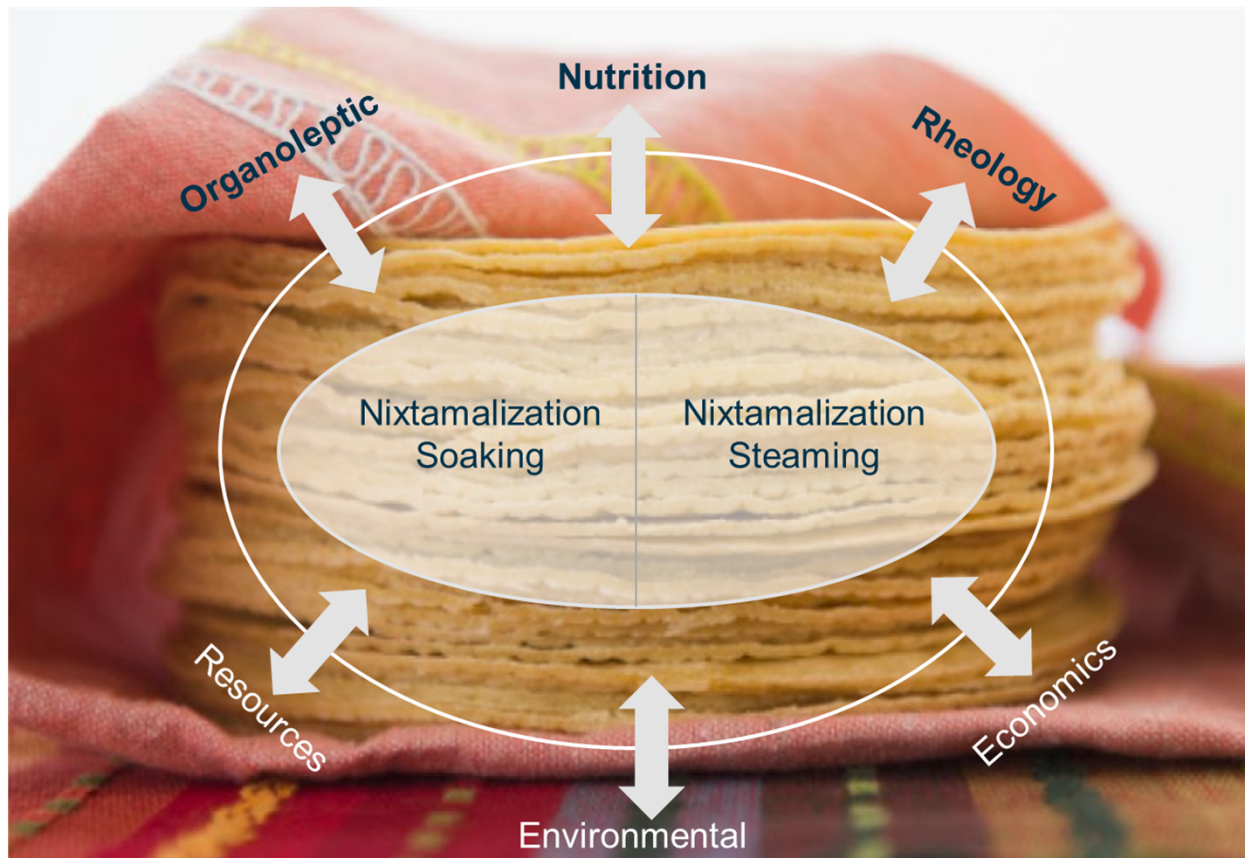# Soaking vs. Steaming
Difference in nutritional value and texture of Nixtamal flour

Daniel Garcia, Process Development Manager Buhler Inc.
TIA Tech Long Beach, CA

Innovations for a **better world.**

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Introduction:
The benefits of steam technology in nixtamalization process.

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Background:

Food Application Center
Minneapolis, MN

Daniel Garcia
Process Development Manager

Playground of the Food Industry.

- Process Application Space.

- Process IoT.

- Training Center.

- Analytical Laboratory

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Tortilla Trends Worldwide.
More Dynamics – More Potential.

MORE DEMAND FROM THE ENVIRONMENT
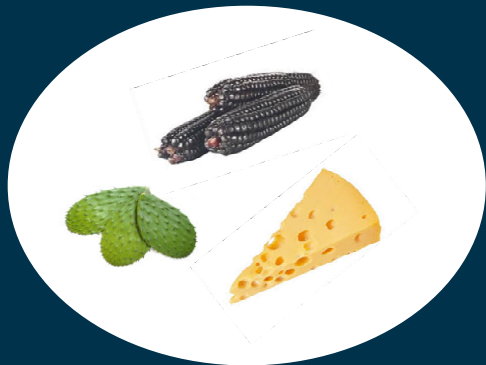
New flavors and ingredients

Fast food chain expansion

A driver of corn tortillas vs. wheat wraps

Conscious nutrition/ Whole grains/ added vitamins/ GMO banned

Market potential.

Maize
Crop >1 bn ton
Food> 175 m ton

CAGR >3%

fastest growing segment within the baking industry

CAGR 4%

Tortillas – ongoing popularity in central and north america

Tortilla Chips – Trend of snackification

13 mio ton tortilla markets in North and Central America alone

60 mio Hispanic Population in the US today

280 bn tortillas are consumed yearly in the US
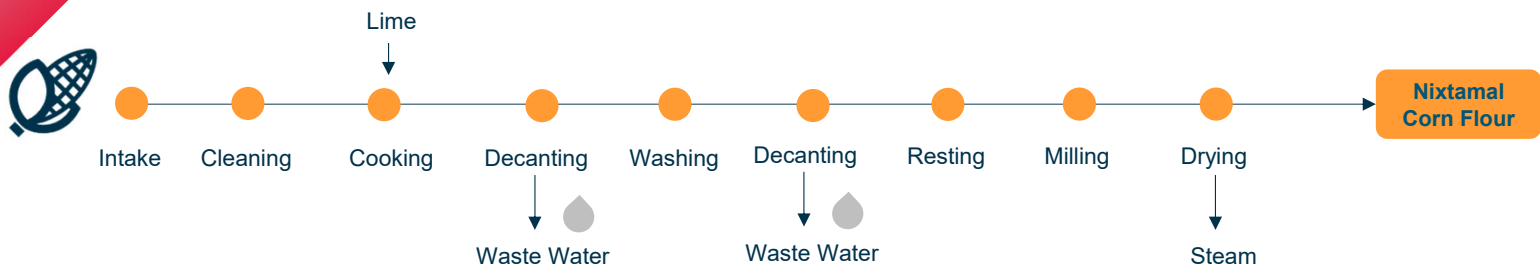
Customer price for Tortilla is around **$9 / kg**

