Applying enzymes in clean label formulations

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CLEAN LABEL

✓ Consumers are skeptical and suspicious of ingredients they do not understand or recognize.

Clean Label Definition

- ***There isn't one!***
- A label with ingredients that are hard to pronounce, synthetic or simply unfamiliar to many people are often unwanted.
- Other interpretations include producing products without ingredients included in the various "no-lists".
- Even stricter interpretations may include only ingredients that are produced organically, not genetically modified, and/or socially/environmentally conscious.

Top 5 label descriptors among clean label shoppers

- Recognizable ingredients, as well as all natural ingredients, are descriptors sought after by all clean label shoppers
- Baby boomers, Gen-Xers and Millennials all seek products with recognizable ingredients, while 65+ consumers seeks products low in sodium, as well as no sugar added
- Millennials are the only group that calls out organic as an attribute that would greatly increased purchase interest

TOP 5 LABEL DESCRIPTIONS THAT GREATLY INCREASE PURCHASE INTEREST

MILLENNIALS:	GEN XERS
All natural ingredients No preservatives No artificial colors Recognizable ingredients Organic	Recognizable ingredients No artificial ingredients Grown without pesticides Locally grown Short ingredient list
BABY BOOMERS:	**MATURES:**
High fiber Contains whole grains No HFCS All natural ingredients Recognizable ingredients	No added sugar No artificial ingredients Low sodium All natural ingredients No preservatives

TOP 5 LABEL DESCRIPTIONS AMONG HEAVY, MODERATE & LIGHT CLEAN LABEL CONSUMERS

HEAVY CLEAN LABEL CONSUMERS:

- No artificial ingredients
- ✓All natural ingredients
- No artificial preservatives
- No HFCS
- ✓Recognizable ingredients

MODERATE CLEAN LABEL CONSUMERS:

- No added sugar
- ✓All natural ingredients
- ✓Recognizable ingredients
- No artificial preservatives
- Organic

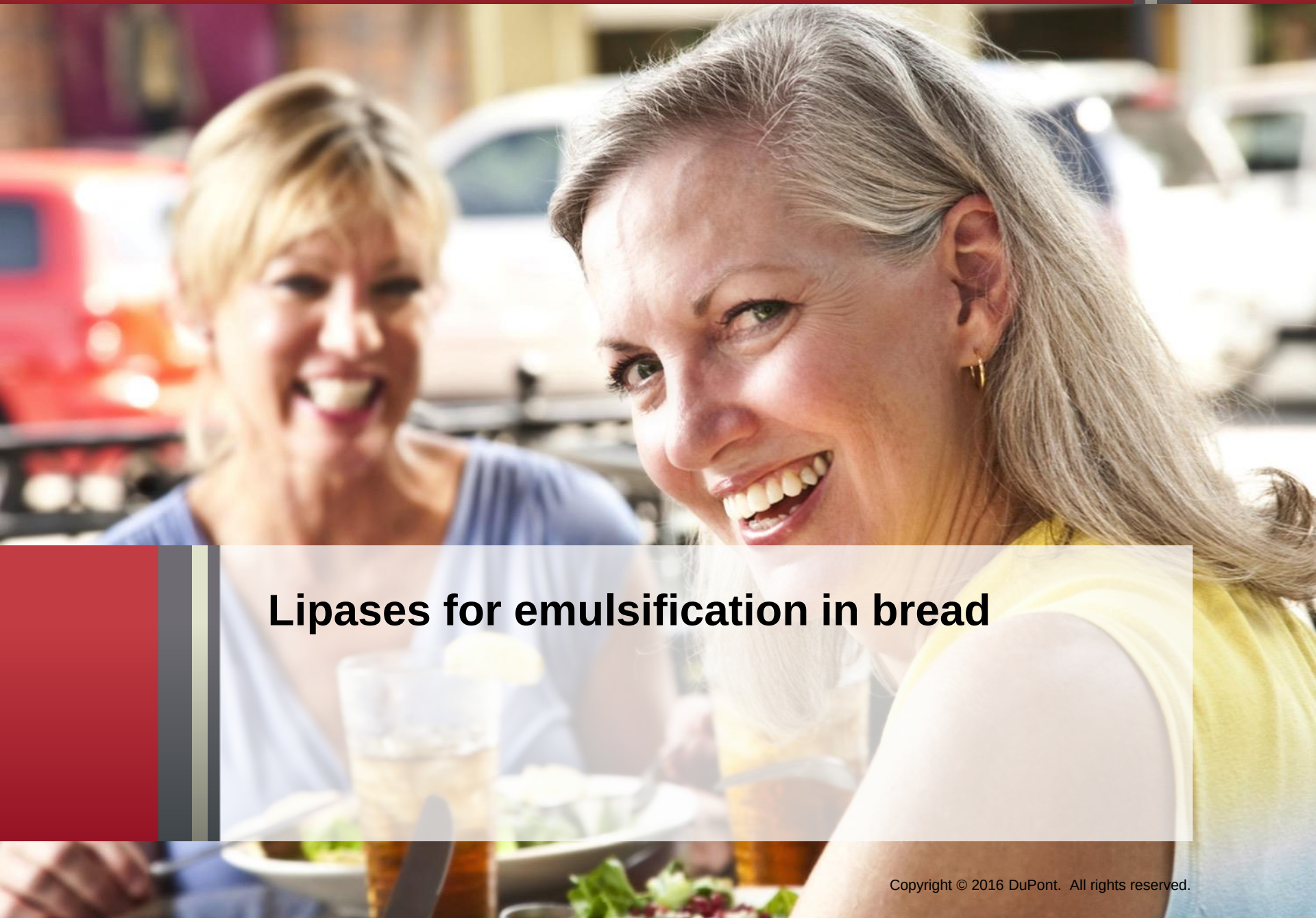
LIGHT CLEAN LABEL CONSUMERS:

- No added sugar
- ✓All natural ingredients
- No HFCS
- ✓Recognizable ingredients
- Organic

Source: 2015 Study of clean label food and beverages, MultiSponsor Surveys, Inc.

