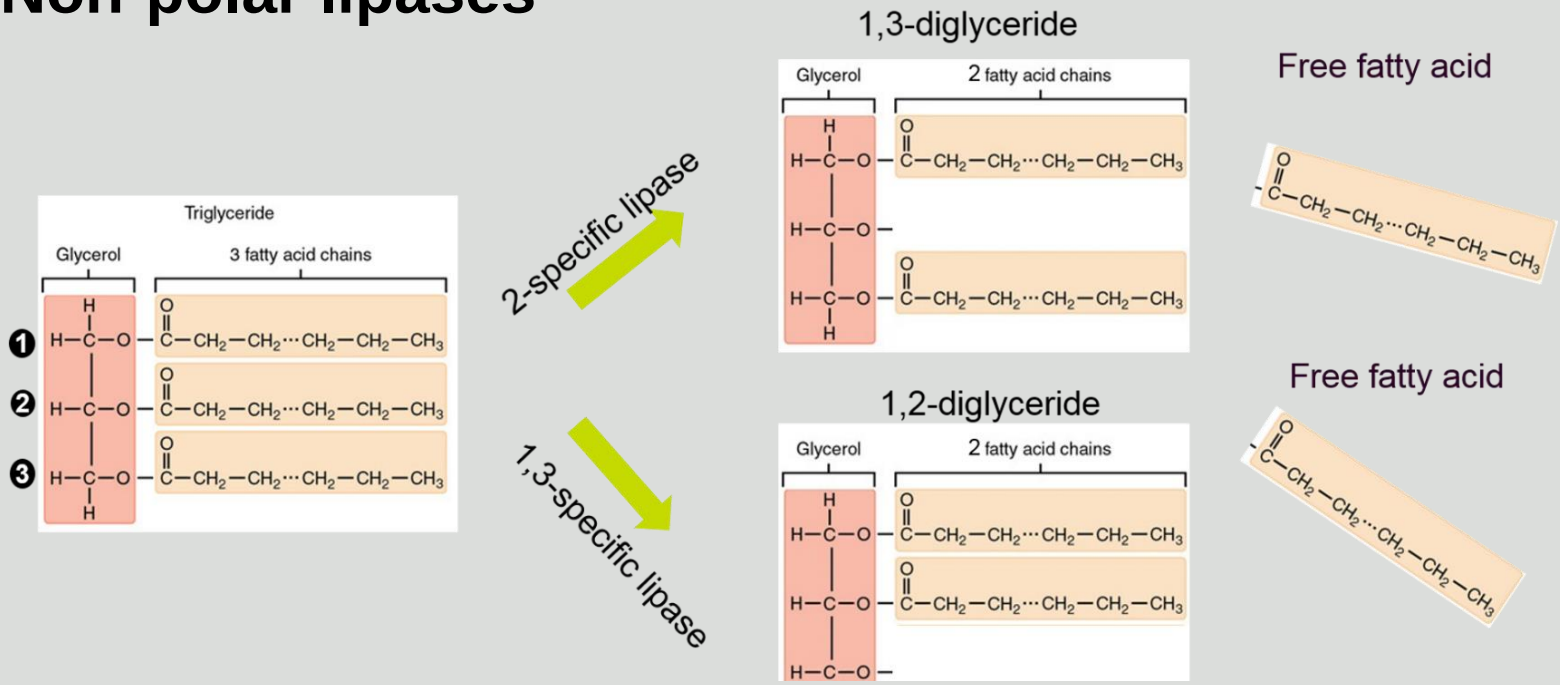
MIGHT give off-flavor solid fat including formulas

Lipids in wheat flour



Modified from Pomeranz, Y. (1987)

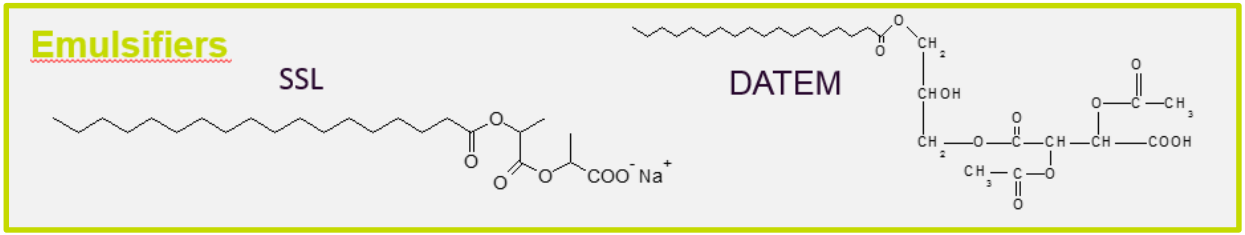
Specificity against polar and non-polar lipids
--Non-polar lipases

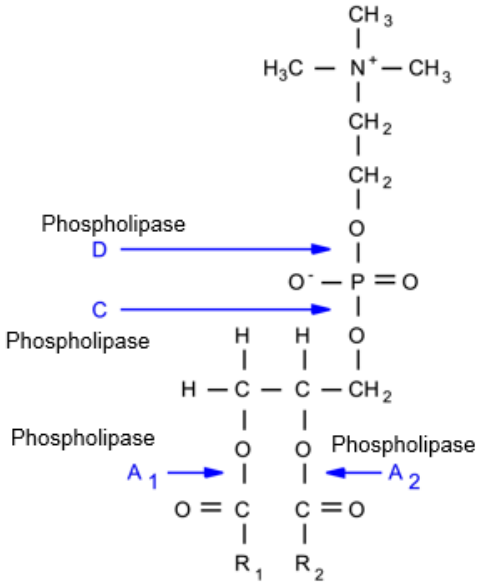


- Acts on butter, shortening with short chain fatty acid containing sources
- **Produces free fatty acids (FFA)**
- Small FFA can be volatile <300 kD; Active at low quantities (ppt-ppm)
- **Interact with receptors in the olfactory system (off-flavour)**

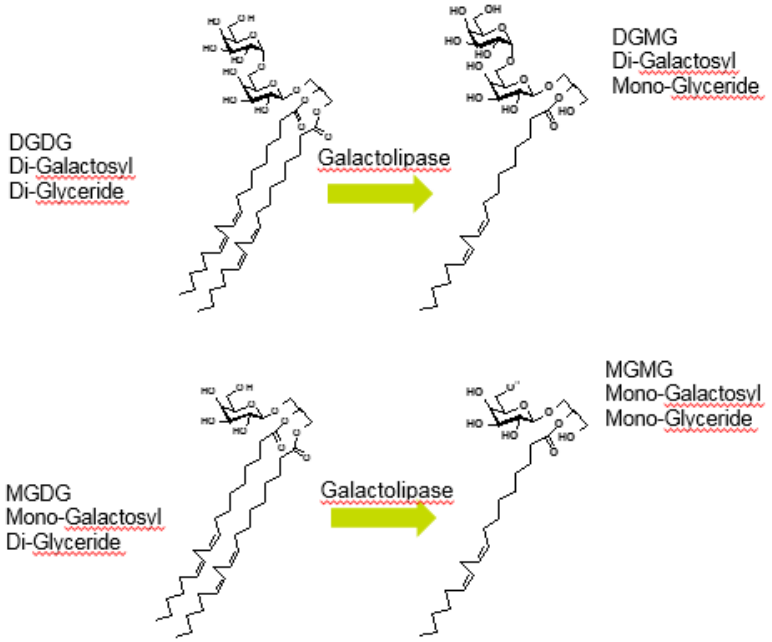
Specificity against polar and non-polar lipids:

--Polar lipases acts on phospholipids and galactolipids to produce emulsulfier-like structures