Global **tortilla chips** consumption **exceeds 1.3 m tons** per year

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Nixtamal Flour Production Today

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The **pain** in the
Soaking Process

Lime

Intake — Cleaning — Cooking — Decanting — Washing — Decanting — Resting — Milling — Drying → **Nixtamal Corn Flour**

Decanting → Waste Water

Decanting → Waste Water

Drying → Steam

- 1.5 tons of wastewater per ton of flour
- Loss of healthy fibers, nutrients and starch
- Additional energy for cooking and drying required
- Wastewater needs treatment

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	part of whole kernel %
pericarp	5.93
testa	
aleurone	7.12
horny Endosperm	51.00
floury Endosperm	22.96
germ	11.53
cap	1.46
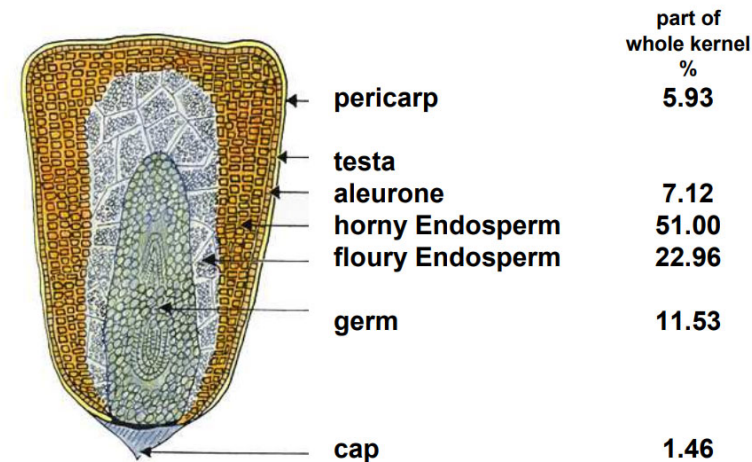
Wastewater Nejayote: diminishing corn nutritional value and consequently, of the foods obtained from it.

Nutritional Loss : Corn Germ and Pericarp

- Soluble and insoluble solids
- Polysaccharides, Starch, Protein and Lipids
- Bioactive compounds: polyphenols, carotenoids.
- Parts of the endosperm: cellulose and hemicellulose

Process Complications

- High pH Value, Biological and Chemical Oxygen Demand
- High Temperature, important energy loss
- Water Treatment Needed
- Hard to treat organic-inorganic mixture.
- Waste solids after filtration
- Overloads Cities Wastewater treatment plants
- Spraying on fields creates odor issues.

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Only 2.5% fresh water vs. 97.5% salt water

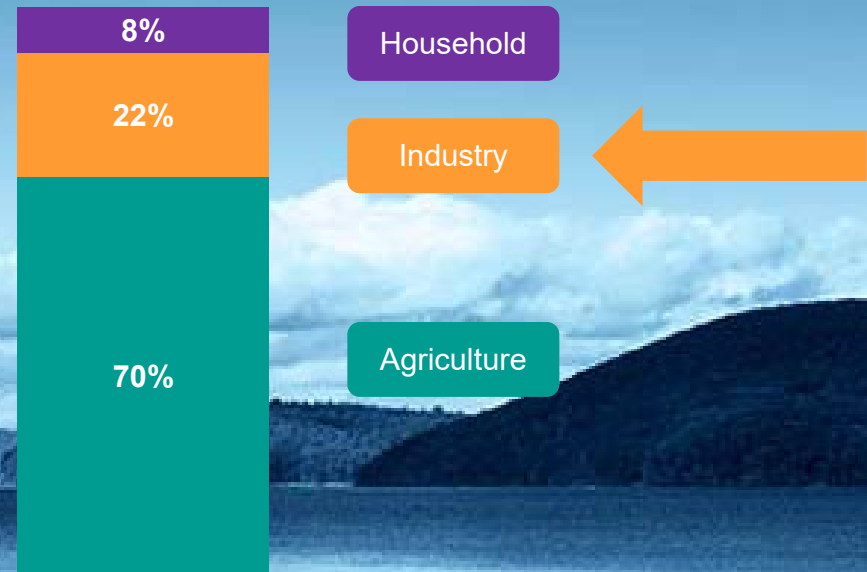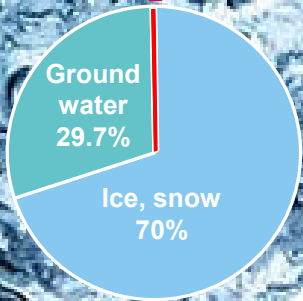**Only 0.3%** lake and river water

Ground water 29.7%

Ice, snow 70%

By 2040 we will be using 70% of the potable H2O
Today we are already using 50%

7 bn people will suffer from **water scarcity** by 2050

8%
22%
70%

Household

Industry

Agriculture

*Source: UNO

Challenges of the Future Nixtamalization

Nixtamalization Challenges

Reduce **Water** Consumption

Reduce **Energy** Consumption

Improve **Yield**

Enhance **Nutritional** Value

Eliminate **Wastewater**

Green Forward

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Overview on Nixtamal Technologies Today

Revalorization of Waste

Reducing waste,
Cooking time

Elimination of
Wastewater

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Overview on Nixtamal Technologies Today
Revalorization of Waste

Revalorization of Waste

Reducing waste, Cooking time

Elimination of Wastewater
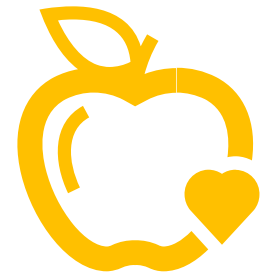
Use in formulation for animal feed

- Nejayote solids combined with soy and sorghum
- Source of calcium for pigs
- Limited % 2-6
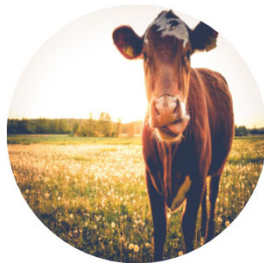
Recovery of Nutritional Value
Extraction, Filtration, etc.

- Carbohydrates
- Calcium components
- Phenolic compounds

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Overview on Nixtamal Technologies Today
Reducing Waste and Cooking Time

Substitution of calcium hydroxide for other calcium salts in the process

- CaCl2, CaSO4, and CaCO3
- fewer polluting residues as compared to those resulting from Calcium Hydroxide

Use of Alternative Technologies

- Ultrasound: high-power sound waves at low frequency (20 kHz)
- Microwave: 915 to 2450 MHz generating heat in the food Matrix
- Pulse Electric Fields and Ohmic Heating: food can resist the flow of electric energy.

→ Increase nutritional value, cooking time, energy efficiency.