Three examples of applying enzymes to create a simpler label

- Lipases generating emulsifying effect in bread
- A lactase for fiber generation and sugar reduction in yogurt
- Achieving oxidative effect by an enzyme (HOX) in bread compared to the use of bromate

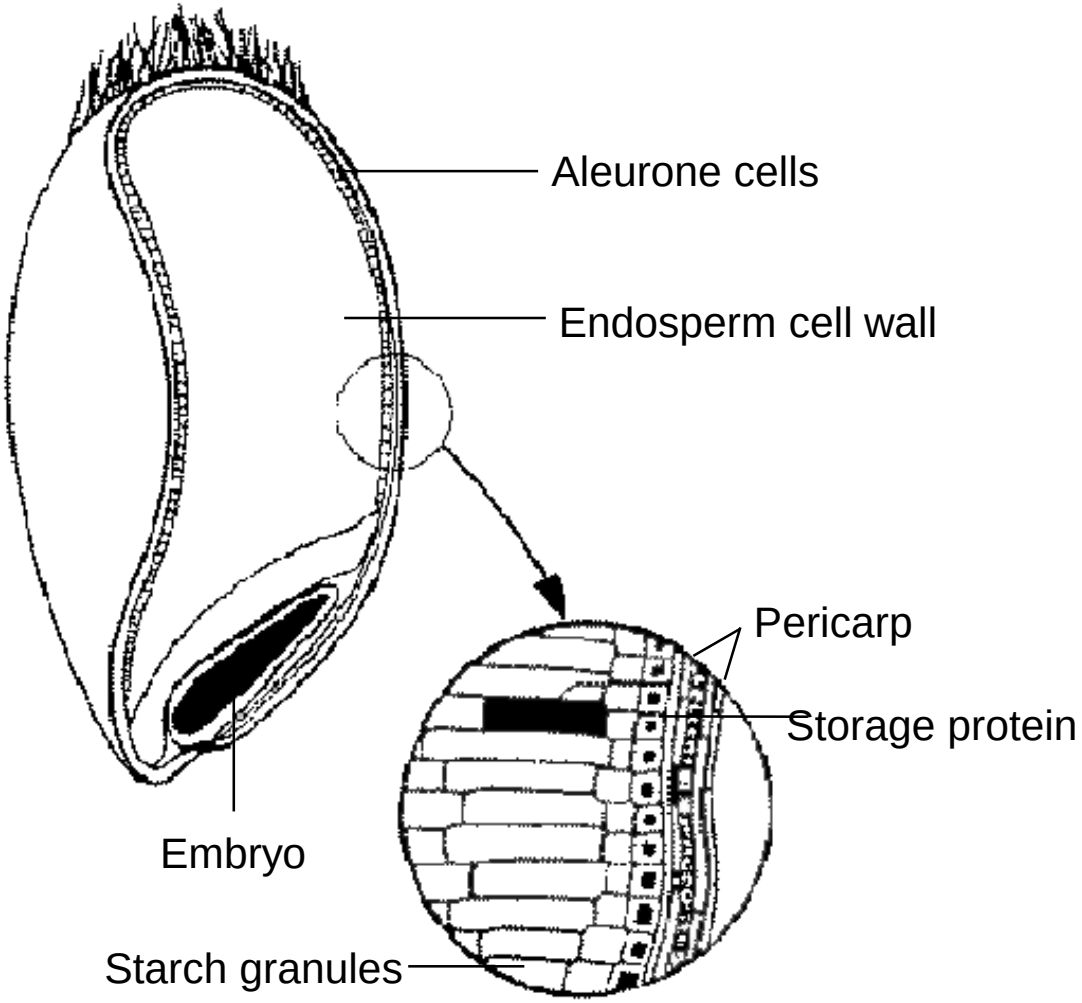


Lipases for emulsification in bread

Functionality of lipases in bread making

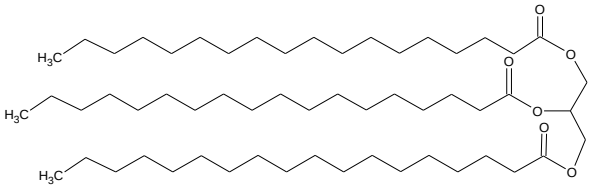
- **In situ generation of emulsifiers from lipids naturally present in flour**
- Creates a synergistic dough strengthening effect
- Improves tolerance to processing variations and raw materials
- Increases the volume of the final product
- Improves crumb texture

The substrate (2-3% lipid)



Nonpolar lipids	Triglycerides (TG)	20.8%
	Steryl esters	7.5%
	Free fatty acids (FFA)	7.0%
	1,2-diglycerides (1,2-DG)	6.2%
	1,3-diglycerides (1,3-DG)	6.0%
	Other nonpolar lipids	3.4%
Glycolipids	Digalactosyl diglycerides (DGDG)	13.5%
	Monogalactosyl diglycerides (MGDG)	4.9%
	Other glycolipids	7.9%
Phospholipids	Lysophosphatidyl cholines (LPC)	7.1%
	Phosphatidyl cholines (PC)	5.8%
	N-acyl phosphatidyl ethanolamines (NAPE)	4.9%
	Other phospholipids	4.9%

