Enzymes cost-effectively enhance quality of wheat tortillas in turbulent times

TIA Europe 2022

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NUTRITION · HEALTH · SUSTAINABLE LIVING

DSM

BRIGHT SCIENCE. BRIGHTER LIVING.

Content

- The wheat-to-tortilla supply chain
- Global challenges in the baking industry
- Raw materials – improve efficiency to reduce costs
  - Flour standardization
  - Gluten modification
  - Lipases with emulsifier functionality

The wheat-to-tortilla supply chain

Farmer and transport

Milling

Ingredient supplier

Bakery

Retailer and consumer

Global challenges and the impact on the baking industry

- Global wheat availability limitations - impact of conflict in Ukraine
- Sourcing raw materials and ingredients
- Inflation drivers

Supply chain to shift and morph under varying pressures

Resulting in varying flour quality, need for flour correction and application expertise

Europe's exports can likely be increased with an additional 4-6 million tons of wheat

Russia and Ukraine are responsible for approximately 30% of global wheat exports

The US, Europe, and Australia are likely to be self-sufficient in wheat production

China is expected to increase import of Russian wheat

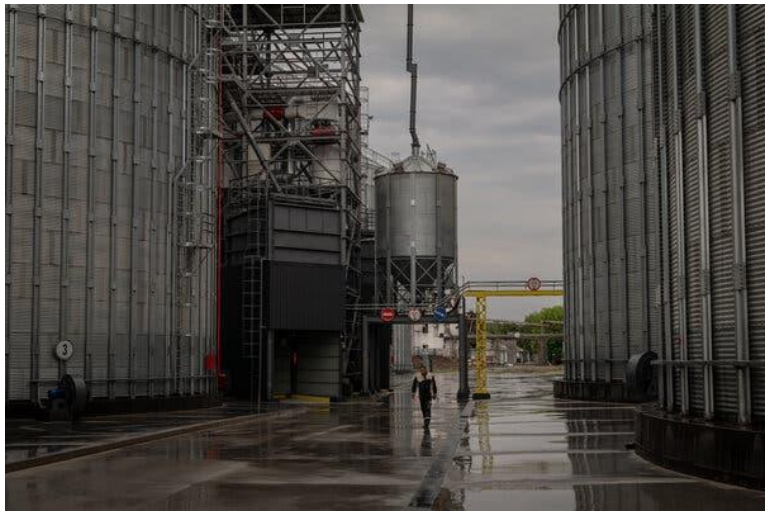
South America is expected to increase wheat exports. Transport times to other continents can cause rapid but short-term disruption in the supply chain

The African continent relies heavily on Ukrainian and Russian wheat. Import from alternative regions is highly likely

Short and long-term impact on baking and various ingredients

Caused by conflict in Russo-Ukrainian region

- The region is responsible for approximately 30% of global wheat supply. Disruption to harvest, quality, and supply inevitable
- Regions that rely on wheat from Ukraine and Russia are likely to find alternative sources for import due to availability and political sanctions
- A sharp increase in energy and transport costs further complicate the supply chain, creating incentive to limit transportation distance



Impact in Baking

- Fluctuations in **flour quality and origin** will have performance consequences in baking processes, creating greater need for solutions such as flour correction
- Rise in **ingredient and energy costs** will translate to increase in consumer prices
- **Price sensitive regions** will decrease baking product consumption as a result

Many ingredients affected

- Ingredient uncertainty will reach beyond grain, wheat, and flour
- Russia and Ukraine account for about **20% of corn exports** globally. Shortages will affect food and feed industry
- **70% of sunflower and safflower oil** comes from Russia and Ukraine. Edible oil and derivatives, such as lecithin, will be severely impacted

Source: World Grain, March 2022. Bloomberg Finance, Rabobank 2022.

Many acute and long-term challenges when sourcing and using raw materials

Increase of transport times
Example More wheat exports from LATAM to Africa

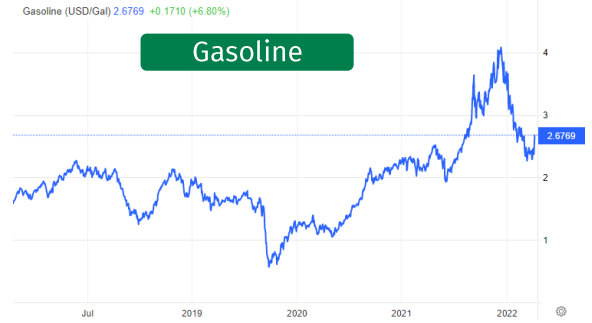
Suboptimal storage of raw materials
Example Flour stored at higher temperatures

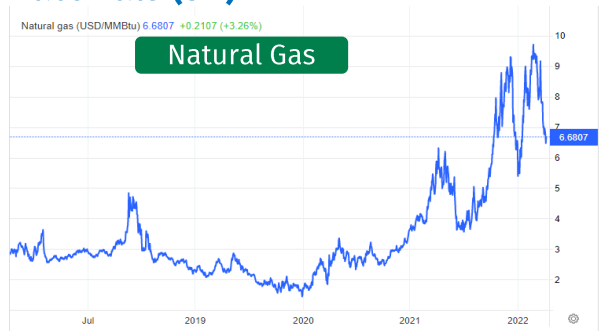
Raw material availability
Example Grains, seed oil availability heavily affected by Russo-Ukrainian conflict