Overview on Nixtamal Technologies Today
Eliminating waste and reducing cooking time

Revalorization of Waste

Reducing waste, Cooking time

Elimination of Wastewater

Thermal + Mechanical Energy

Extrusion

- Food Pressed through die
- High Pressure and Temperature
- Forced to pass Through a geometrical shape

High Shear Forces → Over Gelatinization

Steam Technology

- Steam used as the main input of thermal energy
- Flaking used to accelerate and tune gelatinization

Milder Mechanical Forces + easier control of gelatinization

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Innovative process

Innovations for a **better world.**

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Prime Masa Nixtamal.
Sustainable and innovative solution for tortilla flour.

84%
Savings of water

52%
Savings of energy for cooking and drying

96%
Reduction of Waste

up to **3% more yield**

Intake — Cleaning — Conditioning — Lime Water Addition — **Steaming** — **Flaking** — Drying — Cooling — Grinding — Blending

Nixtamal Corn Flour

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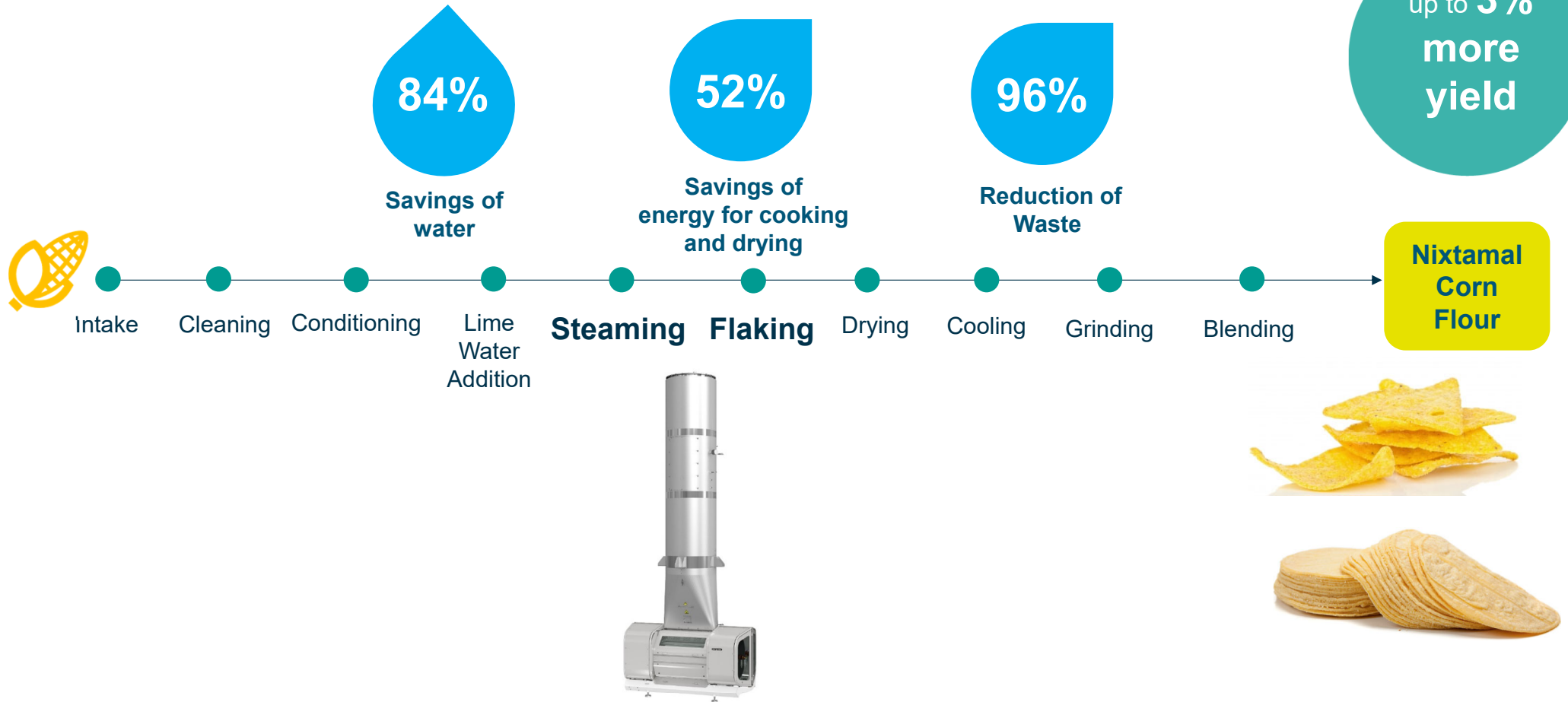
Savings in the Plant due to Prime Masa Process

- 26.2%

Reduction of CO_2e in the Plant

ENERGY

- 52%

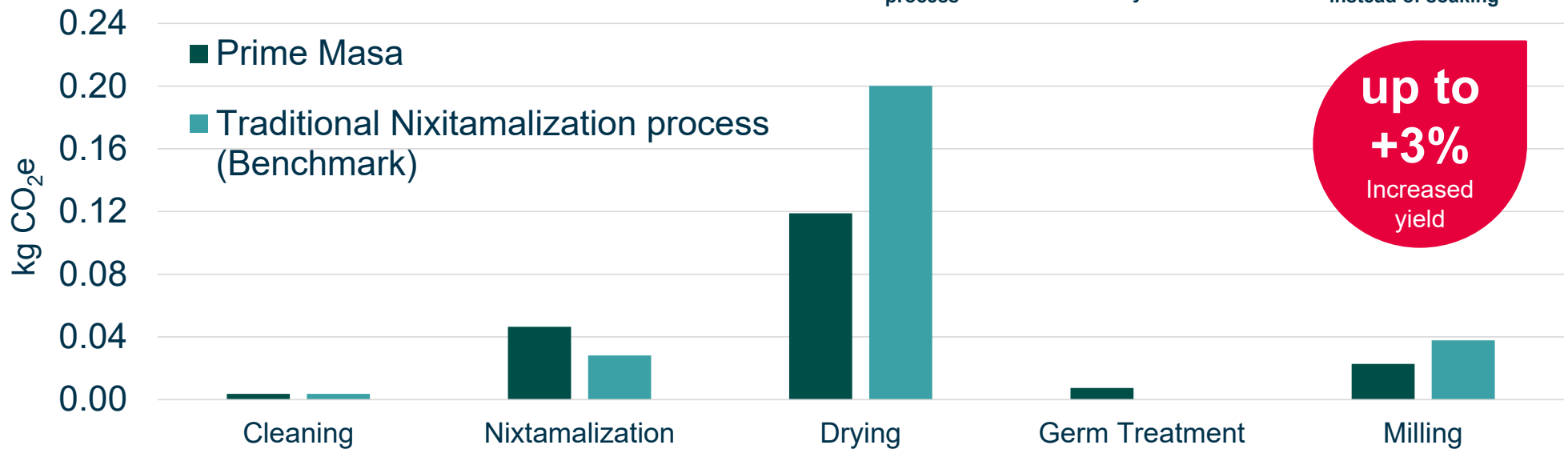**For cooking and drying compared to traditional process**