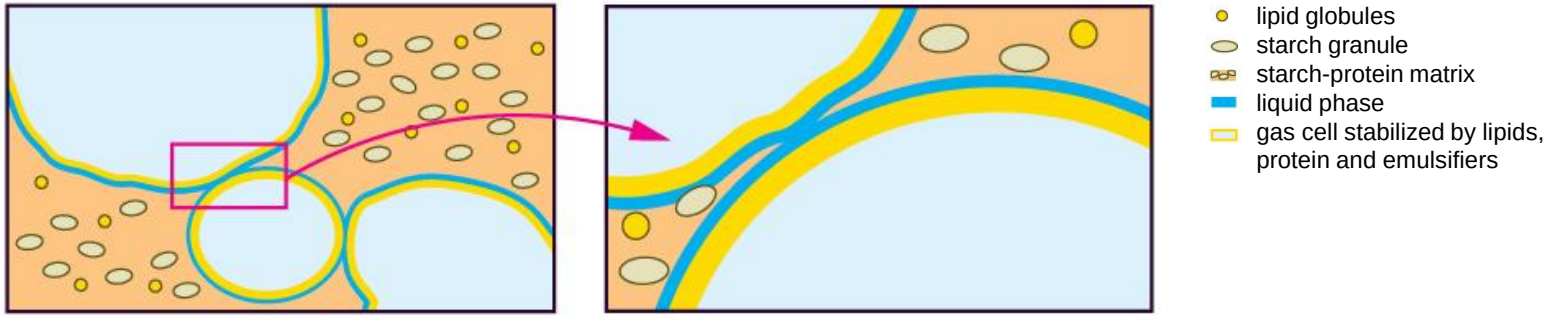


A polar lipase acts on a phospholipid



A polar lipase acts on a galactolipid

Mechanism of polar lipases
Stabilization of gas cells during baking



The conversion of polar flour lipids leads to an increased polarity and thus the emulsifying properties are improved

→

Due to these emulsifying properties the lipids can reduce the surface tension between the air and water phase leading to an improved foam stability

→

Through the improved stabilizing effect of the inherent polar lipids, **polar lipases lead to improved dough stability, larger bread volume and better crumb appearance**

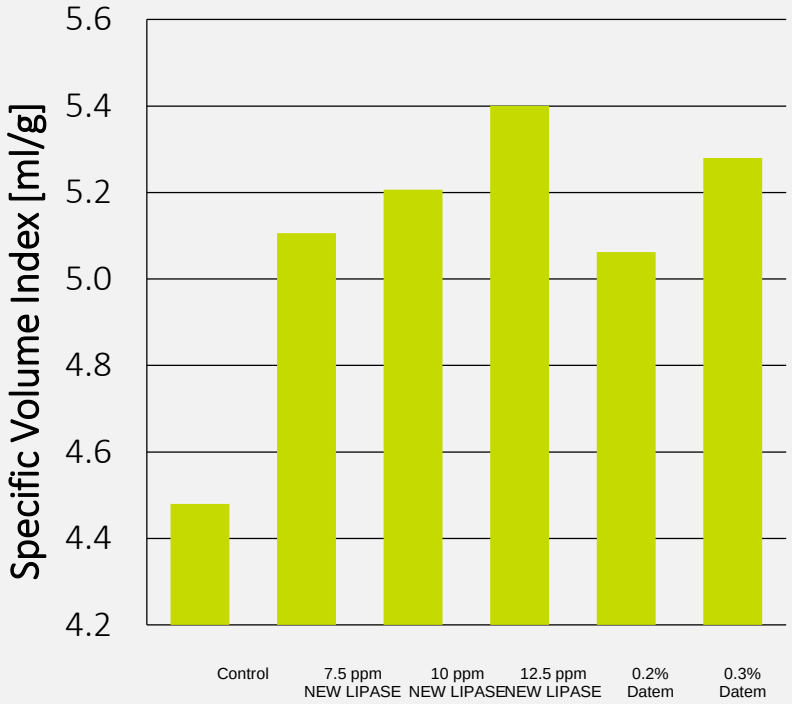
Modified from Gan, Z., Ellis, P.R. and Schofield, J.D. (1995)

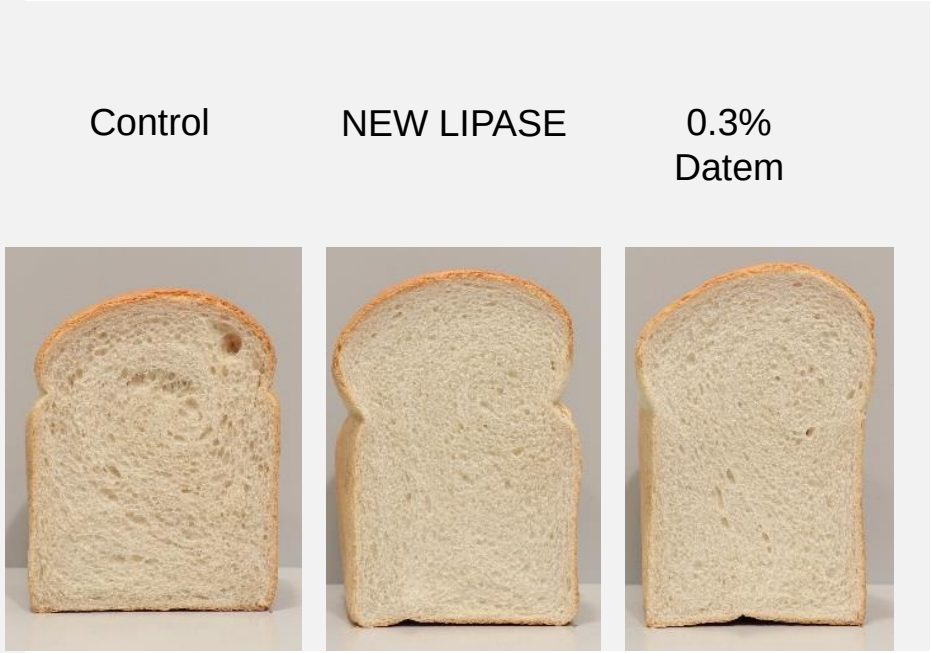
Benefits of lipases in in dough and baked goods

- Improved process tolerance in general (mixing and proofing stability), therefore easiness in handling and improved loaf volume and crumb structure
- Clean label compatible, can replace emulsulfiers depending on the recipe
- Production stability irrespective variations in flour quality