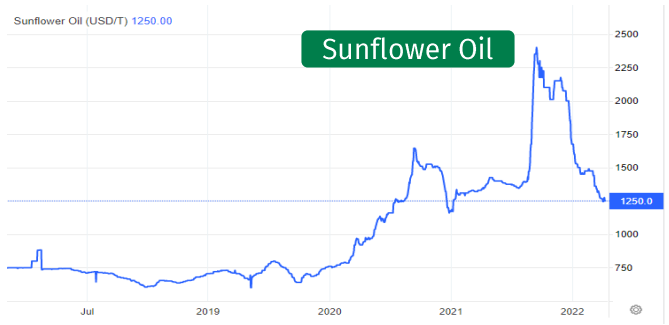
Energy and transport costs
Example Global container shipping 4-5x 2019 rate, making shipping of certain materials unprofitable

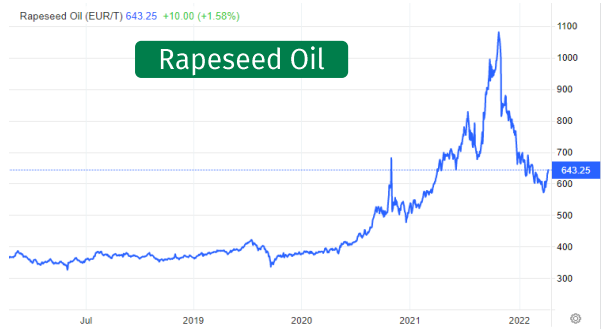
Raw material cost
Example Synthetic emulsifier prices dependent on energy costs and seed oil prices

Price of relevant raw materials (5Y)









The many layers of global inflation

Inflation Drivers

Cost-push

Demand-pull

Rising cost of raw materials

Soft Commodities (eg, corn, soybean, wheat, coffee, rice, cocoa, sugar meat, lumber, rubber, ethanol, cotton,)

Hard Commodities (eg metals, minerals, oil derivatives such as plastics, synthetic fabrics, etc)

Water (ground source)

Energy (eg oil, gas, electricity)

Packaging (eg glass, paper rPET, metals)

Rising cost of manufacturing and distribution

Labour (wages, shortages)

Automation (cost of machinery)

Supply chain (eg re-shoring vs off-shoring, from mega-suppliers to smaller suppliers)

Waste (reduction, disposal, circularity)

Warehousing (shortages)

Transportation (sea, land, air, rail)

- Pandemic demand volatility
- Climate change
- Political drivers/war/ sanctions
- Scarcity of natural resource
- Sustainability demands for ethical sourcing
- Pandemic demand volatility
- Political drivers/ war/ sanctions
- Increased online demand
- Sustainability demands for renewables
- Higher cost of wages
- Structural shifts/ ageing/ migration
- Pandemic supply volatility
- Machinery cost outlay
- Pandemic supply volatility
- Increased online demand
- Sustainability demands for ethical sourcing
- Sustainability demands/ legislation for waste reduction, recyclability, repairability, de-carbonisation, etc
- Increased online demand
- Supply chain bottlenecks driving larger inventories
- Shipping container/ haulier shortage; cross-border delays, accidents
- Political drivers/ war/sanctions
- Fuel costs

Short- to mid-term: Pandemic-induced drivers

Long-term: Sustainability, political instability, online demand

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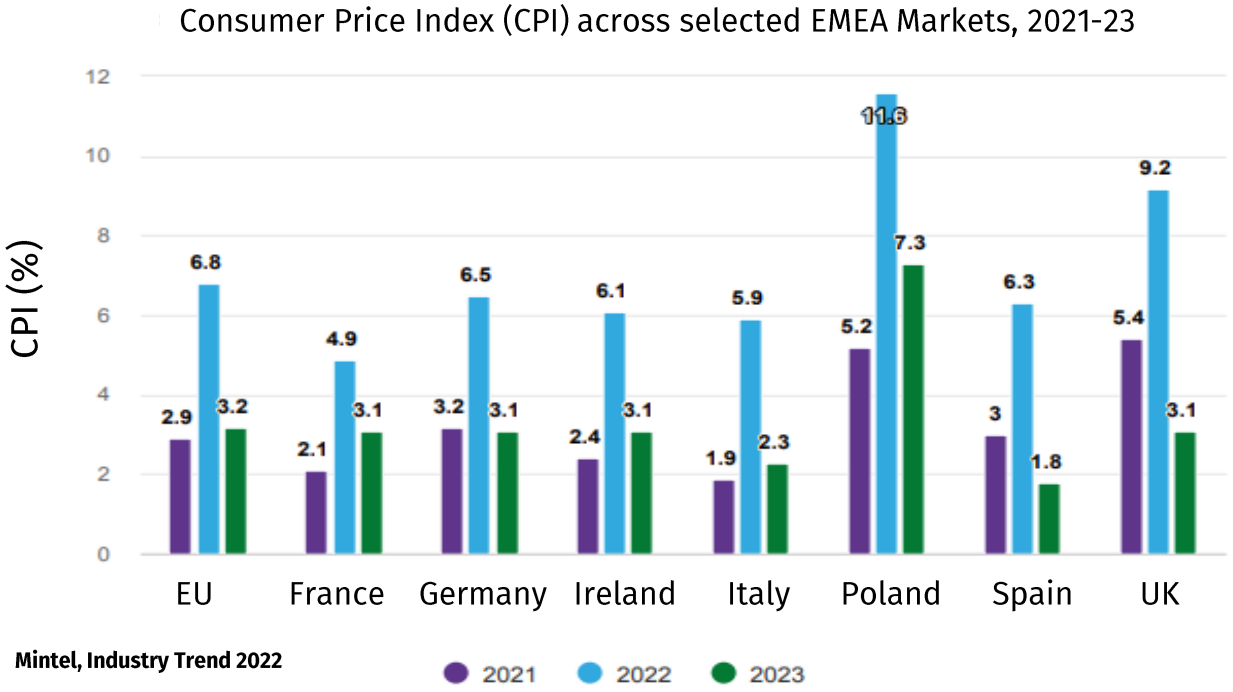
The current global situation is like a ‘perfect storm’