WASTE

- 96%

Due to elimination of waste water and better yield in Maize

WATER

- 84%

Due to steaming and flaking technology instead of soaking

up to +3%

Increased yield

Bar chart — y-axis: kg CO_2e (0.00 to 0.24). Legend: Prime Masa; Traditional Nixitamalization process (Benchmark). Categories: Cleaning, Nixtamalization, Drying, Germ Treatment, Milling.
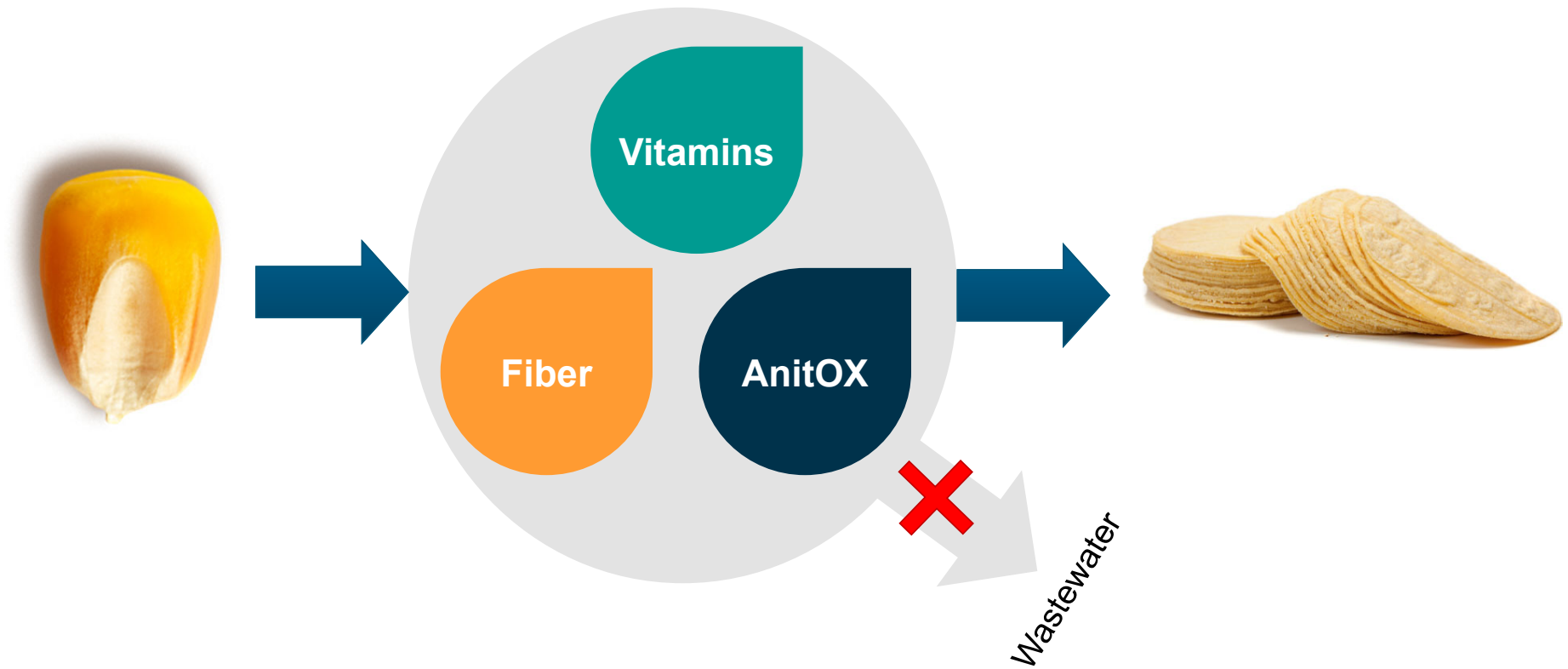
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Savings in Customer's Value Chain

Comparison of Benchmark & Innovation
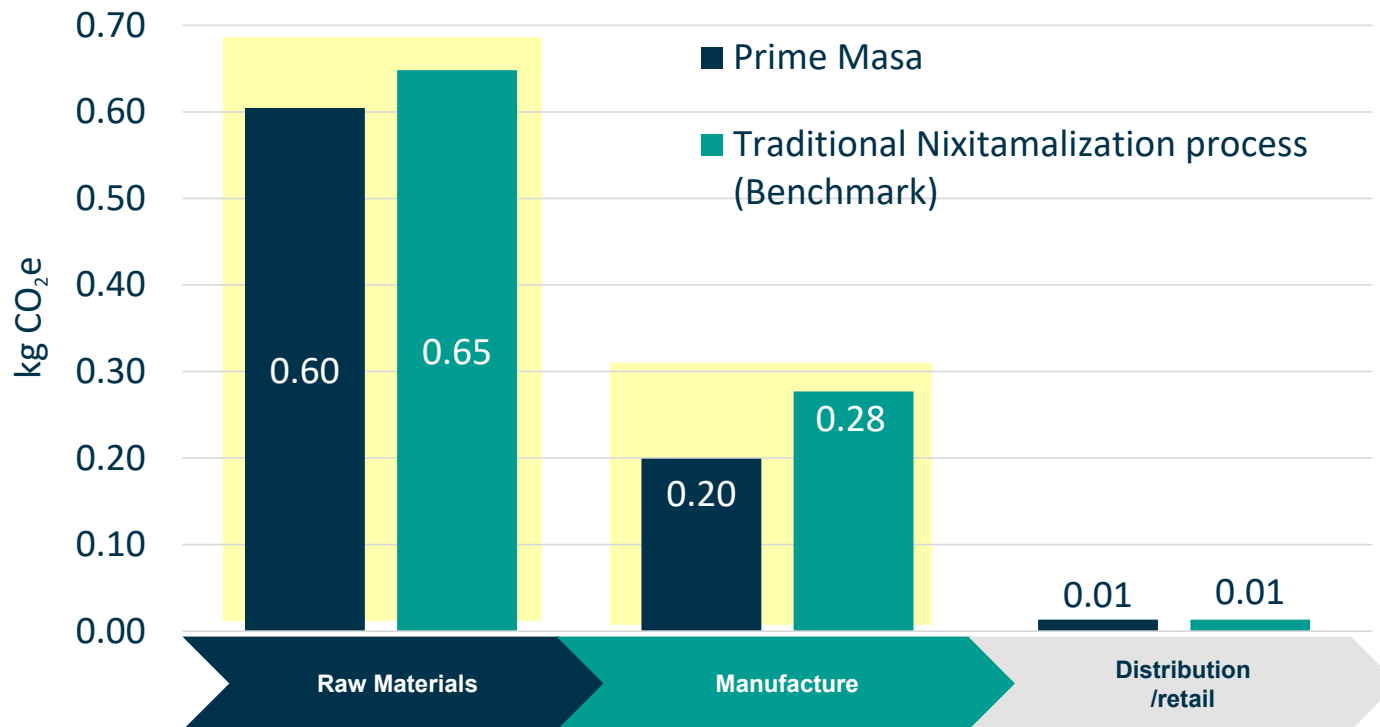
- 12.9%