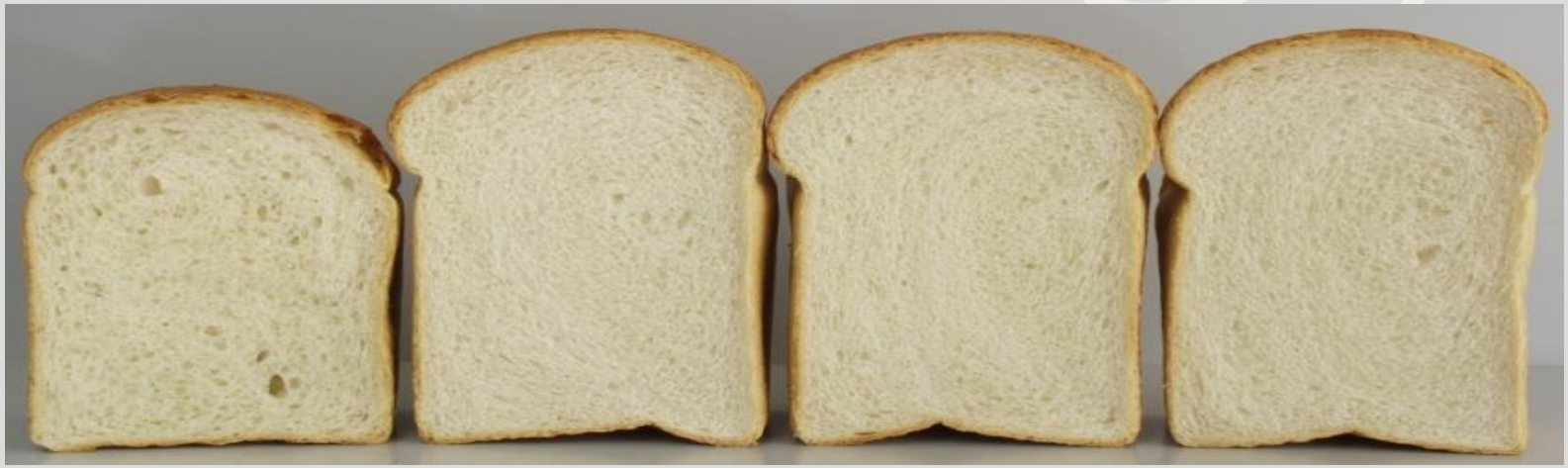
NEW LIPASE improves dough strength gives higher volume and better crumb structure similar to DATEM

(Diacetly tartaric acid ester of mono- and diglycerides, also E472e)



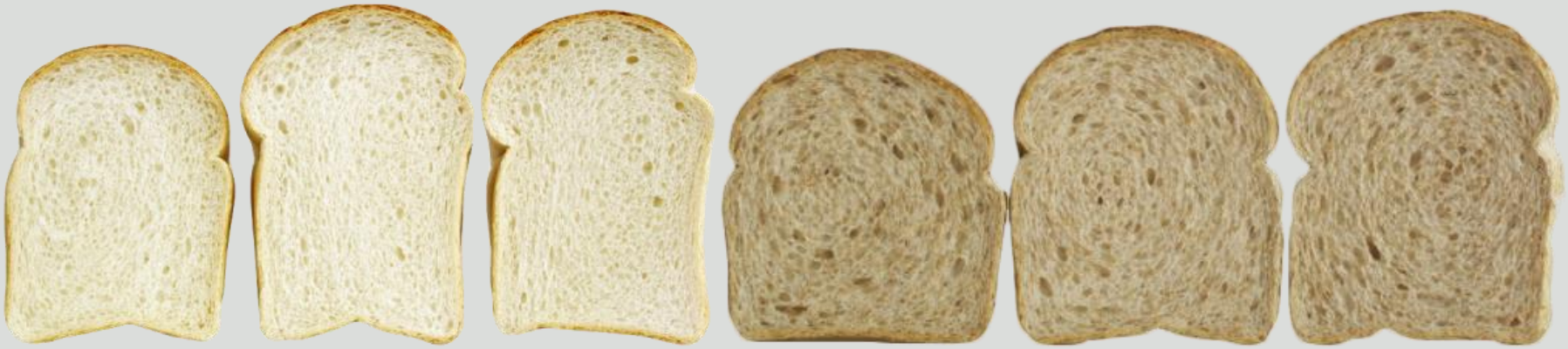


NEW LIPASE can eliminate DATEM and SSL (Sodium stearoyl lactylate) **in pan bread in high speed mixing process**



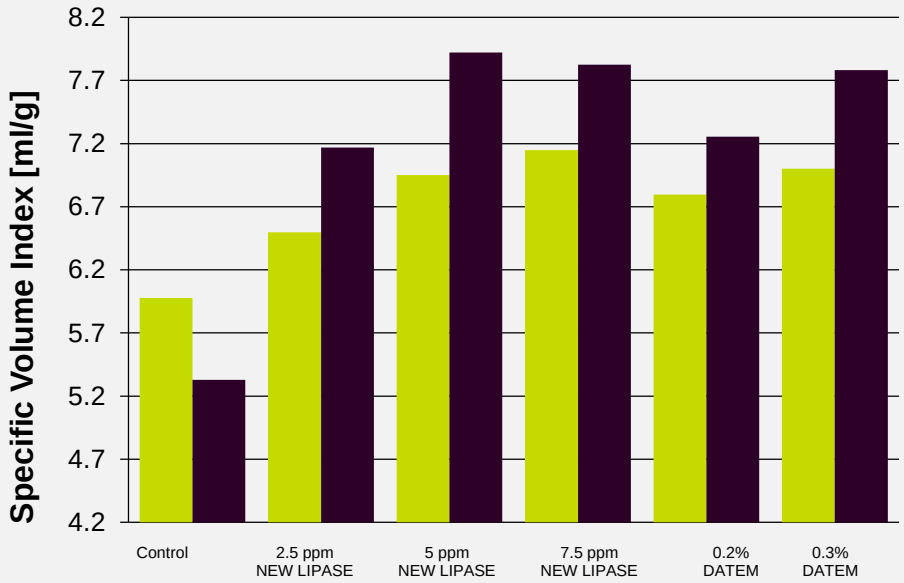
No lipase | 0.5% SSL | 0.4% DATEM | NEW LIPASE

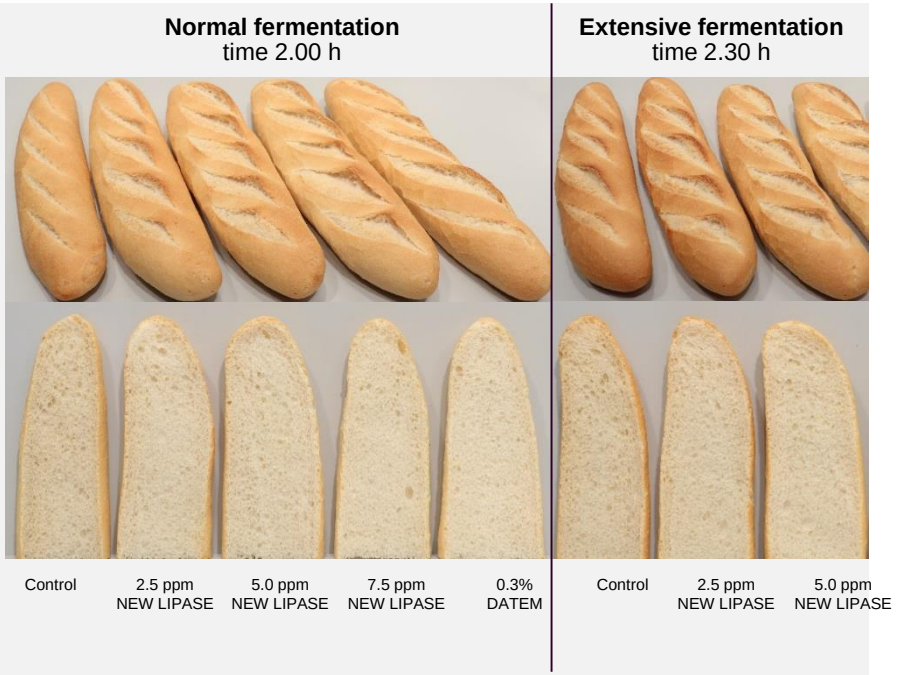
NEW LIPASE matches DATEM performance in white pan and whole meal bread