Inflation is likely to remain significantly higher than consumers are used to (2022-23)

- Economies are re-emerging post-COVID, face disrupted supply chains, and rising global tensions
- Current predictions show a decrease of inflation at the end of 2022 and in 2023, but geopolitical developments can disrupt this forecast at any given time



Mintel, Industry Trend 2022

Raw materials – improve efficiency to reduce costs

Flour standardization

Gluten modification

Lipases with emulsifier functionality

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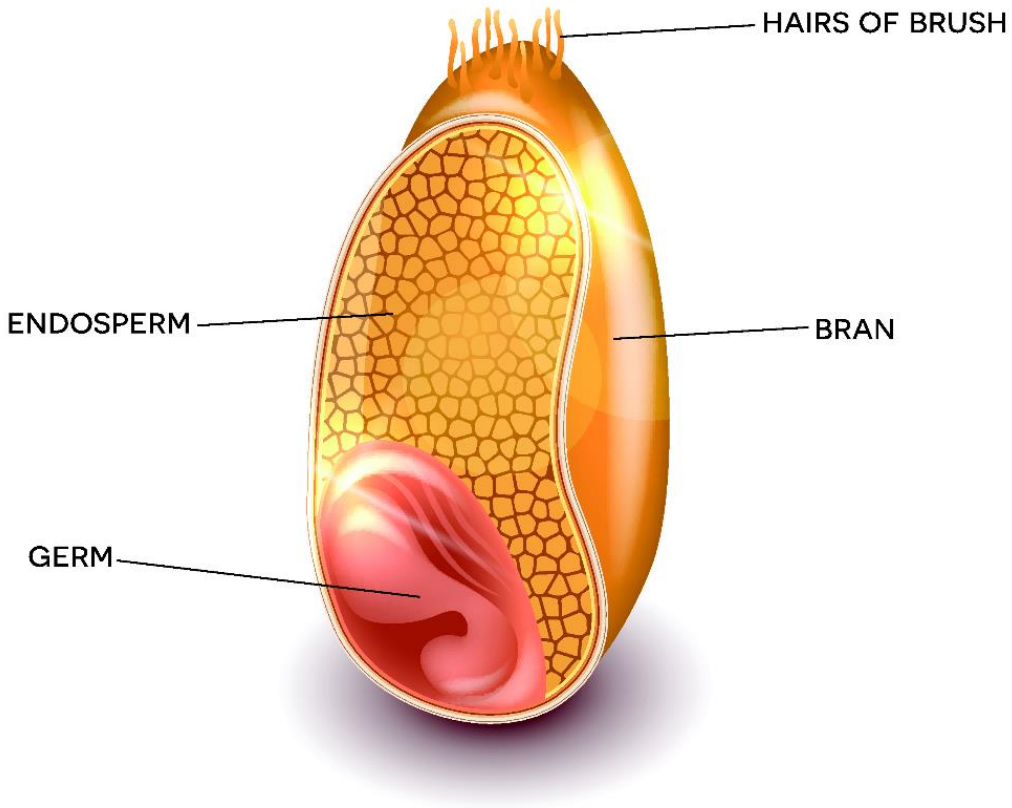
Wheat from various geographical regions

Standardization of flour

Composition of wheat flour

Endosperm	80-82 %
Bran	16-18 %
Germ	2 %



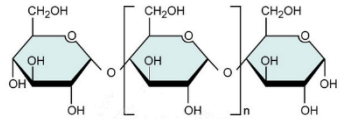
Wheat flour components
(after removal of the bran and germ)

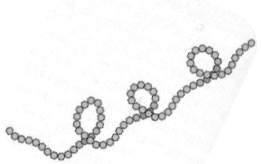
Starch	65-70 %
Sugars	1-2 %
Fibers (NSP)	1-3 %
Proteins	8-15 %
Lipids	1.5-3 %
Minerals	0.5 %
Water	12-15 %