**Reduction of CO_2e
in Bühler's customers' Masa
Flour Value Chain**

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Nutritional Value of Steam Cooked Nixtamal

Vitamins

Fiber

AnitOX

Wastewater

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Comparison of vitamin content in Steam Processing (Prime Masa) versus Soak Processing (Maseca, Minsa)

Reference used

Steam Processing: Prime Masa* without fortification.

Soak Processing: Maseca and Minsa after fortification

Vitamin D: responsible for increasing intestinal absorption of calcium, magnesium, and phosphate, and many other biological effects

Vitamin D

Vitamin	unit	Prime Masa	Maseca	Minsa
D2 Ergocalciferol	µg/100g	1.38	0.49	0.7
D3 Cholecalciferol	µg/100g	1.78	1.03	0.86

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Comparison of vitamin content in Steam Processing (Prime Masa) versus Soak Processing (Maseca, Minsa)

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Steam Processing: Prime Masa* without fortification.

Soak Processing: Maseca and Minsa after fortification

Vitamin B: responsible for cell health and overall well being

Vitamin B

Vitamin	unit	Prime Masa	Maseca	Minsa
B1 Thiamine	mg/100g	0.69	0.51	0.64
B2 Riboflavin	mg/100g	0.28	0.57	0.7
B3 Niacin	mg/100g	8.32	3.93	3.66
B6 Pyridoxine	mg/100g	0.81	0.25	0.33
B12 Cobalamins	µg/100g	14.63	14.51	22.24

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Comparison of phenolic content

Reference used

Steam Processing: Prime Masa* without fortification.

Soak Processing: Maseca and Minsa after fortification

Phenolic Compounds: important roles in improving human health and may protect against heart disease, cancer, the effects of aging, and membrane damage.

Phenolic Compounds

FREE Phenolics

Compund	unit	Prime Masa	Maseca	Minsa
Cumaric Acid	µg/g	27.2	14.5	20.1
Ferulic Acid	µg/g	7.9	26.9	71
3	µg/g	10.3	53.4	52.5
4	µg/g	44.6	7.9	6.2

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Comparison of phenolic content

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Steam Processing: Prime Masa* without fortification.

Soak Processing: Maseca and Minsa after fortification

Phenolic Compounds: important roles in improving human health and may protect against heart disease, cancer, the effects of aging, and membrane damage.

Phenolic Compounds

BOUND Phenolics

Compund	unit	Prime Masa	Maseca	Minsa
Cumaric Acid	µg/g	61.69	61.56	65.83
Ferulic Acid	µg/g	455.71	206.42	381.66
3	µg/g	57.32	16.22	29.62
4	µg/g	82.84	110.91	35.68

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Comparison of phytosterol content

Reference used

Steam Processing: Prime Masa* without fortification.

Soak Processing: Maseca and Minsa after fortification

Phytosterols: 2 grams of phytosterols per day can reduce your LDL cholesterol by anywhere from 8 to 10%.
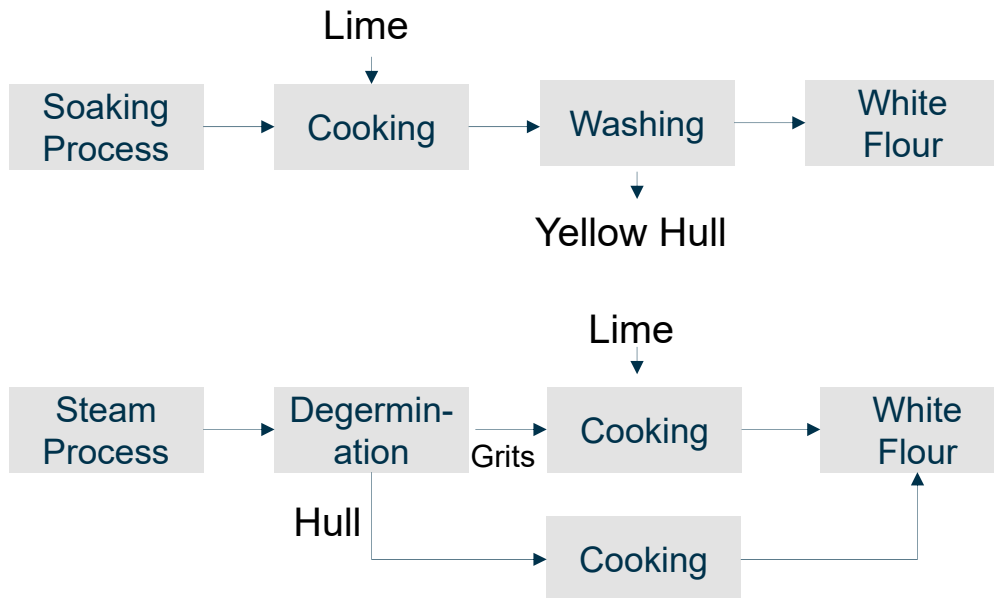
Phytosterols

| Compund	unit	Prime Masa	Maseca	Minsa
Campesterol	µg/g	267.87	83.94	66.48
Stigmasterol	µg/g	492.65	135.94	98.24
B-Sitosterol	µg/g	215.57	155.46	128.13

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Comparison of Fiber

Fiber

- Most of the fiber content get lost in the nejayote
- Due to a reaction of the hull/pericarp with the lime the color changes from white to yellow.
- Washing Process is used to remove the yellow hull/pericarp


```
                    Lime
                     |
                     v
Soaking  --->    Cooking    --->   Washing   --->   White
Process                                             Flour
                                      |
                                      v
                                 Yellow Hull


                              Lime
                               |
                               v
Steam  --->  Degermin-  Grits  Cooking   --->   White
Process      ation    -------->                 Flour
                  Hull                            ^
                      -------->  Cooking  --------|
```

- Control of fiber content
- Specific Fiber Milling possible
- Whole Grain Tortillas

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Nutritional Value of Steam Cooked Nixtamal