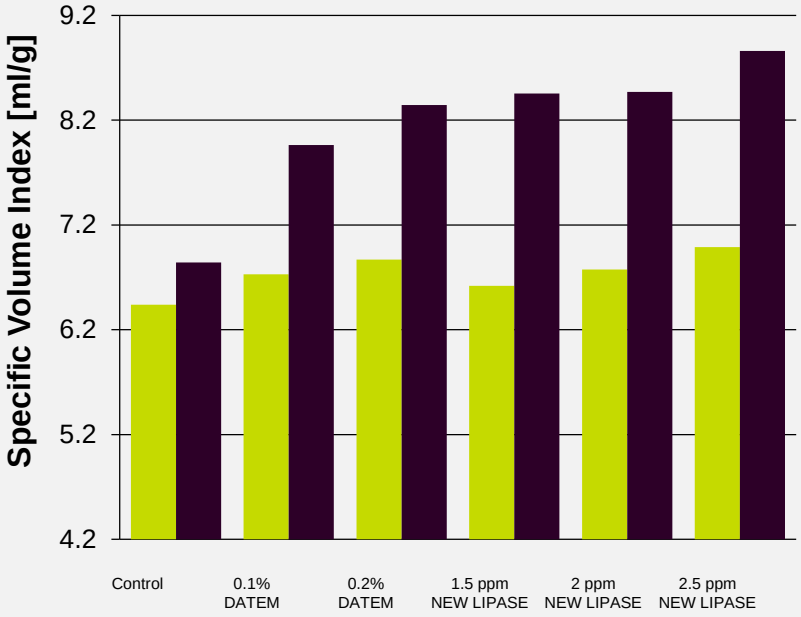
Control | 0.3% DATEM | NEW LIPASE | Control | 0.3% DATEM | NEW LIPASE

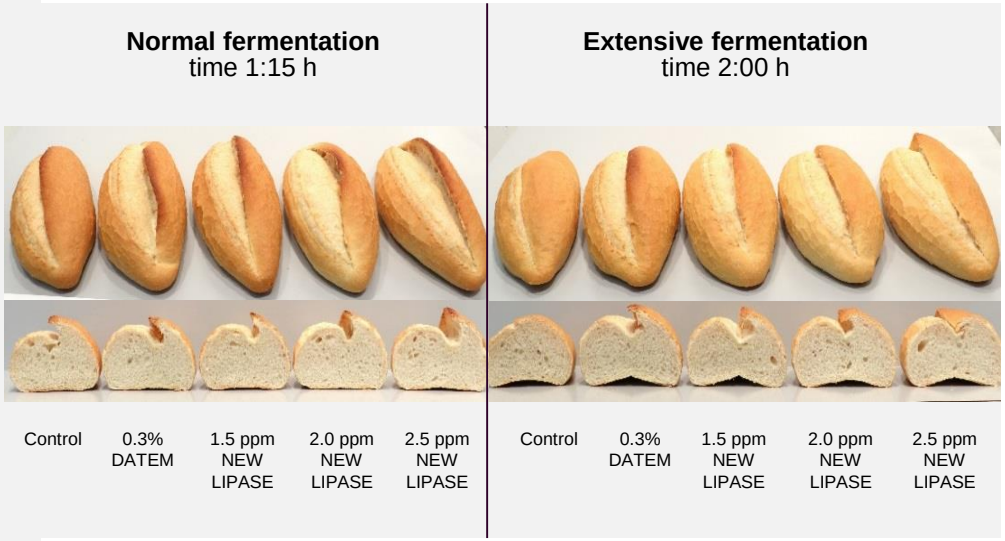
NEW LIPASE improves proofing tolerance, volume, bloom and crispiness in French baguette





NEW LIPASE gives better bloom after normal and extensive proofing time in crusty-style bread





Example of improved bread sliceability with a lipase

Control

A lipase

Bread sliced at a core temperature of 118-122 F (48–50°C); slice thickness 12.5 mm

Factors influencing sliceability: bread core temperature, speed of slicing, changes in recipe
All pictures shown are for illustration purpose only

Lipases and off-flavour

Flour, yeast, and Maillard reaction gives desirable flavor in bread.

Lipases that have specificity towards non-polar lipids break down dairy derived fats, releasing sharp smelling, short-chain fatty acids.

This is desirable for cheese production, **it is undesirable in baked goods.**

If the bread contains a significant amount of butter or milk fat, it can take on a putrid, vomit-like odor if such lipases are used in the recipe.

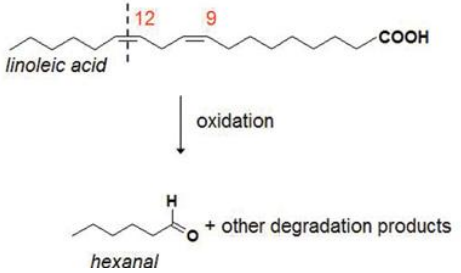
Fatty acids and off-flavor

Examples of fat sources in baking: fatty acid composition

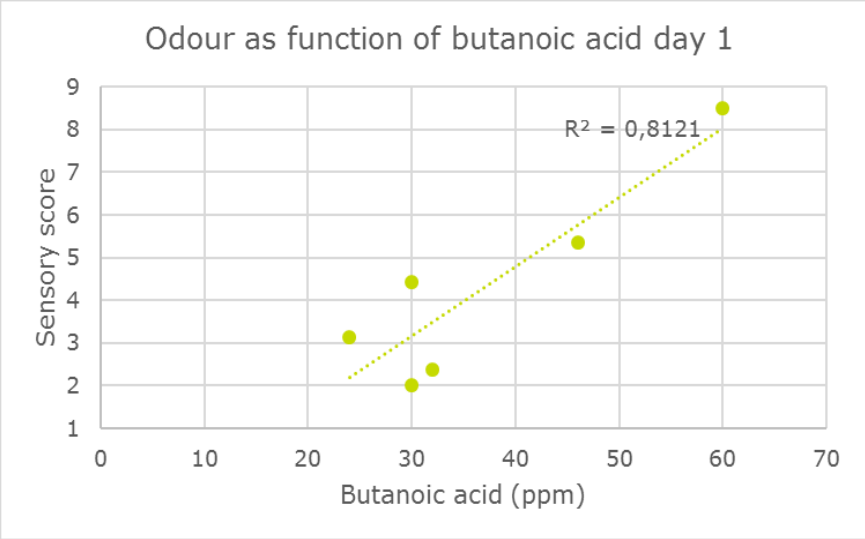
Fatty acid		Wheat flour	Rapeseed	Coconut	Butter	Flavour
Butyric	C4:0				4	Sharp, acetic, cheese, butter
Hexanoic	C6:0				2.3	Sour, fatty, sweaty, cheesy
Octanoic	C8:0			7	2	Fatty, waxy, rancid, oily
Decanoic	C10:0			8	3	Rancid, sour, fatty, soapy
Lauric	C12:0			48	4	Fatty, coconut
Myristic	C14:0			16	10	
Palmitic	C16:0	20	2	10	27	
Palmitoleic	C16:1		3		2	Long chain fatty acids: no flavour, but unsaturated fat can oxidise => **odour**ous volatiles (eg pungent, green, fatty aldehydes)
Stearic	C18:0	2	2		11	
Oleic	C18:1	15	14	7	21	
Linoleic	C18:2	60	14		2	
Linolenic	C18:3	5	9			
	C20:2		8			
Erucic	C22:1		45			