Composition of wheat flour

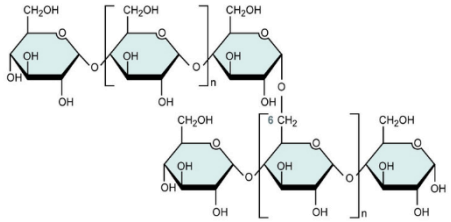
Starch

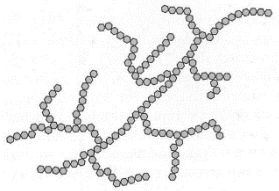
Amylose





Amylopectin





Proteins

Gluten

Gliadin
30-80 kDa

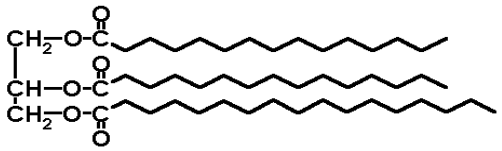
Glutenin
>80 kDa

Albumins

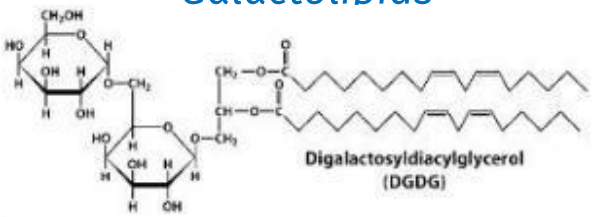
Globulins

Lipids

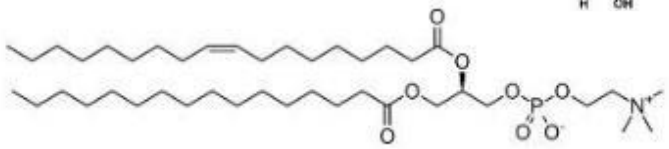
Triglycerides



Galactolipids

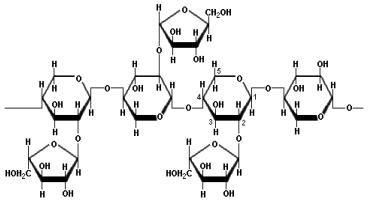


Phospholipids

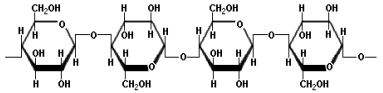


NSP

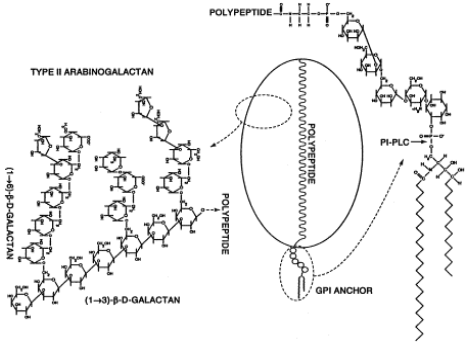
Arabinoxylan



Cellulose

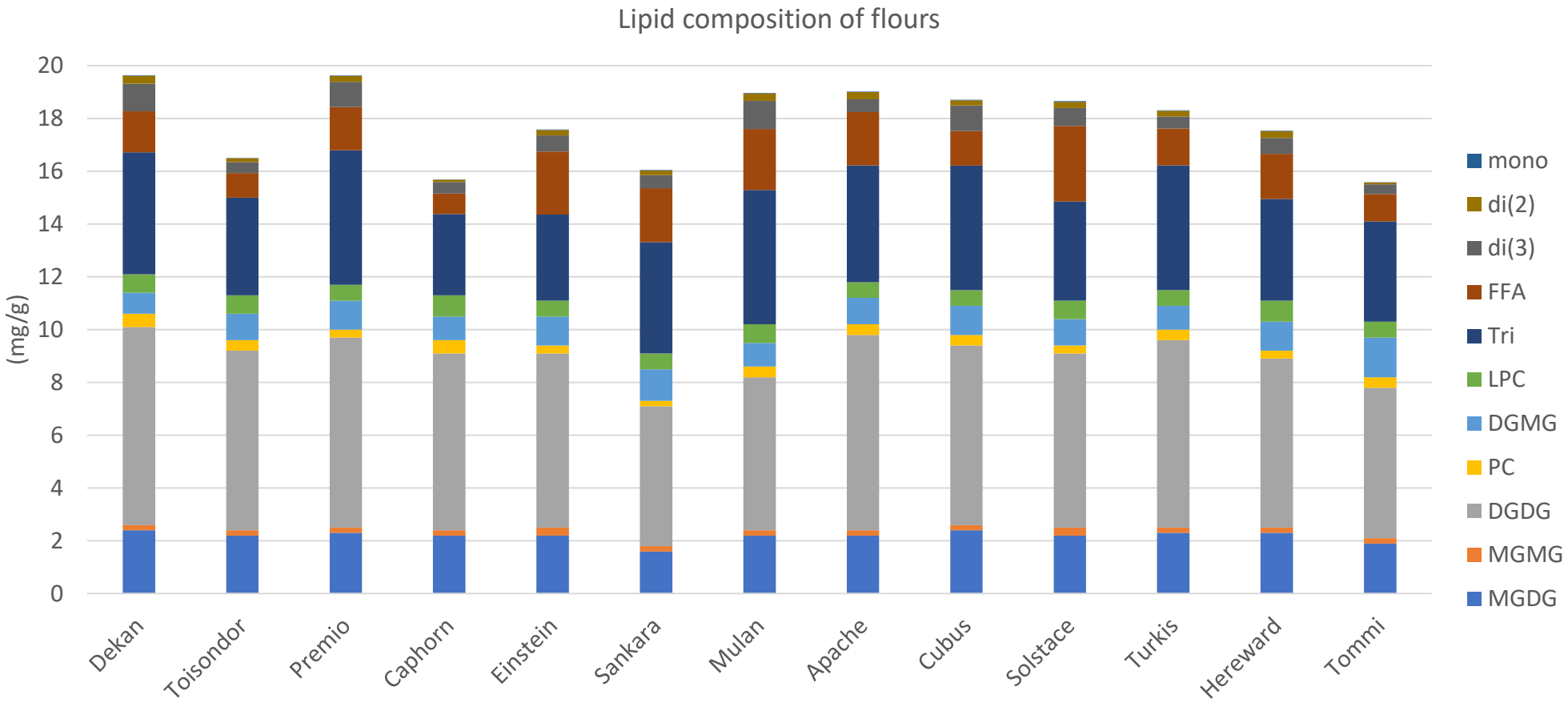


Arabinogalactans



Example of 13 European wheat varieties

Differences in lipid composition



Abbreviations: MGDG, monogalactosyldiglyceride; MGMG, monogalactosymonooglyceride; DGDG, digalactosyldiglyceride; PC, phosphatidylcholine; DGMG, digalactosylmonoglyceride; LPC, lysophosphatidylcholine; Tri, triglyceride; FFA, free fatty acid; di(3), 1,3-diglyceride; di(2), 1,2-diglyceride; mono, monoglyceride.