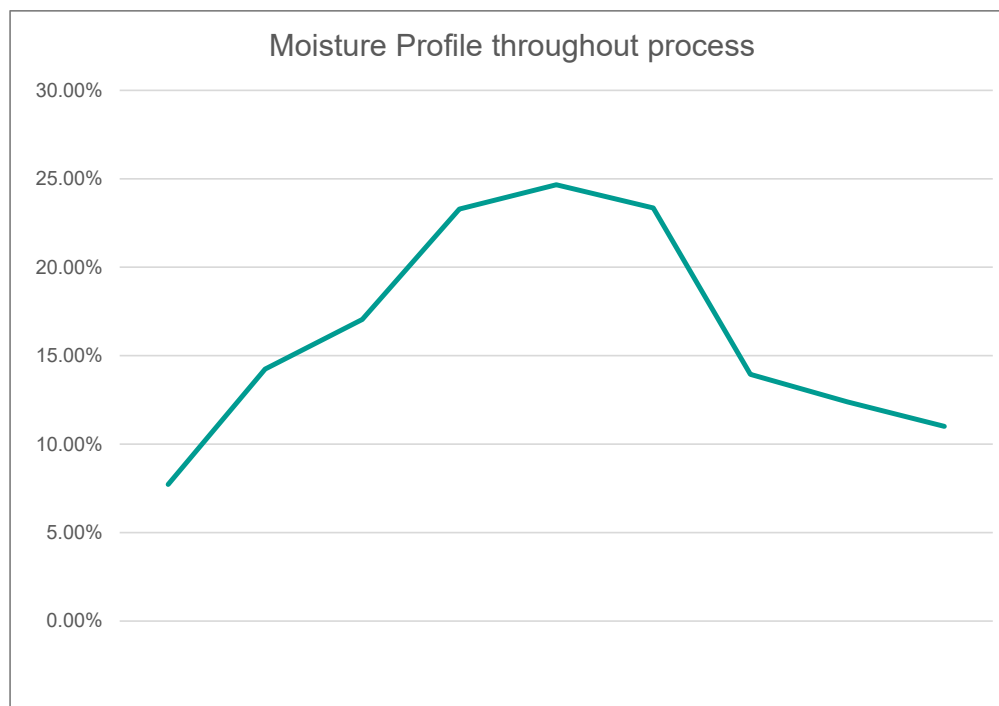Vitamins

Fiber

AnitOX

Wastewater

BÜHLER
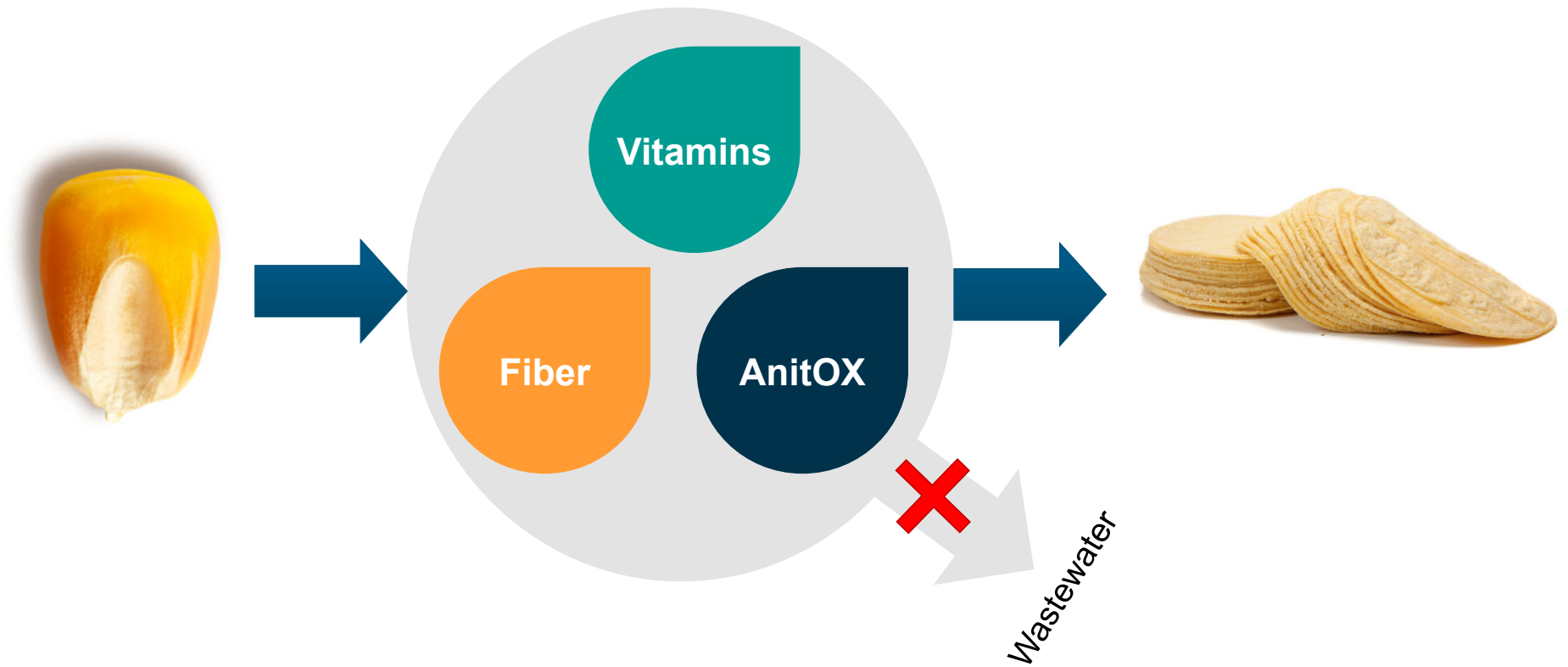
Flour Properties

- Moisture 8-12%
- Color
- pH 6-7
- Granulation: Fine for Tortillas Coarse for Frying
- Gelatinization: High for Tortillas, Low for Frying

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Flour Properties

Characterization of Nixtamal Flour

- **Moisture 8-12%**
- Color
- pH 6-7
- Granulation: Fine for Tortillas Coarse for Frying
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Moisture Profile throughout process