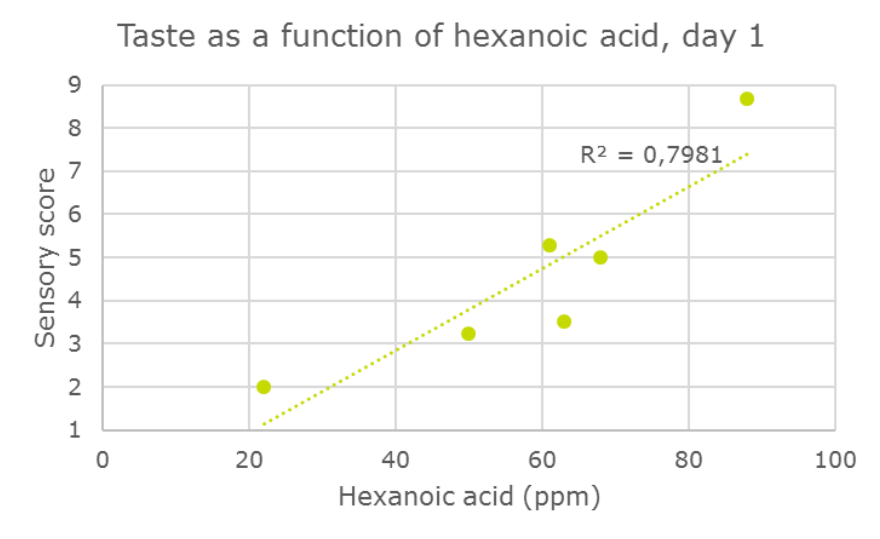
Short and medium chain free fatty acids give immediate flavour

Oxidation flavour forms over time:

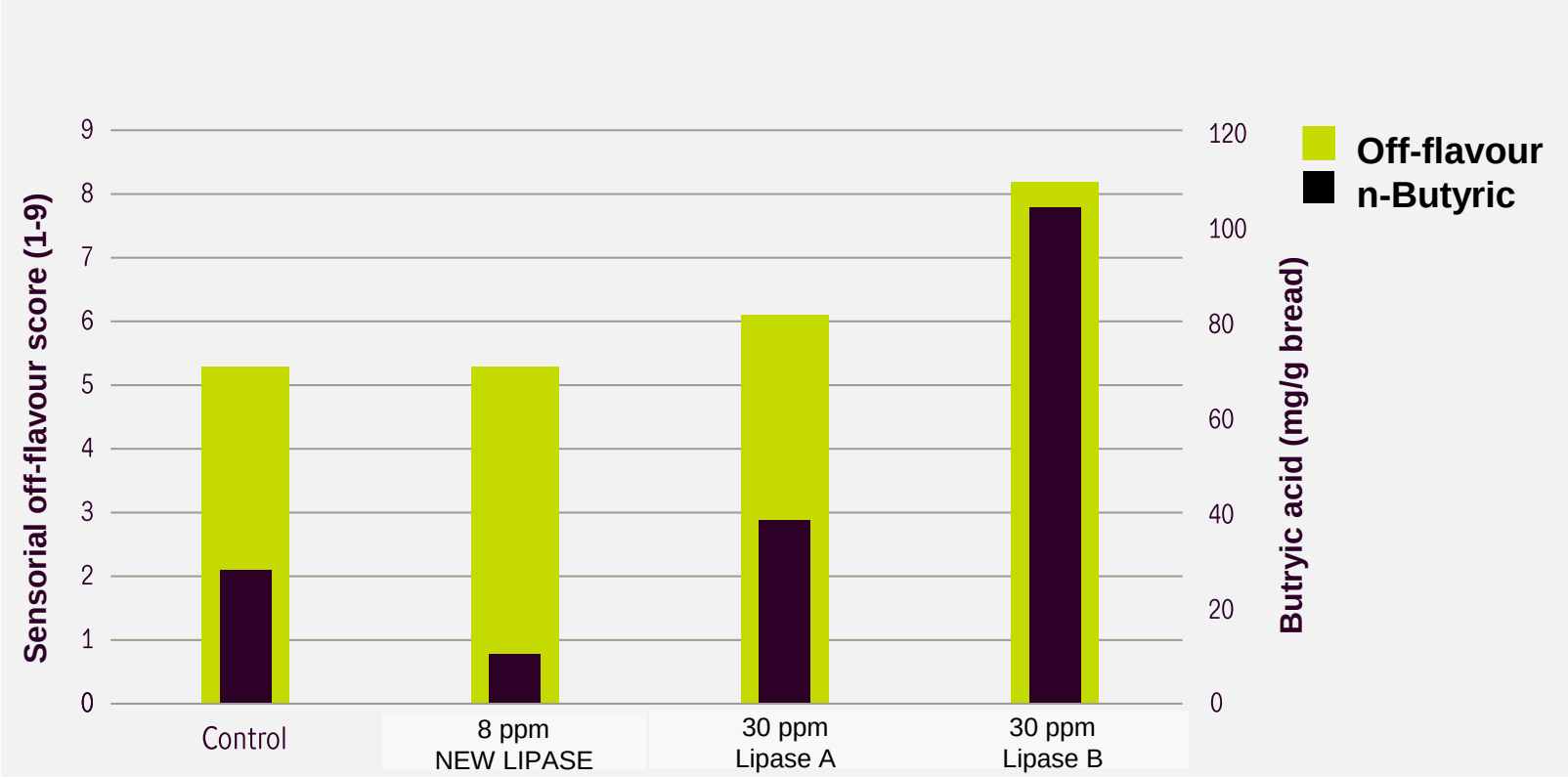


Fair correlation between sensorial perception and short-medium FFA in baked goods acids