Correction towards constant quality

Flour improvement agents for flour treatment

Wheat gluten

- standardize protein level

Diastatic activity

- adjust Falling Number

Oxidative agents

- ascorbic acid
- glucose oxidase

Reducing agents

- L-cysteine
- glutathione
- sodium metabisulphite

Why correction on flour and on final product are both needed

Differences and similarities

FLOUR CORRECTOR		BREAD IMPROVER
	Applied by	
• Flour mills		• Bakeries
	Objective	
• Reduce quality variations in flour		• Improve processing and final product characteristics
	Dosage	
• 5-50 grams per 100 kg		• 0.3-30% on flour weight base
	Examples	
• Enzymes • Ascorbic acid • Reducing agents (L-Cystine, SMBS) • Malt flour • Wheat gluten		• Enzyme (single or blends) • Ascorbic acid • Emulsifiers • Potentially can contain any bread ingredient
	Enzyme dosage	
• Low to medium		• Medium to high
	Limitations	
• Flow characteristics • Number of micro feeder pots • Additives requiring declaration • Enzyme concentration • Particle size		• Usage of enzymes limited to water free formulations
	Formulators	
• Home made • Specialized companies		• Spezialized companies • Contract blenders

Flour characterization

Source: Chopin (Alveograph), Brabender (Farinograph, Extensograph), Perten (RVA)

Raw materials – improve efficiency to reduce costs

Flour standardization

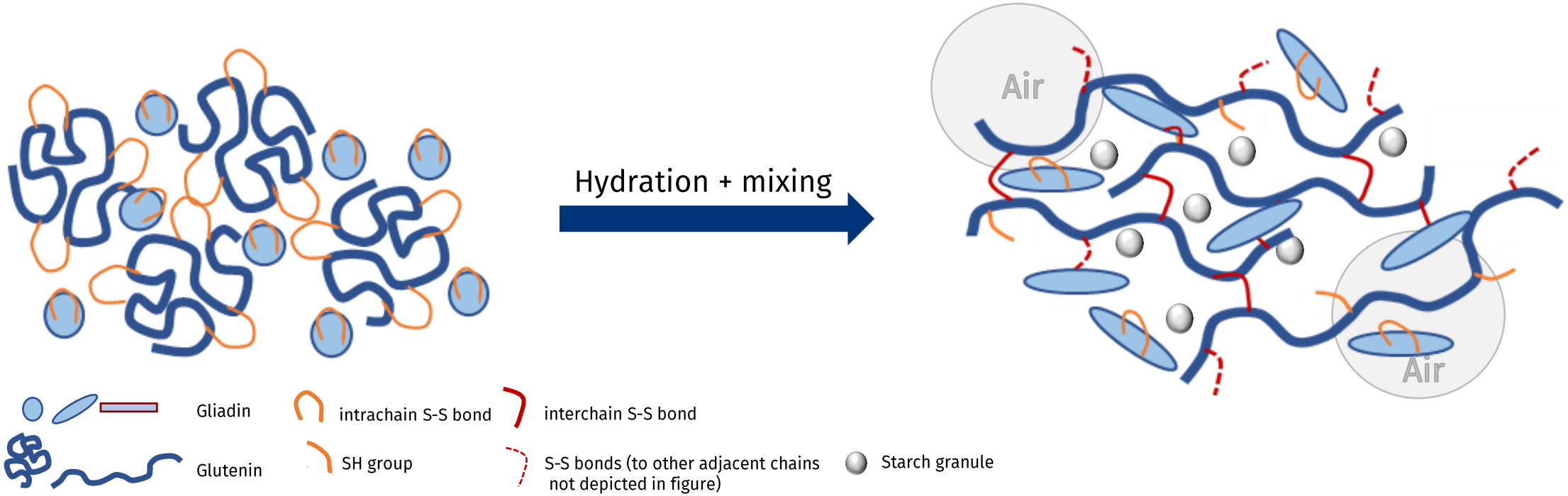
Gluten modification

Lipases with emulsifier functionality

Gluten modification

To obtain the desired dough machinability, strength and extensibility to improve process efficiency

Upon mixing gluten absorbs approximately twice its weight in water and forms a three-dimensional network

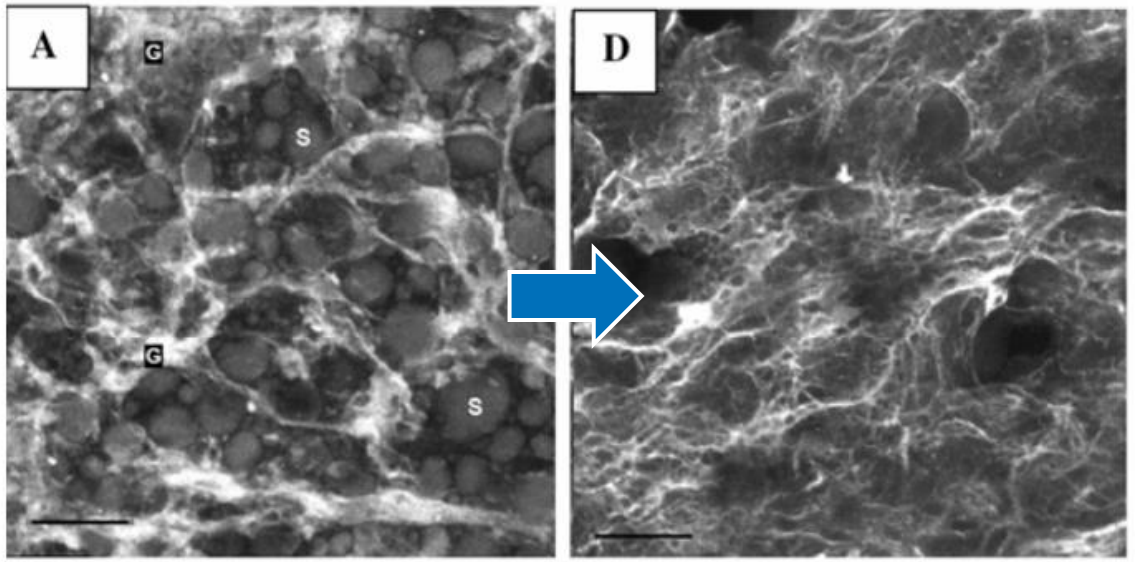


- During dough mixing the gluten absorbs water and the gluten forming proteins start to swell up.
- As result of the shear forces of the dough mixer, a three-dimensional network is formed through SH-SS interchanges.
- In this network air is entrapped and starch granules distributed