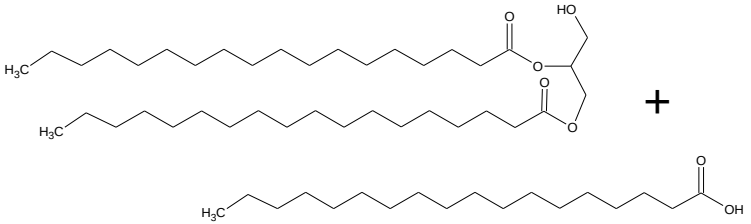
Lipases / Glycolipases / Phospholipases



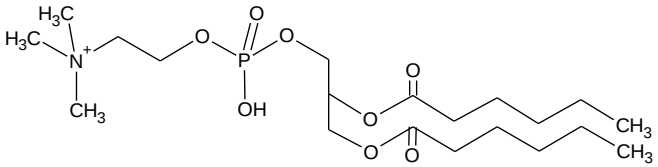
TAG

H_2O

TAG - Lipase



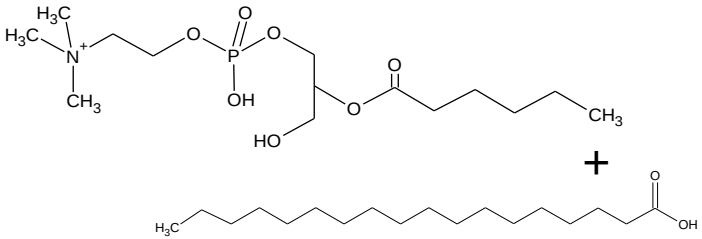
DG + FFA



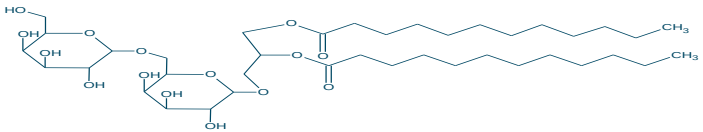
PC

H_2O

Phospholipase



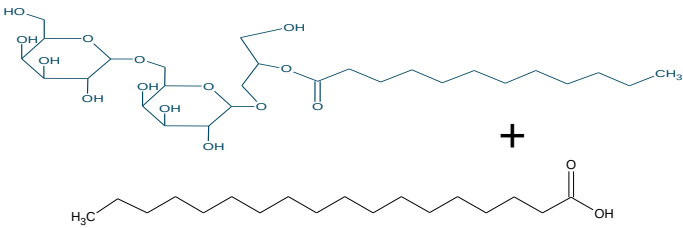
Lyso-PC + FFA



DGDG

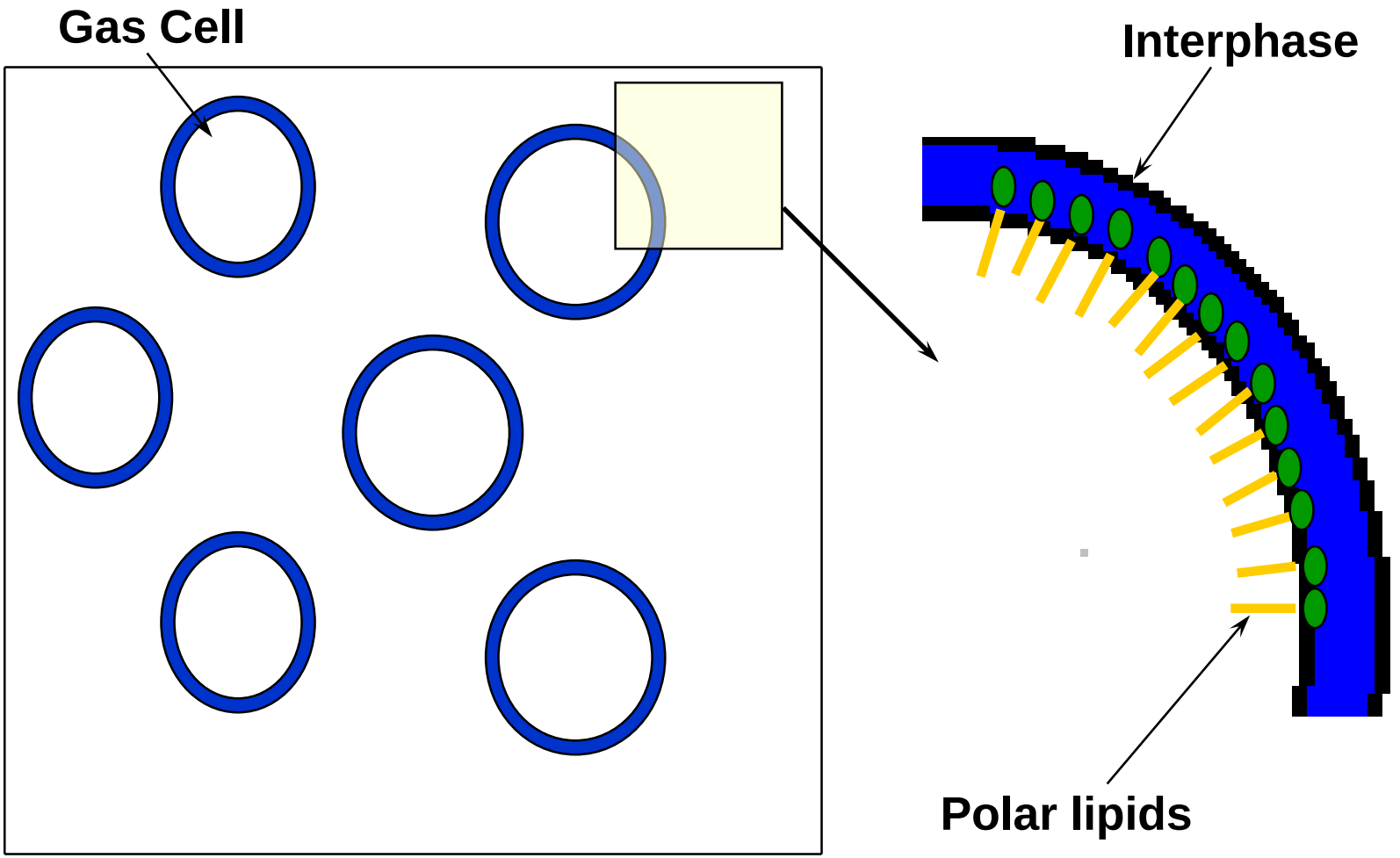
H_2O

Glycolipase

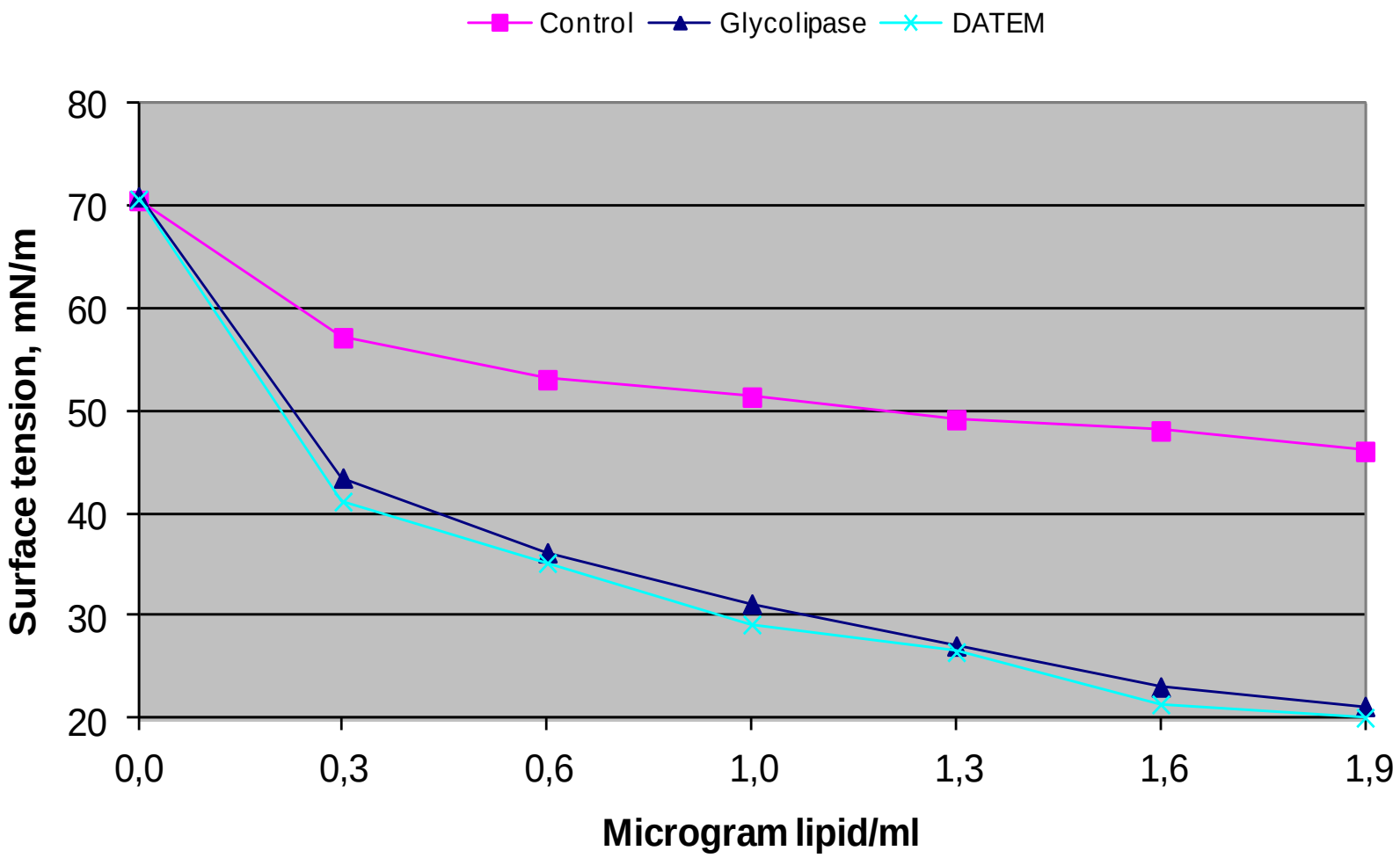


DGMG + FFA

Functionality of lipases in bread making – Gas cell stabilisation



Surface tension



FIBERLine™ 3105 + emulsifiers vs. FIBERLine™ 3106

Solution 1	Solution 2	Solution 3
500ppm FIBERLine™ 3105 + 0.55% PANODAN® A2020 + 0.3% DIMODAN® HP 75 + 3% gluten	500ppm FIBERLine™ 3106 + 5% gluten (No emulsifiers) Enzymes including lipase	5% gluten

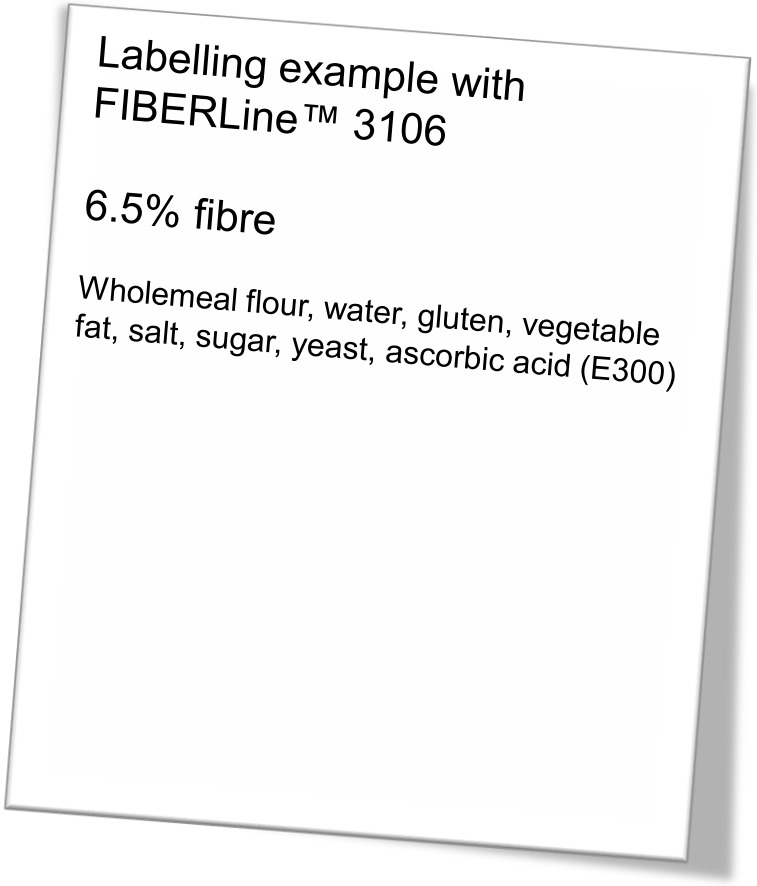
FIBERLine™ 3106 gives a simple label

Healthy soft bread with superior volume

- FIBERLine™ 3106 facilitate production of a 100% wholemeal bread with a volume and softness close to that of white wheat bread

Natural

- FIBERLine™ 3106 enables production of high-fibre bread with 100% natural wholemeal and no compromise on texture and shelf life



A new enzyme for generating pre-biotic fibers and reducing sugar in dairy products

Introducing DuPont™ Danisco® ZymStar™ GOS

- DuPont™ Danisco® ZymStar™ GOS is an innovative enzymatic solution that enables dairy manufacturers to produce **dietary fibers** in the form of Galacto-oligosaccharides (GOS) in situ from existing lactose in dairy products; reducing the **lactose** level, reducing the **lactose calorie** contribution and bringing down the **total sugars** content.