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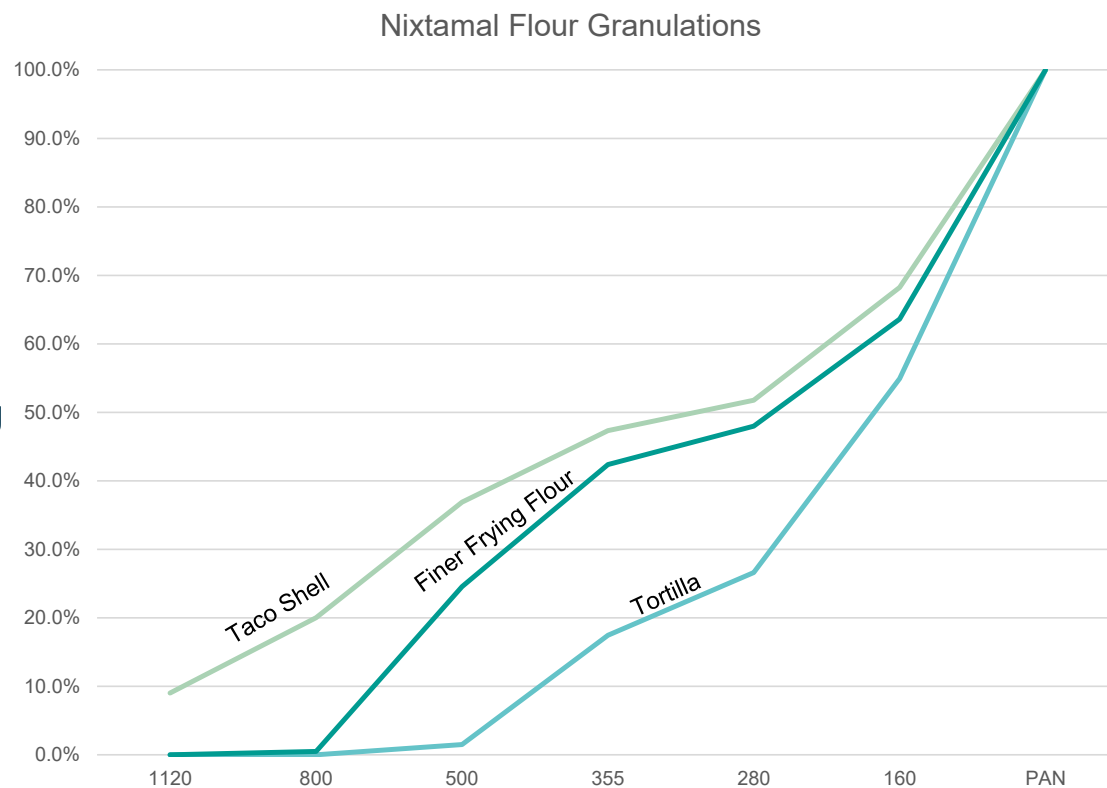# Flour Properties

Characterization of Nixtamal Flour

- Moisture 8-12%
- **Color, controlled by lime content**
- **pH 6-7, controlled by lime content**
- Granulation: Fine for Tortillas Coarse for Frying
- Gelatinization : High for Tortillas, Low for Frying
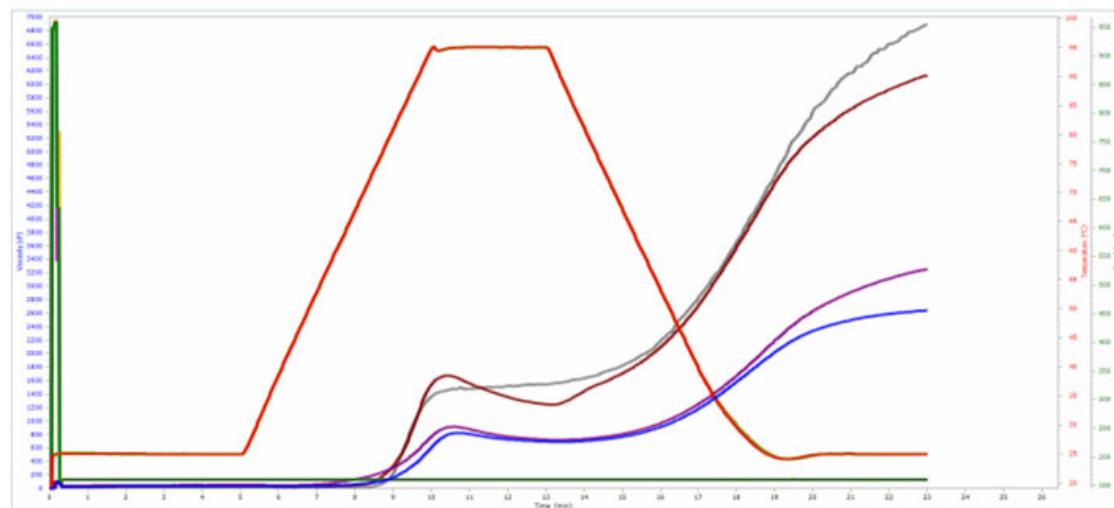
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Flour Properties

Characterization of Nixtamal Flour

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- Color, controlled by lime content
- pH 6-7
- **Granulation: Fine for Tortillas Coarse for Frying**
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Nixtamal Flour Granulations

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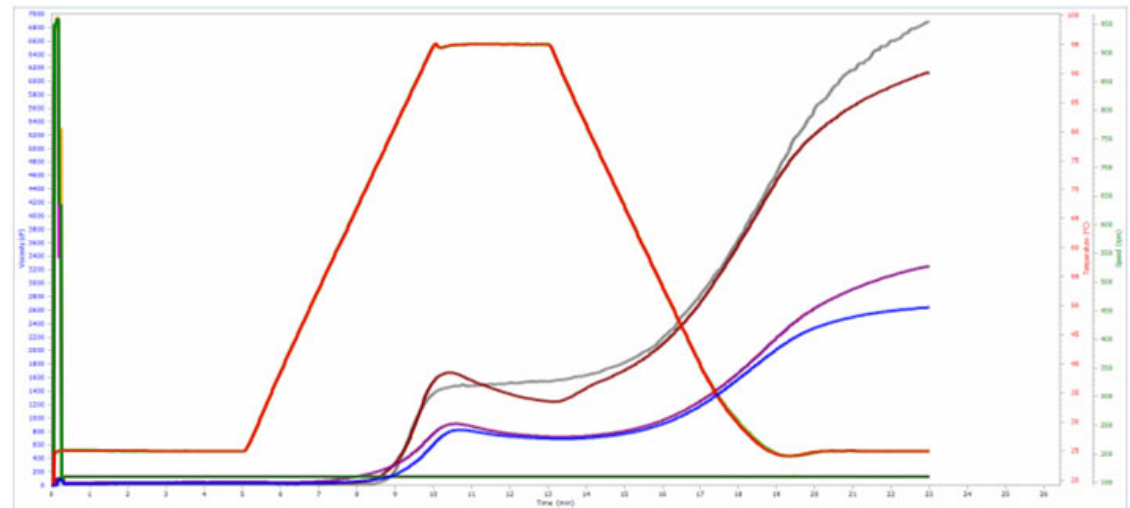
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Flour Properties

Characterization of Nixtamal Flour

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- pH 6-7
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- Gelatinization **: High for Tortillas, Low for Frying**