Dough making

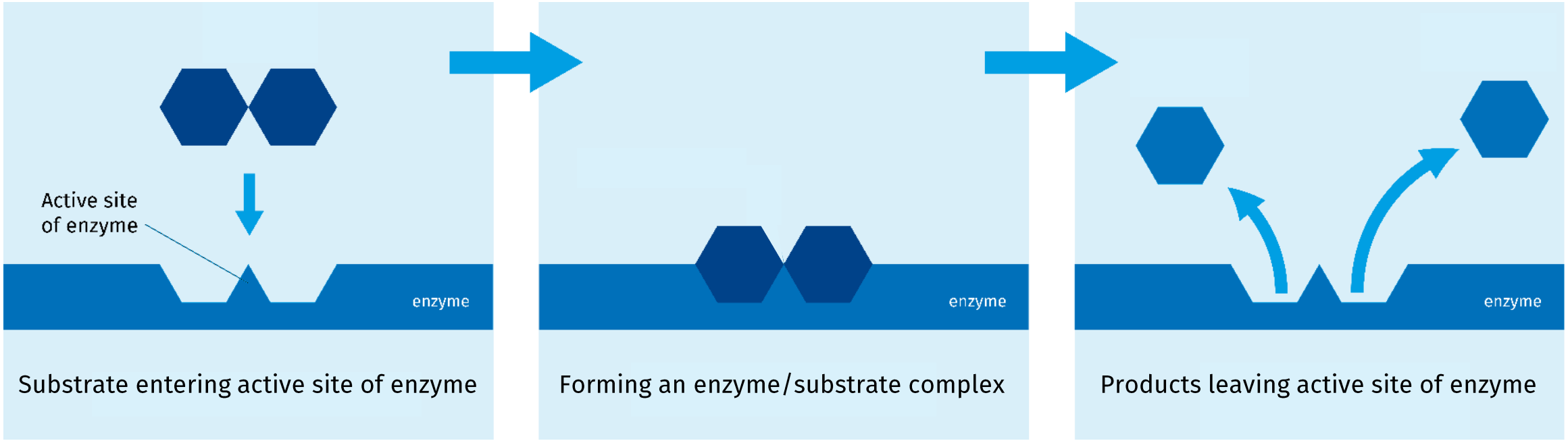
- Kneading
  - Mixing of ingredients (including enzymes)
  - Binding of water
  - Development of an optimal gluten structure
  - Uptake of air
- Wheat gluten quantity and quality determine baking quality of dough
  - Impact of oxidants (AA) – reducing agents (L-cysteine), redox enzymes (GOX)
  - Vital wheat gluten addition
- Proper hydration of all components is of importance

Dough Tortilla



Source: Alviola et al, 2008: Role of Gluten in Flour Tortilla Staling

How do enzymes work?



Substrate entering active site of enzyme

Forming an enzyme/substrate complex

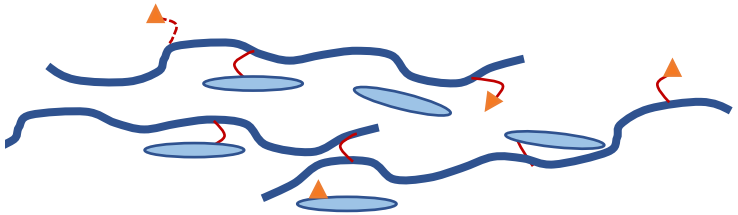
Products leaving active site of enzyme

Enzyme functionality is affected by:

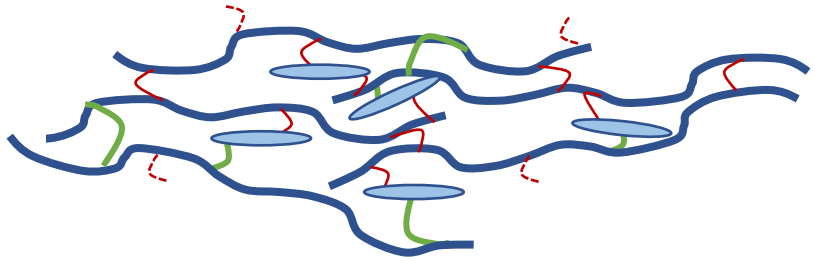
- Time, Temperature and pH of the process
- Water activity
- Substrate availability and accessibility
- Amount of enzyme
- Inhibitors (like salt, sugar etc.)
- Enzymes are being inactivated during the baking process

Extensible dough leads to a larger tortilla

Extensibility: stretch of dough without retracting



Extensible dough
Fewer connection points, less retraction after deformation



Elastic dough
More connection points, stronger retraction (more elastic) after deformation

Tailor the size of your tortilla with enzymes

Strengthening of flour

BakeZyme® GO 10.000 / BakeZyme® Go Pure

Dough strengthening solution for improving dough handling and stability and creating drier doughs