Sensory perception and off-flavor affected by lipases

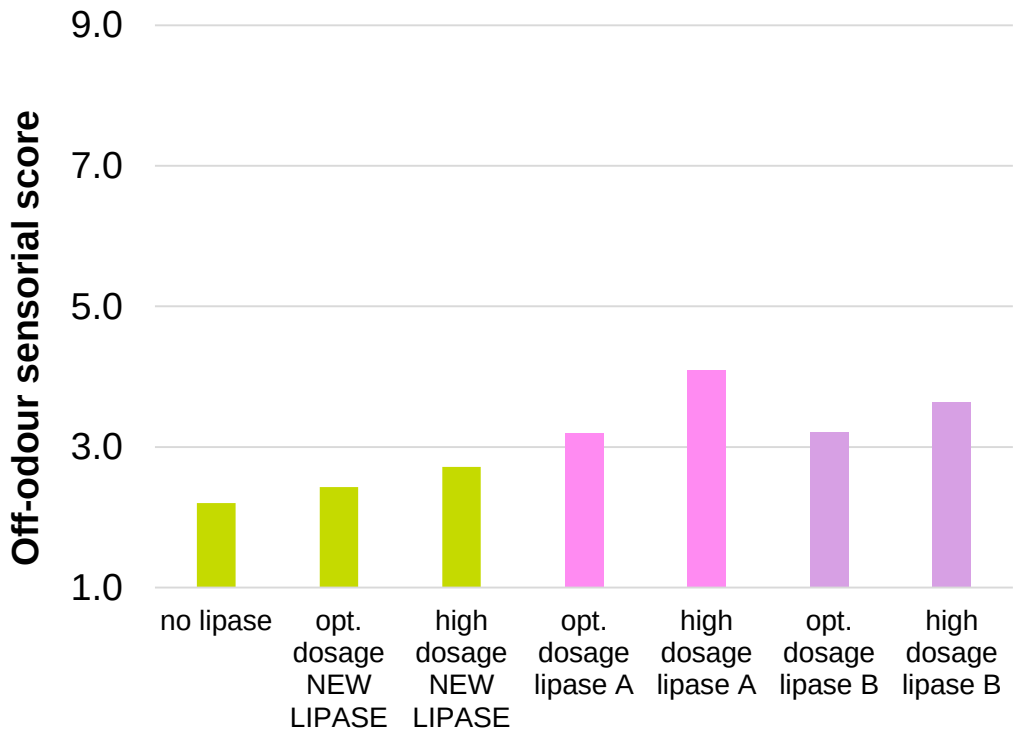


CONTROL

Butter bread (3% butter) sponge-dough process

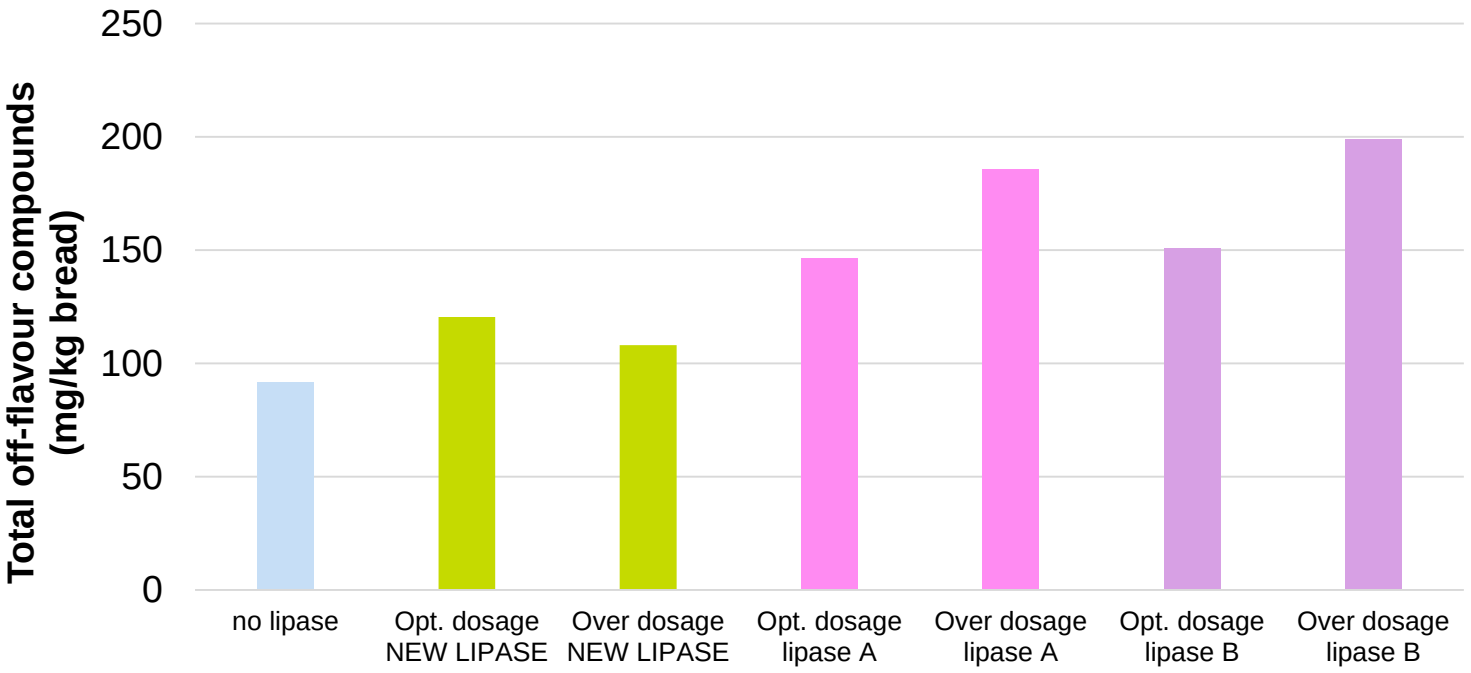
Sensory testing shows NEW LIPASE CAN NOT be overdosed and does not produce off-flavour

4 day-old bread



NEW LIPASE does not produce more off-flavour compounds even overdosed

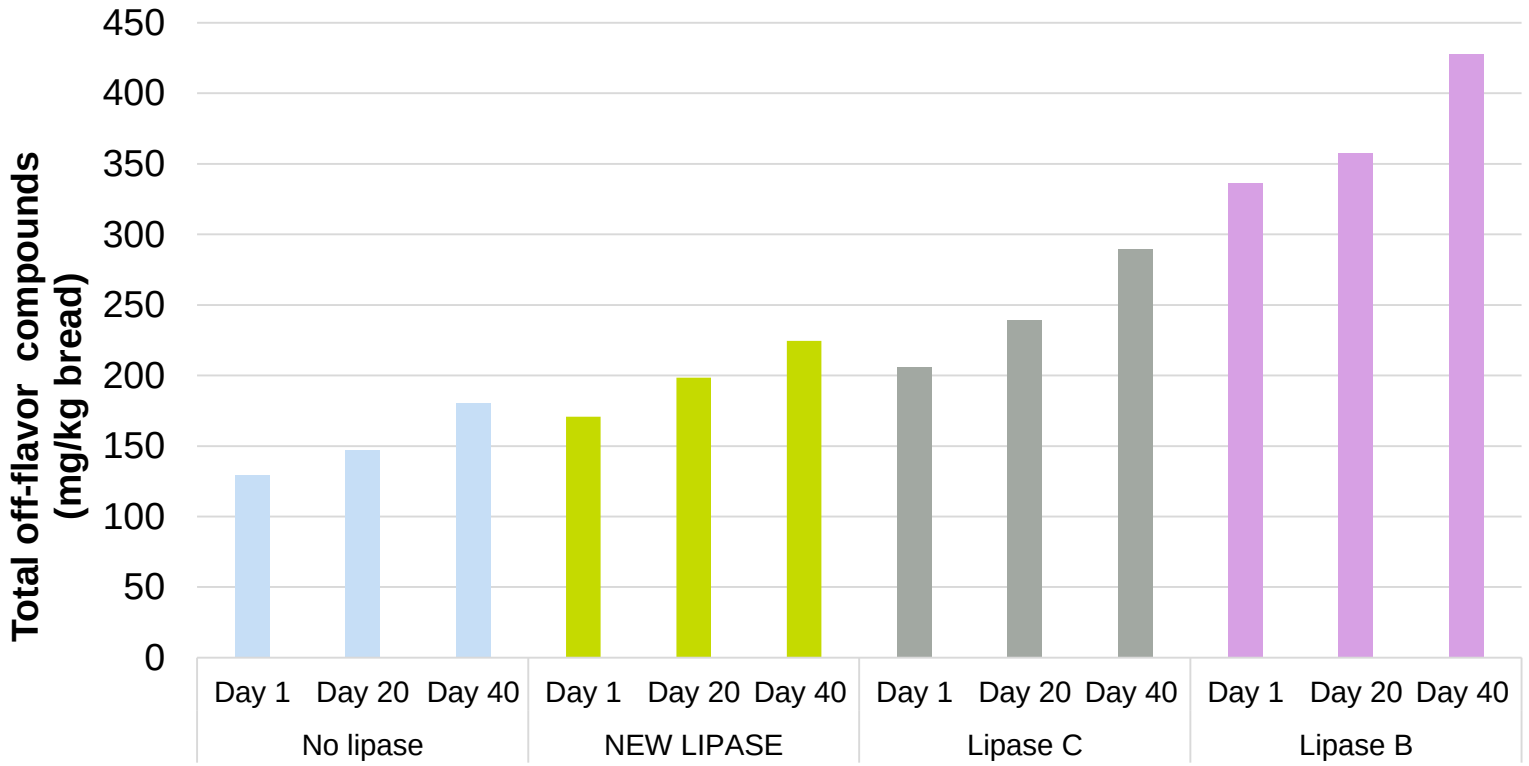
4 day-old bread



Total off-flavour compounds (n-butanoic acid, n-hexanoic acid, octanoic acid, decanoic acid, lauric acid)