→ *Most important parameter*

Measured indirectly

- **Rapid Viscosity Analysis RVA**
- Expansion
- Bostwick
- Penetrometer

‎ ‎ ‎ ‎ ‎ ‎ = Reference A ‎ ‎ ‎ ‎ ‎ ‎ = Prime Masa MX White Corn

‎ ‎ ‎ ‎ ‎ ‎ = Reference B ‎ ‎ ‎ ‎ ‎ ‎ = Prime Masa US White Corn

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Flour Properties

Characterization of Nixtamal Flour

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- pH 6-7
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- Gelatinization **: High for Tortillas, Low for Frying**

→ *Most important parameter*

- In Soaking process controlled by residence time
  – Harder corn varieties need **a longer residence time, slower capacity**
- In Steaming process tunned by **flake thickness**
  – Harder corn does not affect drastically the process

	= Reference A		= Prime Masa MX White Corn
	= Reference B		= Prime Masa US White Corn

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Flour Properties

Characterization of Nixtamal Flour

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- Granulation: Fine for Tortillas Coarse for Frying
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→ _Most important parameter_

Measured indirectly

- Rapid Viscosity Analysis RVA
- **Expansion**
- **Bostwick**
- Penetrometer

Reference: 19   Prime Masa: 17

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Flour Properties

Characterization of Nixtamal Flour

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- **Penetrometer**

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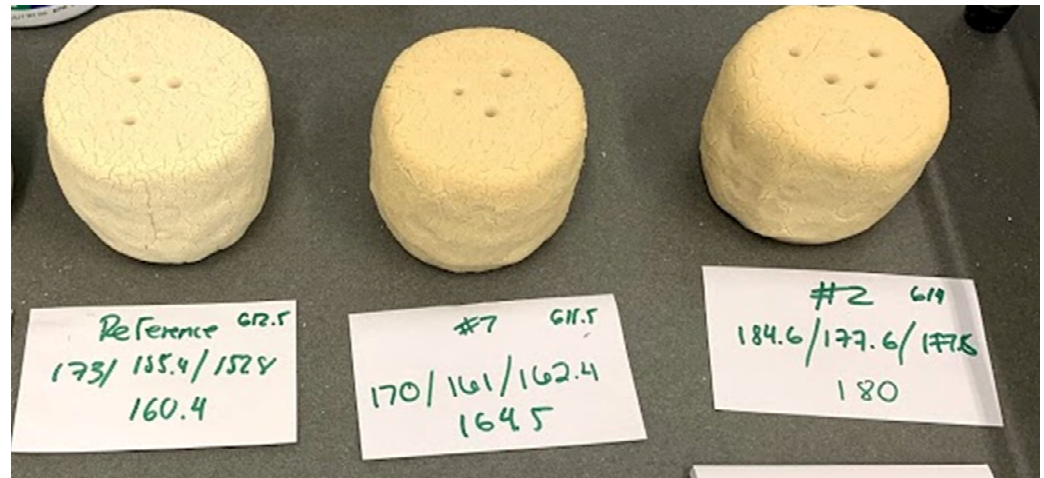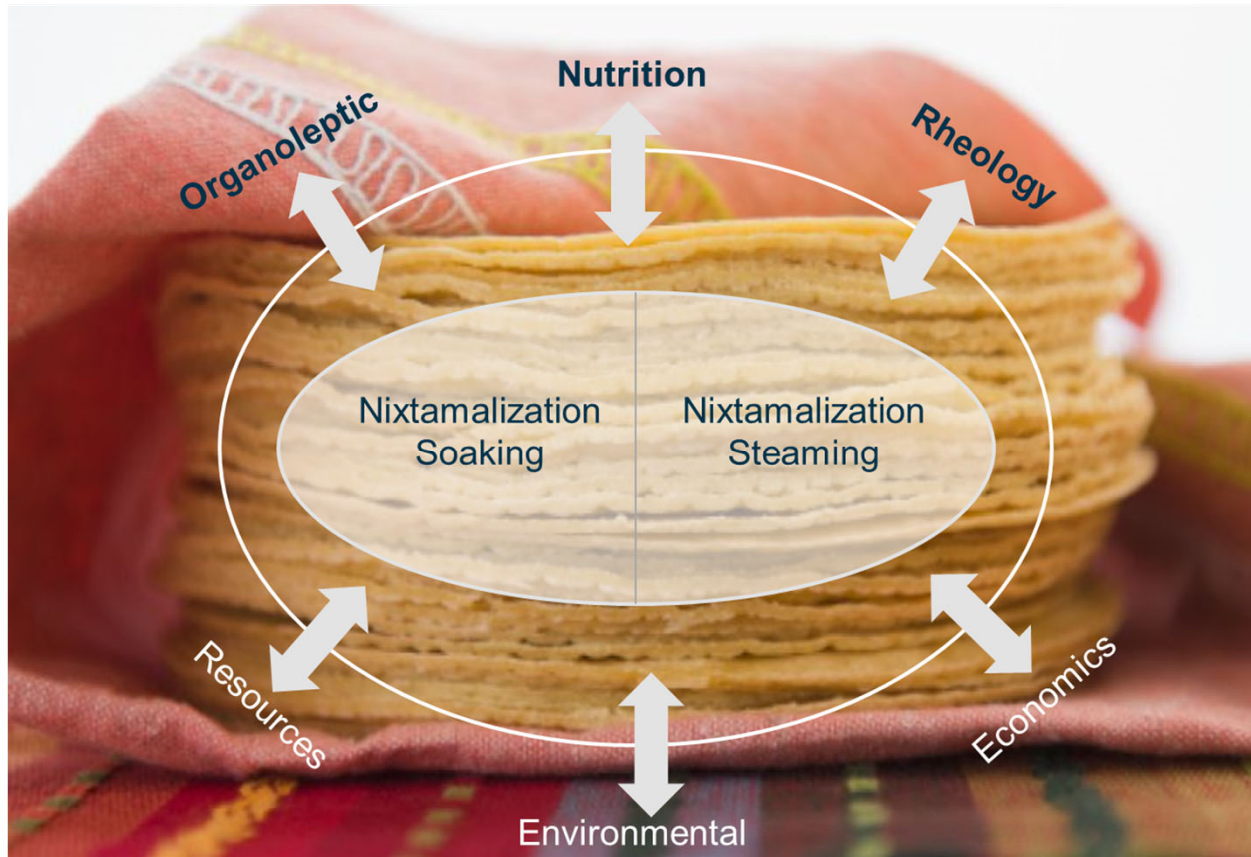
Nixtamalization will evolve

Reduce **Water** Consumption

Reduce **Energy** Consumption

Improve **Yield**

Enhance **Nutritional** Value

Eliminate **Wastewater**

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