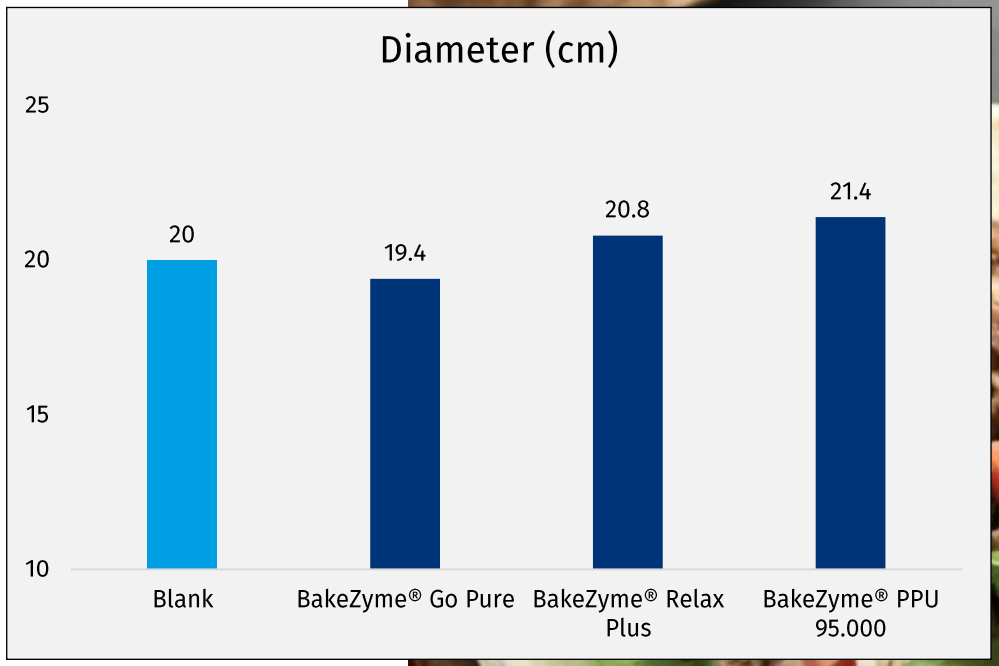
Relaxation of flour

BakeZyme® PPU 95.000

Mild acting protease for relaxation of strong flours

BakeZyme® Relax Plus

The natural relaxing solution for improvement of dough extensibility



Raw materials – improve efficiency to reduce costs

Flour standardization

Gluten modification

Lipases with emulsifier functionality

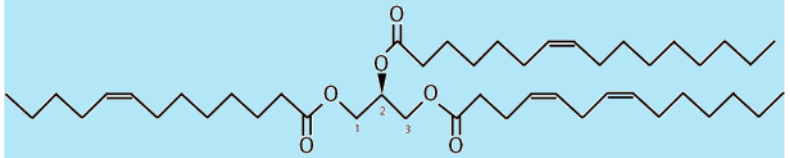
Lipases with emulsifier functionality

To create soft, fluffy and cleaner label tortillas

Lipids in wheat flour

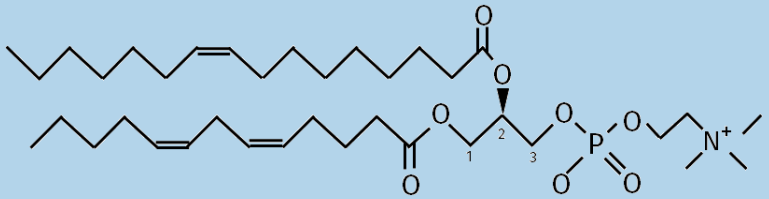
most important lipid classes in wheat flour

Triglyceride (TAG)

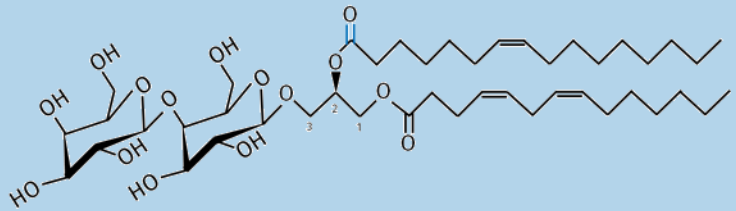


neutral lipids

Phospholipids



Galactolipids



polar lipids

- (Phosho)lipases act on wheat flour lipids during dough processing bringing multiple benefits.

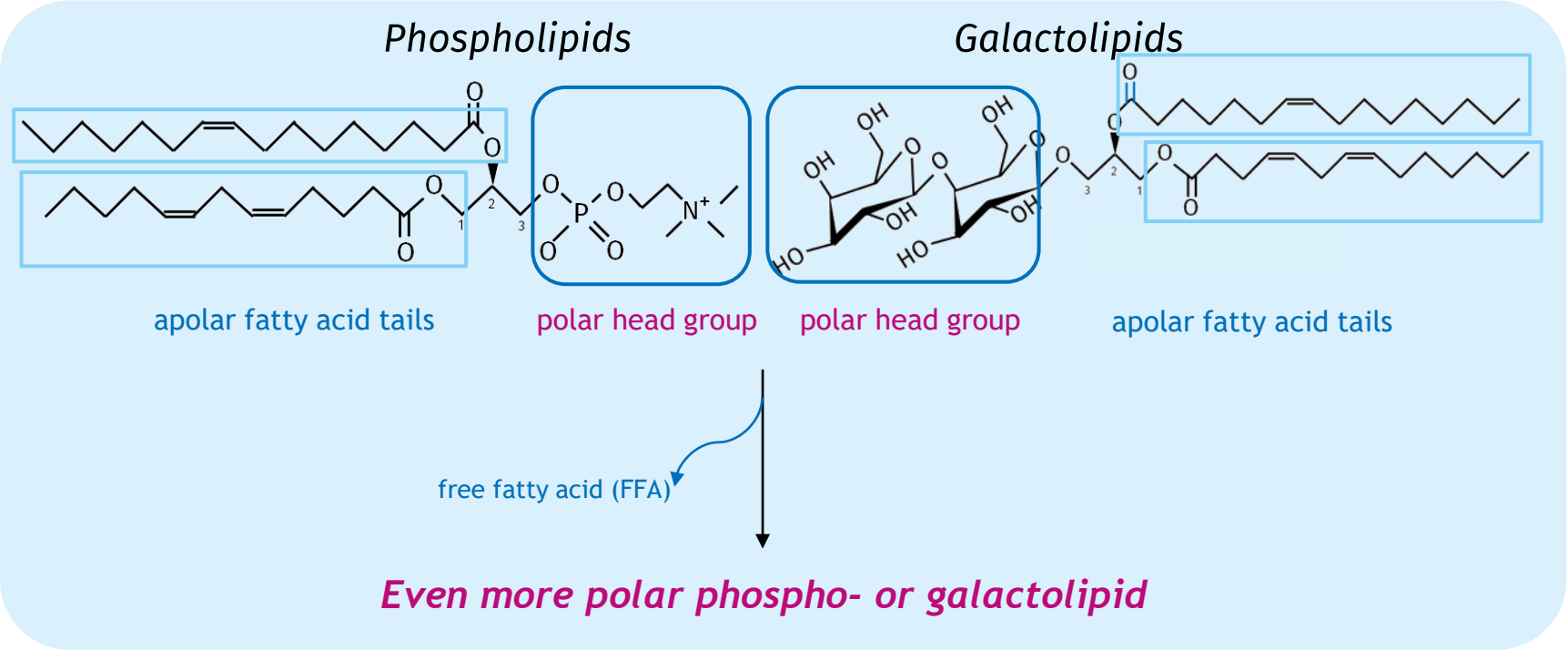
Improved dough stability by Phospholipase