Brioche-20% butter

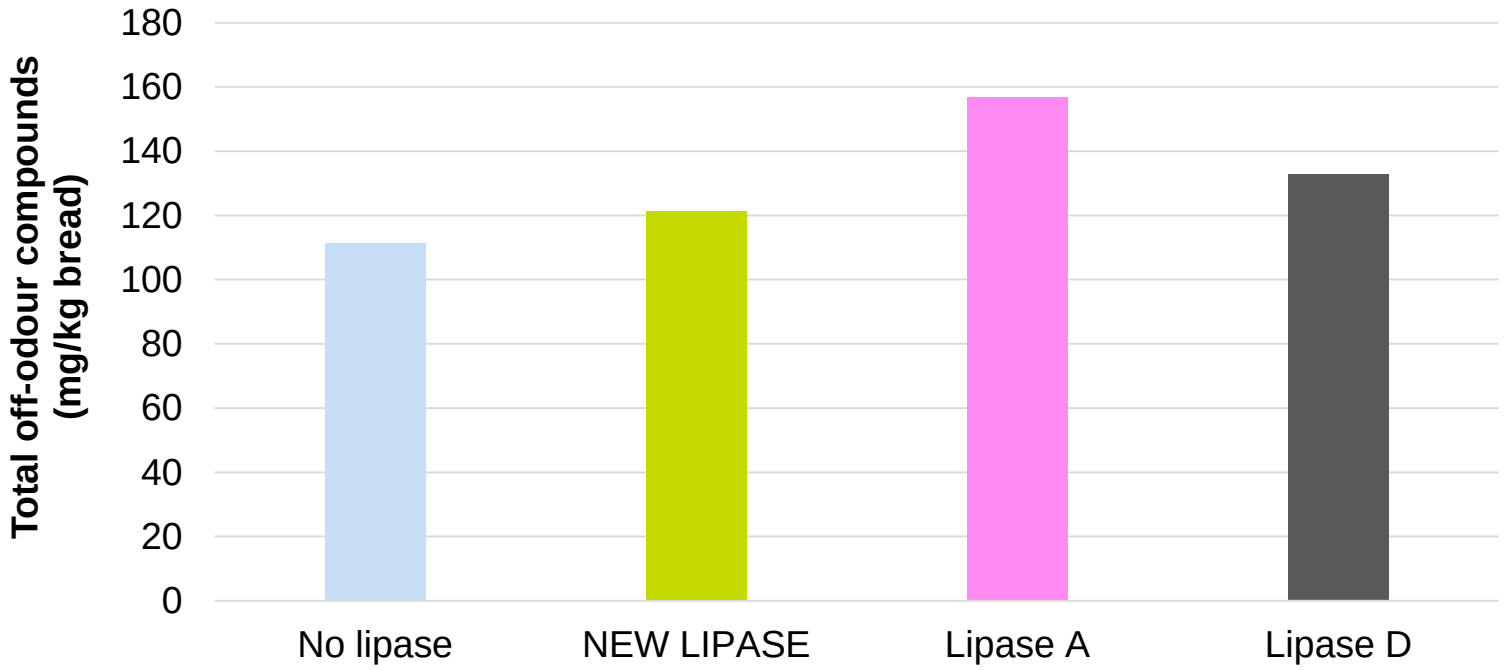
NEW LIPASE is more tolerant producing off-flavour compounds in longer retardation periods



Total off-flavour compounds (n-butanoic acid, n-hexanoic acid, octanoic acid, decanoic acid, lauric acid)

Pandesal
(coconut shortening)

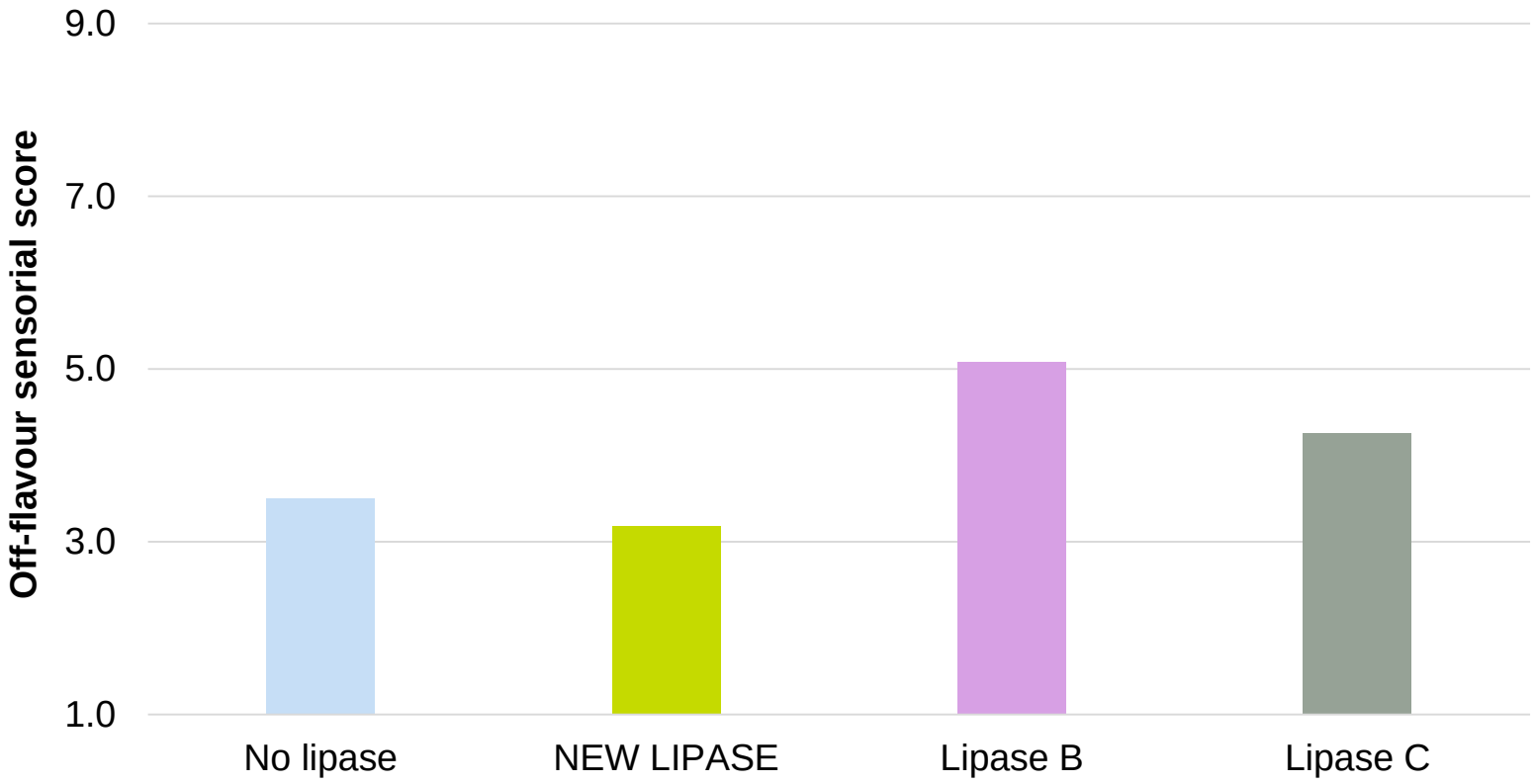
NEW LIPASE does not produce off-flavour in Pandesal (coconut shortening) **compare to control** at Day 7