Generation of GOS fiber

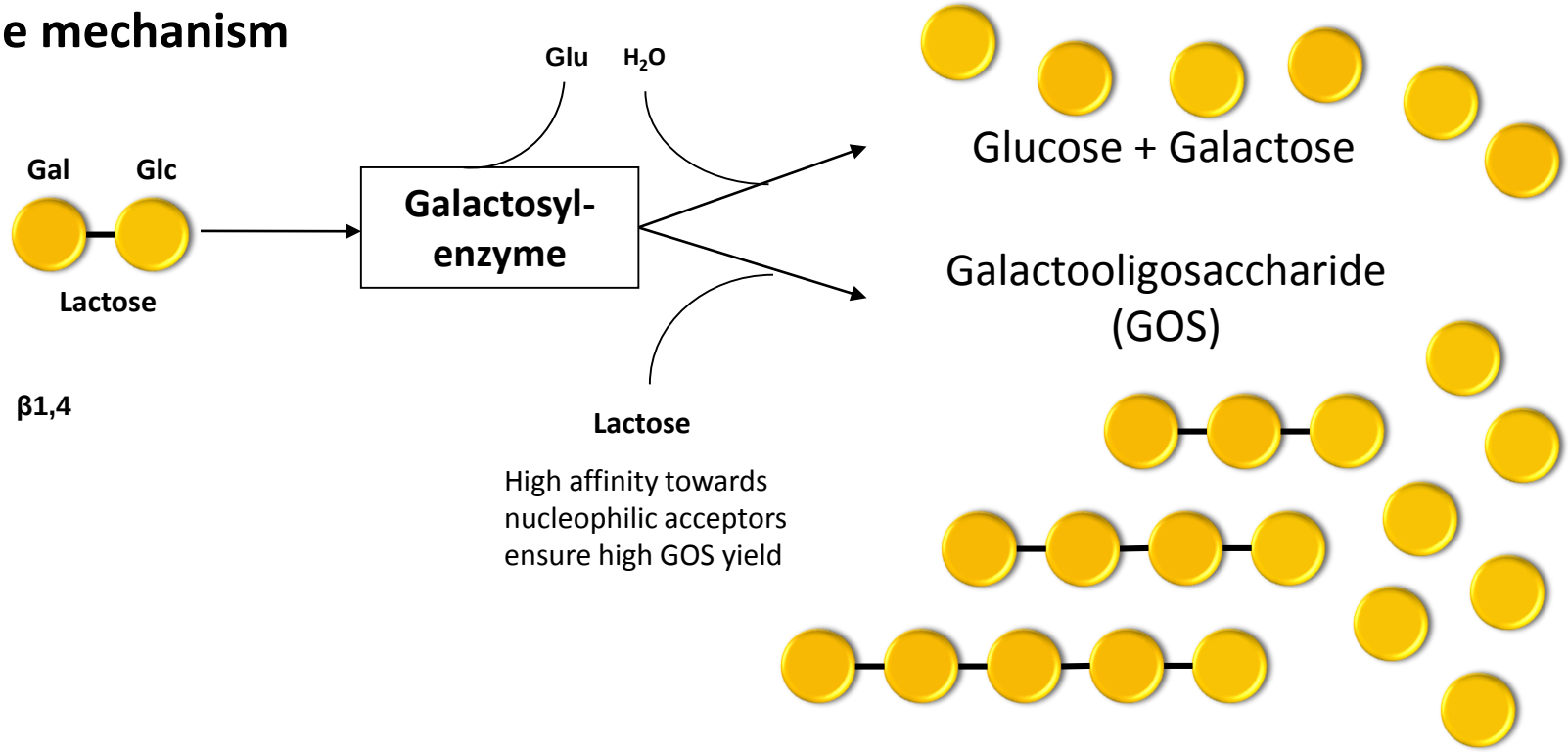
Lactose content reduction

Sugars and calorie reduction

Galactooligosaccharides (GOS)

- **Galacto-oligosacharides are made up of Galactose and Glucose units. GOS are non-digestible fibers and classified as prebiotics giving increased gut health to the consumer**

Enzyme mechanism



APPLIED AND ENVIRONMENTAL MICROBIOLOGY, May 2001, p. 2276–2283 Vol. 67, No. 5
0099-2240/01/$04.00+0 DOI: 10.1128/AEM.67.5.2276–2283.2001

Intra- and Extracellular β-Galactosidases from *Bifidobacterium bifidum* and *B. infantis*: Molecular Cloning, Heterologous Expression, and Comparative Characterization

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ORIGINAL PAPER

F. Jørgensen · O. C. Hansen · P. Stougaard

High-efficiency synthesis of oligosaccharides with a truncated β-galactosidase from *Bifidobacterium bifidum*

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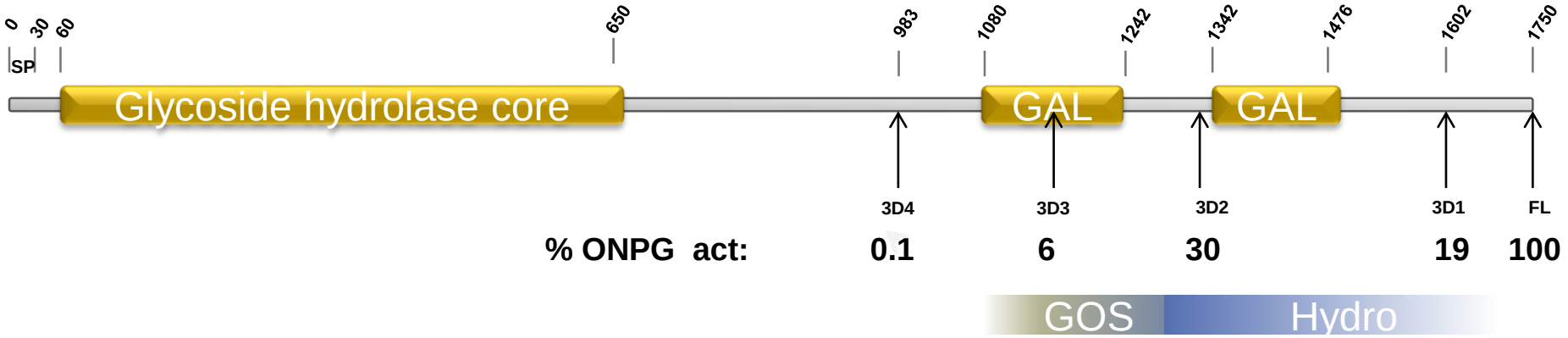


Sugar and calorie / energy reduction Claims in EU

- **ENERGY-REDUCED**
- A claim that a food is energy-reduced, and any claim likely to have the same meaning for the consumer, may only be made where the energy value is reduced by at least 30 %, with an indication of the characteristic(s) which make(s) the food reduced in its total energy value.
- **REDUCED SUGARS**
- A claim stating that the content in sugars has been reduced, and any claim likely to have the same meaning for the consumer, may only be made where the reduction in content is at least 30 % compared to a similar product,
- “sugars” means all monosaccharides and disaccharides present in food, but excludes polyols;

“Sugars” reduction examples

Plain Yogurt:

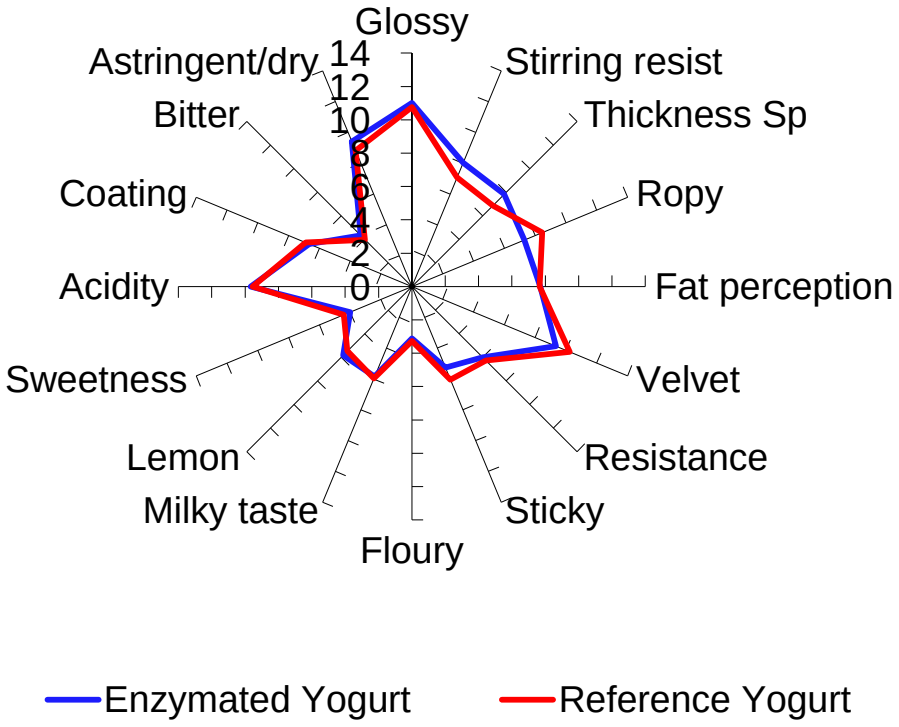
	Lactose and other sugars %	Sucrose%	Fibers%	total sugars%	sugar reduction%
Plain yogurt	4.6	0	0	4.6	
Plain yogurt +*b*-gal	2.4	0	2.2	2.4	**47.8**

Yogurt + sucrose:

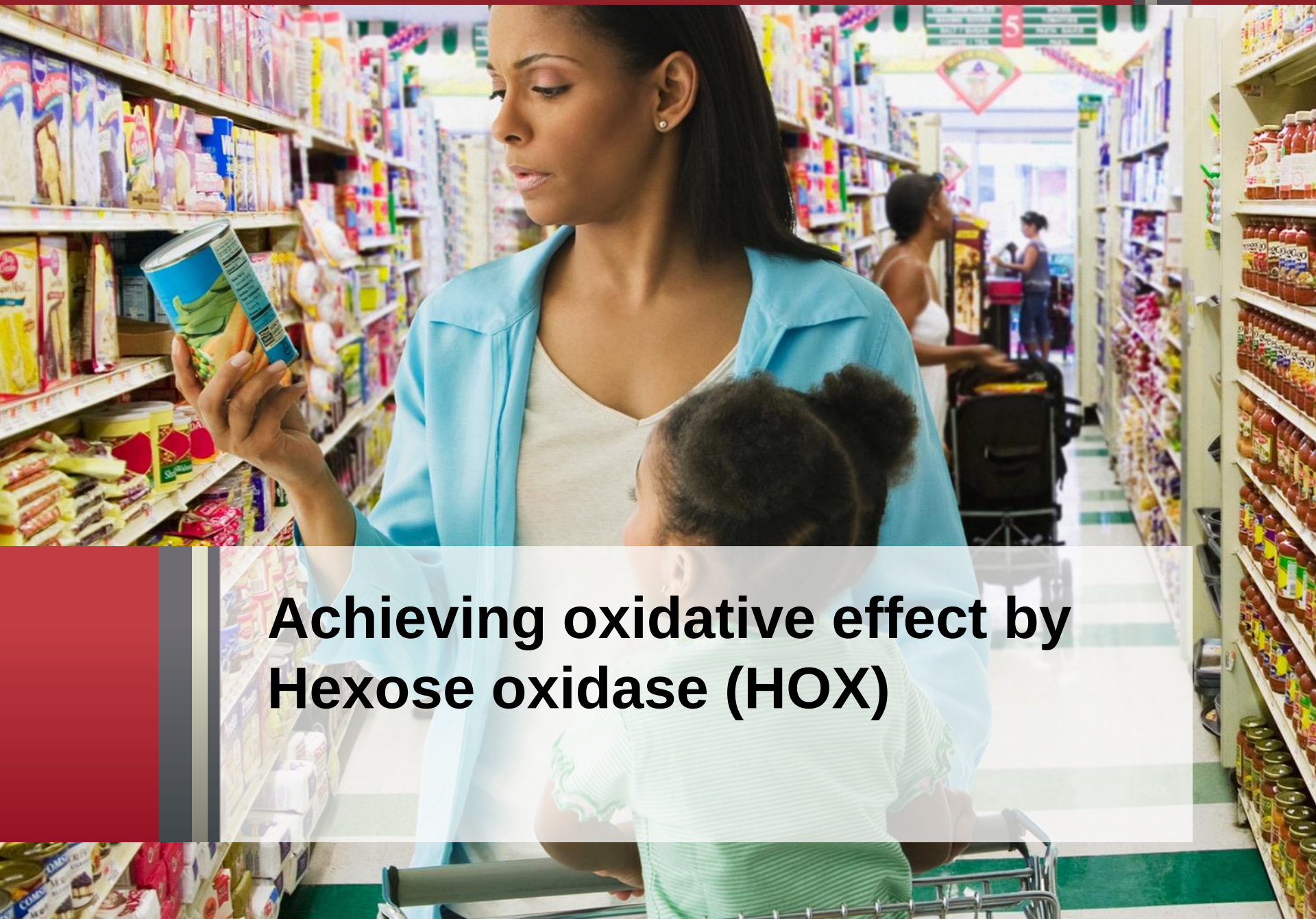
	Lactose and other sugars%	Sucrose%	Fibers%	total sugars%	sugar reduction%
flavoured yogurt	4.6	4	0	8.6	
flavoured yogurt +*b*-gal	2.4	4	2.2	6.4	**25.6**

Sensory analysis of product prototypes

Exemplary spider-graph of a Dairy product tasting



- No difference in sweetness comparing an enzymated to a non-enzymated Dairy product
- No off-flavors were detected (lipase or e.g. protease)
- Stirring resistance and Thickness on spoon may be increased



Achieving oxidative effect by Hexose oxidase (HOX)

Functionality of oxidative enzymes in bread-making

- Better dough handling properties
- Improved dough tolerance
- Improved bread quality
- Improved crumb structure
- Improved bread volume
- Can supplement chemical oxidants
- Gluten replacement