Phospholipase acts on polar wheat lipids

The more polar the phospho- or galacto-lipid, the better it is at stabilizing gas cells.

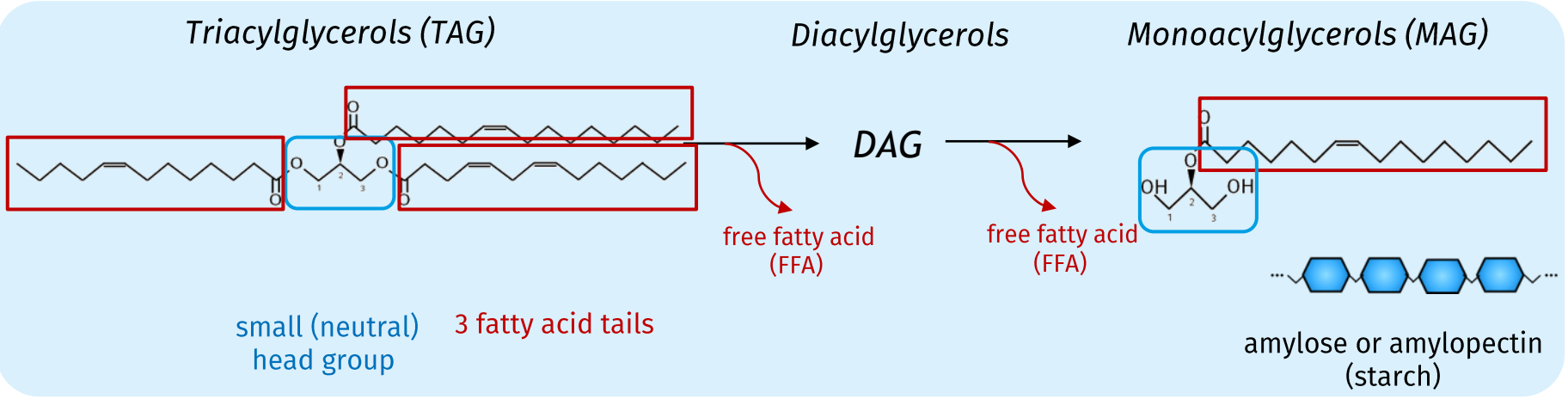
This way, it can replace emulsifier functionality.

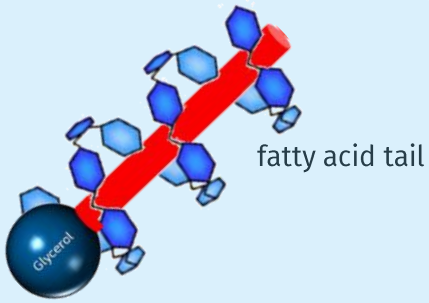
Panamore® Golden



Improved softness by triacylglycerol lipase

Lipase acting on neutral wheat lipids





Starch molecules that interact with MAG and form lipid inclusion complexes, can no longer crystallize. This way, a softer tortilla is obtained.

BakeZyme® L80.000 B

(Phospho)lipases can replace emulsifiers in tortillas

Benefit of (Phospho)lipases:

- Soft dough
- Improved gas stability
- Enhanced emulsification
- Soft fluffy tortilla
- Maintained softness over shelf life
- Reduced staling

DSM Solutions Improving Flour Tortillas

Improved dough extensibility / increased size

Hemicellulases
- BakeZyme® BXP 5001
- BakeZyme® HSP 6000
- BakeZyme® FXP 1500
- BakeZyme® Real-X

Proteases
- BakeZyme® PPU 95.000
- BakeZyme® B 500

Glutathione
- BakeZyme® Relax Plus

Improved dough elasticity

Glucose Oxidases
- BakeZyme® GO 10.000
- BakeZyme® Go Pure

Reduced Sticking of tortillas

Glucose Oxidases
- BakeZyme® GO 10.000
- BakeZyme® Go Pure

(Phospho)lipases
- Panamore® Golden
- BakeZyme® L 80.000 B

Freshness / rollability / foldability (shelf life)

Maltogenic Amylase
- BakeZyme® Master

Pectin
- Pectner™ APC 170

Gellan gum
- Gellaneer™ HS-204-S2

Check regulatory status for approved countries

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