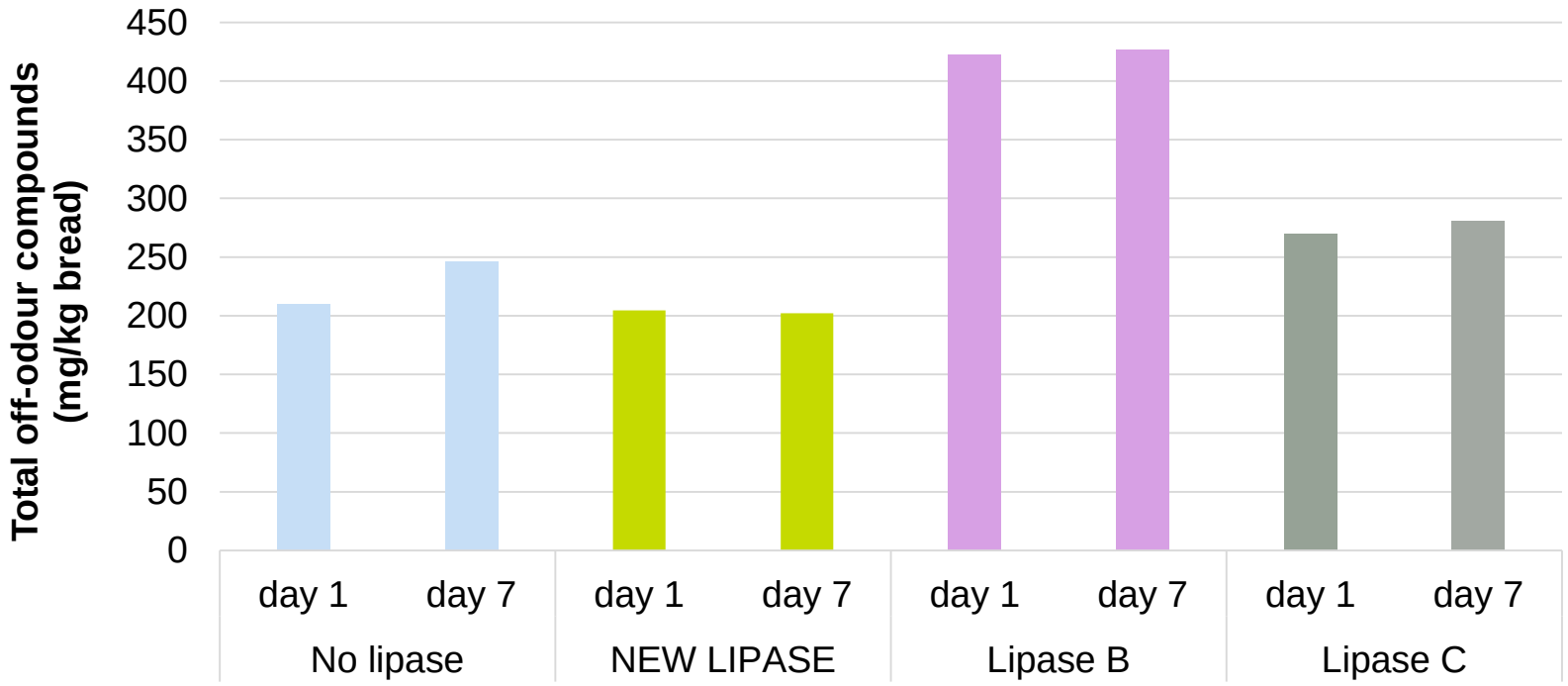
Total off-flavour compounds (n-butanoic acid, n-hexanoic acid, octanoic acid, decanoic acid, lauric acid)

Pan Blandito (butter)

Sensory testing on Pan Blandito (butter) **shows the NEW LIPASE does not produce off-flavour in Pandesal** (coconut shortening) **compare to control** at Day 7



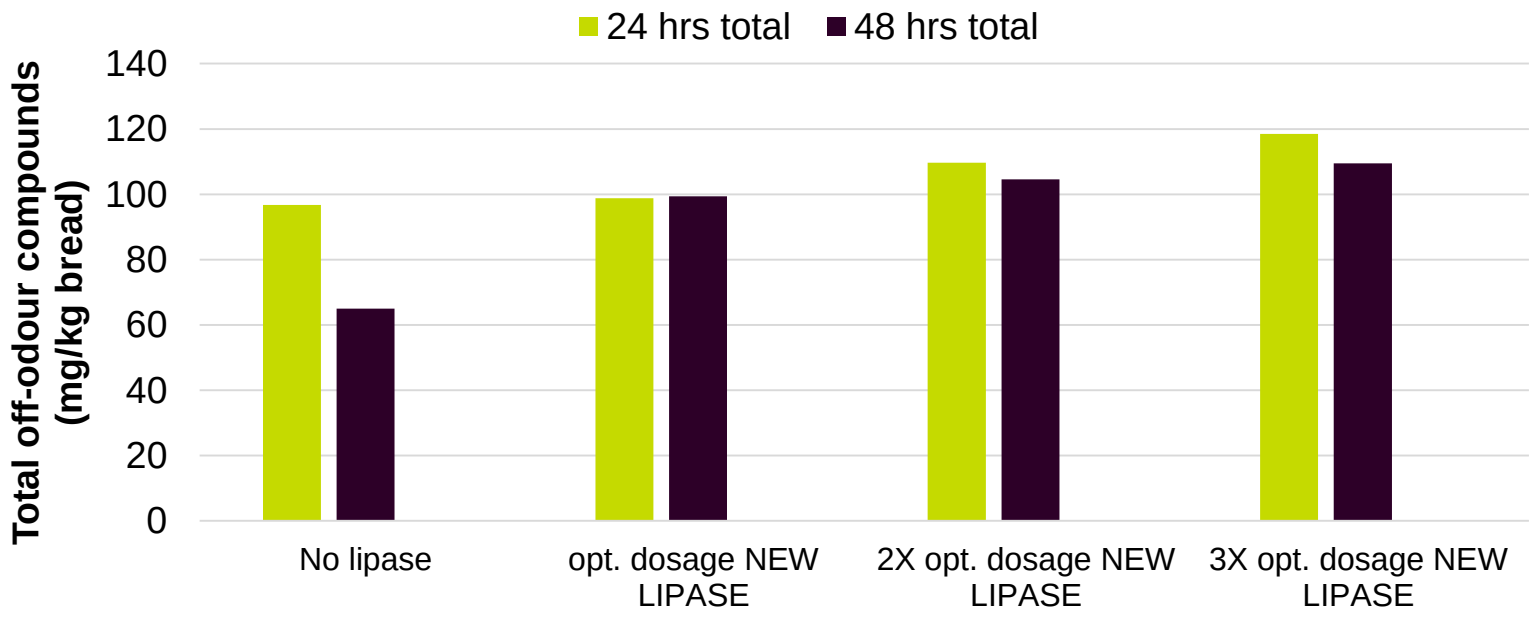
NEW LIPASE does not produce off-flavour in Pan Blandito (butter) **compare to control over time**



Total off-flavour compounds (n-butanoic acid, n-hexanoic acid, octanoic acid, decanoic acid, lauric acid)

Brioche (retarded dough)

Off-flavor compounds does not increase during dough retardation with NEW LIPASE in Brioche even with overdosing



Total off-flavour compounds (n-butanoic acid, n-hexanoic acid, octanoic acid, decanoic acid, lauric acid)

LIPASES

- Improves process tolerance in general (mixing and proofing stability), therefore easiness in handling and improved loaf volume and crumb structure
- Clean label compatible, can replace emulsulfiers depending on the recipe
- Production stability irrespective variations in flour quality

NEW LIPASE for your enzyme tool box

Stronger, easy to handle dough

Satisfy clean label demands

NO unpleasant flavour

QUESTIONS?

DILEK AUSTIN. PHD.

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Novozymes North America Inc.

ASB19, February 25, 2019, Chicago IL

Rethink Tomorrow

novozymes