Mechanism of hexose oxidase reaction in dough

Hexose oxidase reaction

Glucose + O_2 ⟶ δ -gluconolactone + H_2O_2

or

Maltose + O_2 ⟶ γ-maltobionolactone + H_2O_2

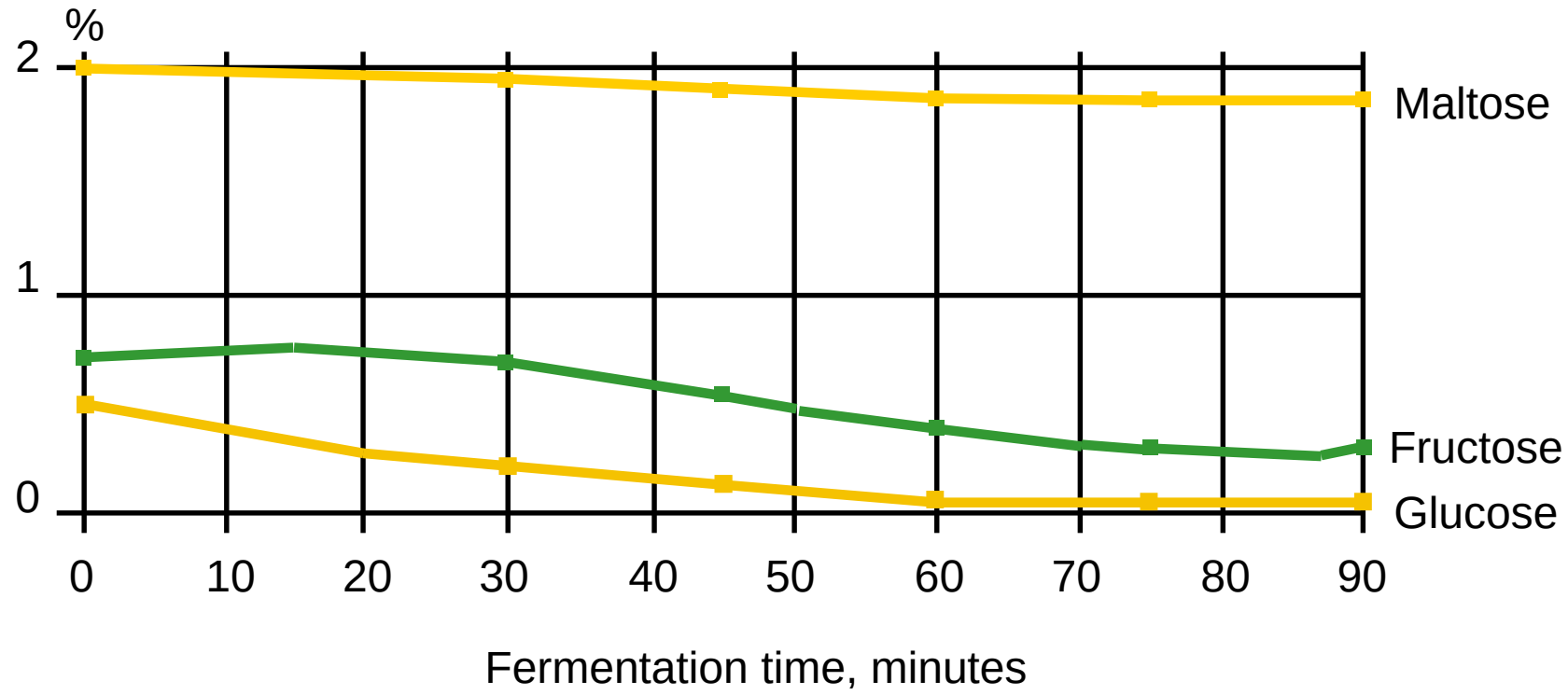
Oxidation in gluten

2 RHS + H_2O_2 ⟶ RS -SR + $2H_2O$

R: Protein molecule	HS: Thiol groups	S-S: Disulfide bonds

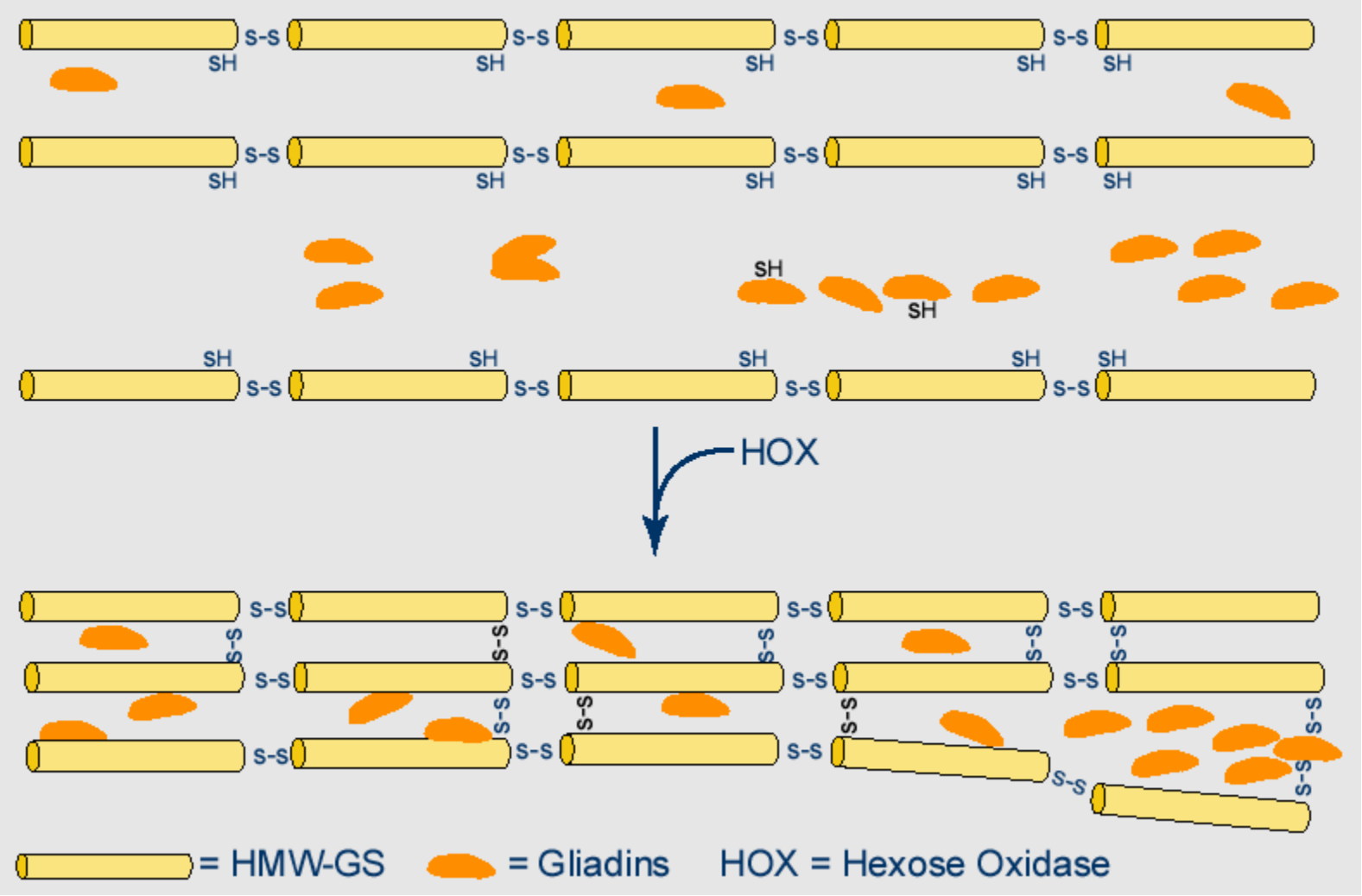
Carbohydrates in bread

- as a function of fermentation time

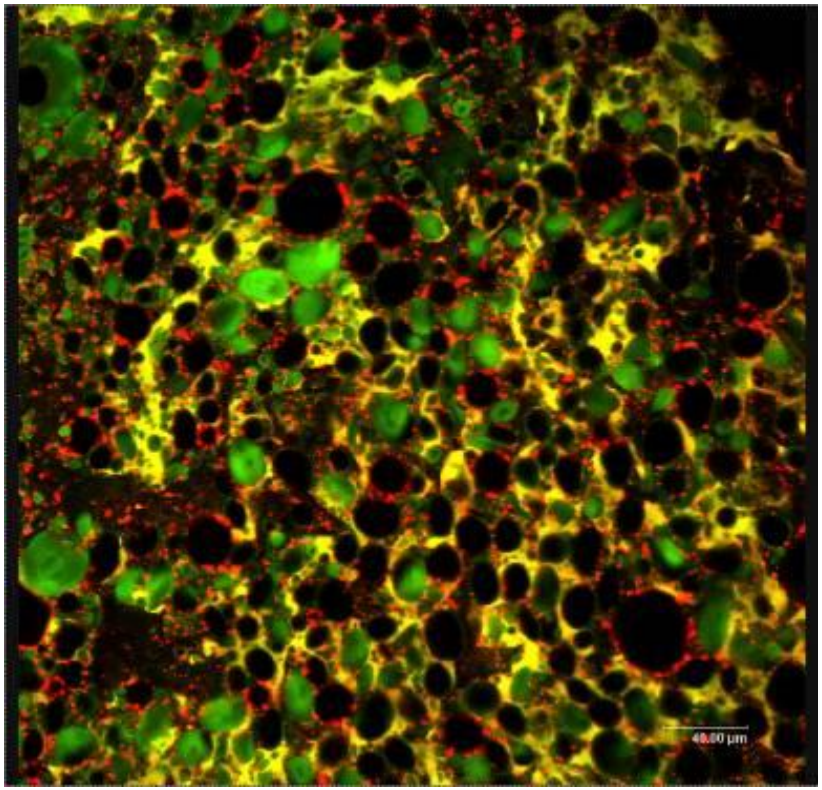


Ref: Agnete Dal Thomsen, Närungsforskning, Årg. 32, 105-107, 1988

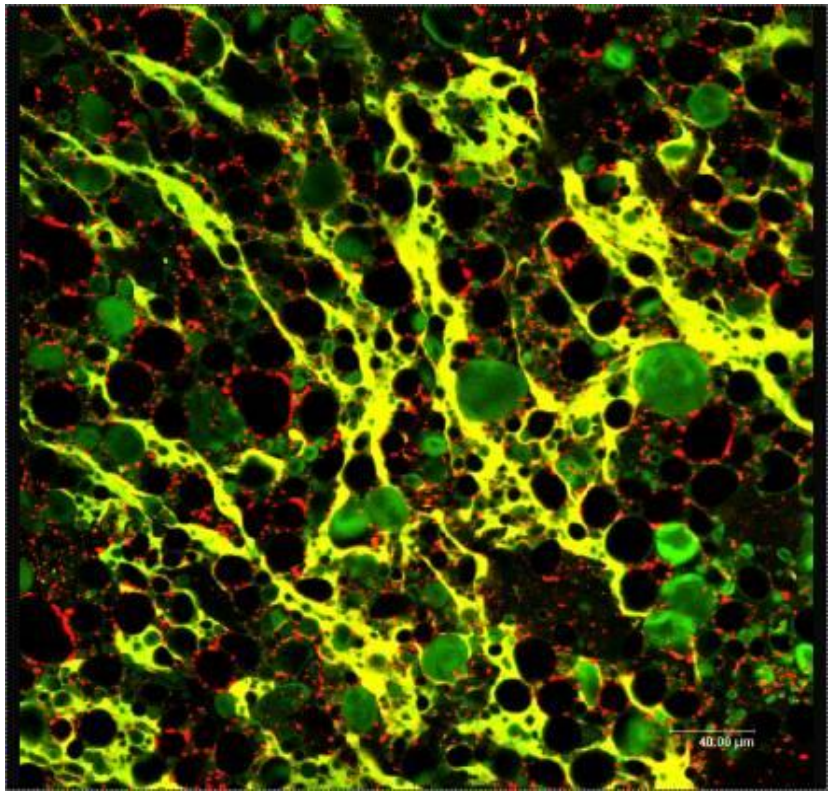
Oxidation of gluten network by Hexose oxidase



Confocal laser scanning microscopy

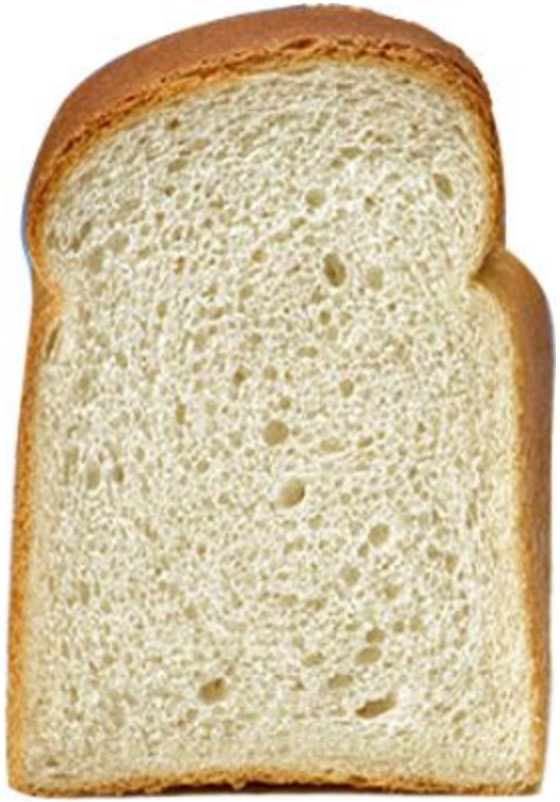


Dough without
GRINDAMYL™ SUREBake

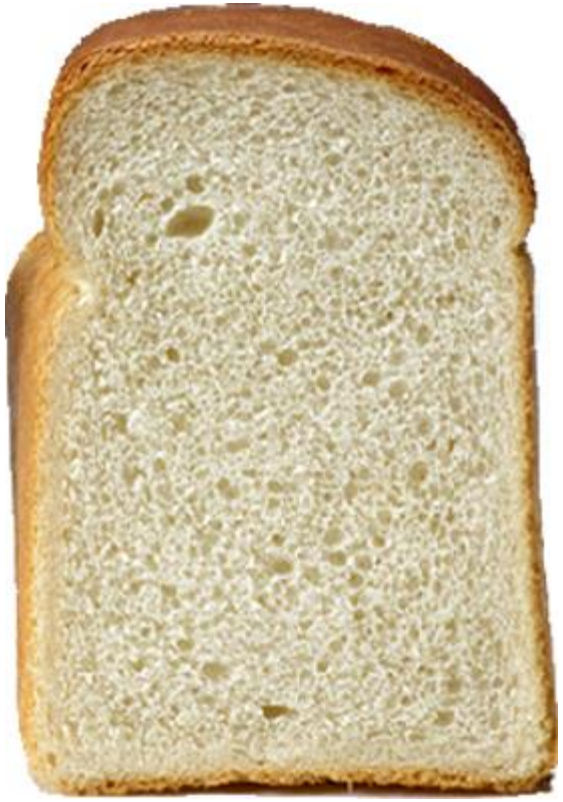


Dough with
GRINDAMYL™ SUREBake

US no-time dough



90 U/kg flour
Hexose Oxidase



30 ppm
Potassium Bromate

Conclusion: Enzymes used in food processing are catalysts for

Food with improved properties

- **Enhancing health & nutritional value of products**
- **Producing soluble fiber content** / bioavailability
- **In-situ generation of ingredients** based on food raw material constituents
- Improving food texture & taste

Reduced costs & increased yields

- Improving food production stability, efficiency & safety
- Overcoming raw material variations
- Enabling more stable and palatable products
- Reducing food waste and energy consumption

All the above can help enable **CLEAN LABEL** solutions in different aspects of the concept.

The miracles of science™