Tortilla Antimicrobials: A Market Review

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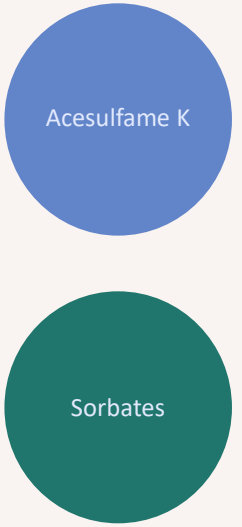
Who are we?

As the pioneer in manufacturing and commercialization of the sweetener Sunett® Acesulfame Potassium (Ace-K) and the preservatives Nutrinova® Potassium Sorbate and Nutrinova® Sorbic Acid, Nutrinova ensures outstanding quality, safety, and industry expertise.

Being the sole producer of Sunett® Acesulfame Potassium (Ace-K) and Nutrinova® Sorbates in the Western hemisphere, we guarantee security of supply, sustainability, and consistent superiority of our solutions.

Nutrinova is a joint venture of Mitsui & Co. and Celanese Corporation with a 50-year history of production and global distribution of sweetening and preservation solutions.



Agenda

1. Introduction
    1. Shelf-life
    2. Controlling microbial growth
2. Market Survey of preservatives in tortillas
    1. Collecting information on ingredients of grocery tortillas
    2. Analysis of data
3. Overview of different strategies
4. Conclusion

Introduction

What marks the end of shelf-life for tortillas?

- Oxidation of lipids causing off flavors or aromas and discoloration
- Loss of nutrient content
- Product losing moisture content and drying out (staling)
- **Microbial growth causing sensory and potential health issues.**
  - Bacteria, Yeast and Mold growing

Todays focus:

Anti-microbial strategies for slowing the growth and proliferation of microorganisms

Controlling microbial growth using multiple “hurdles”

Factors affecting microbiological growth

- pH
- Water activity
- Nutrient content
- Anti-microbial constituents
- Gases in the environment
- Temperature of storage
- Processing

- Manipulating these factors to create unfavorable conditions for microbial growth prolongs shelf-life.
- The more of these “hurdles” that are in place the longer the more we can slow or stop microbial growth.

In case these hurdles are not sufficient, preservatives are used in addition to guarantee shelf life

Assessment of preservatives in tortilla products on the market

- What are the preservative strategies are currently being used?
  - Traditional Preservatives
  - pH Adjusters
  - Clean Label Preservatives
- In what combinations are they being used?
- Are there trends regarding the types of products the preservatives are being used (wheat, corn, other)?

Methods

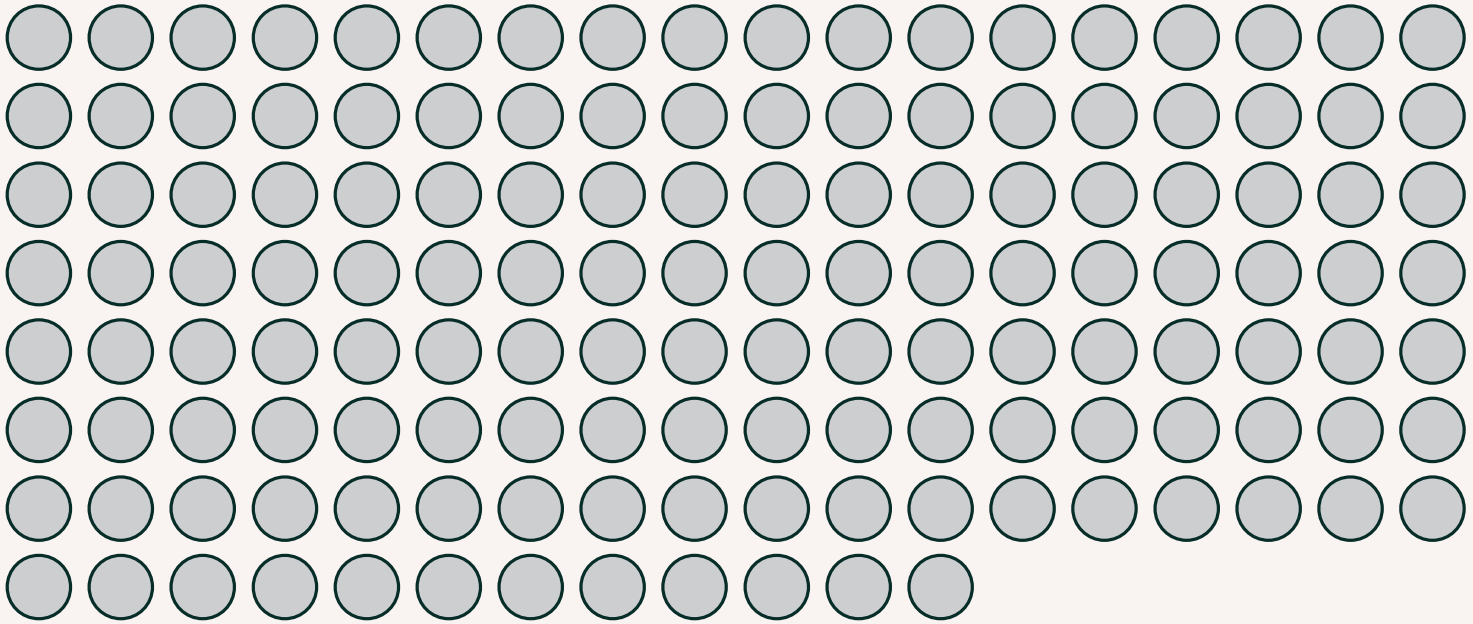
In-house analysis on preservative use was conducted using ingredient lists for tortilla products from 6 main grocery stores (websites and store visits).

6 Different Retail outlets:

- 3 x Regional Grocery Chains
- 1 x Premium Grocery Chain
- 2 x Natural Oriented Grocery Chains

Results

Ingredient lists from **138 tortillas** were evaluated.
25 different Brands



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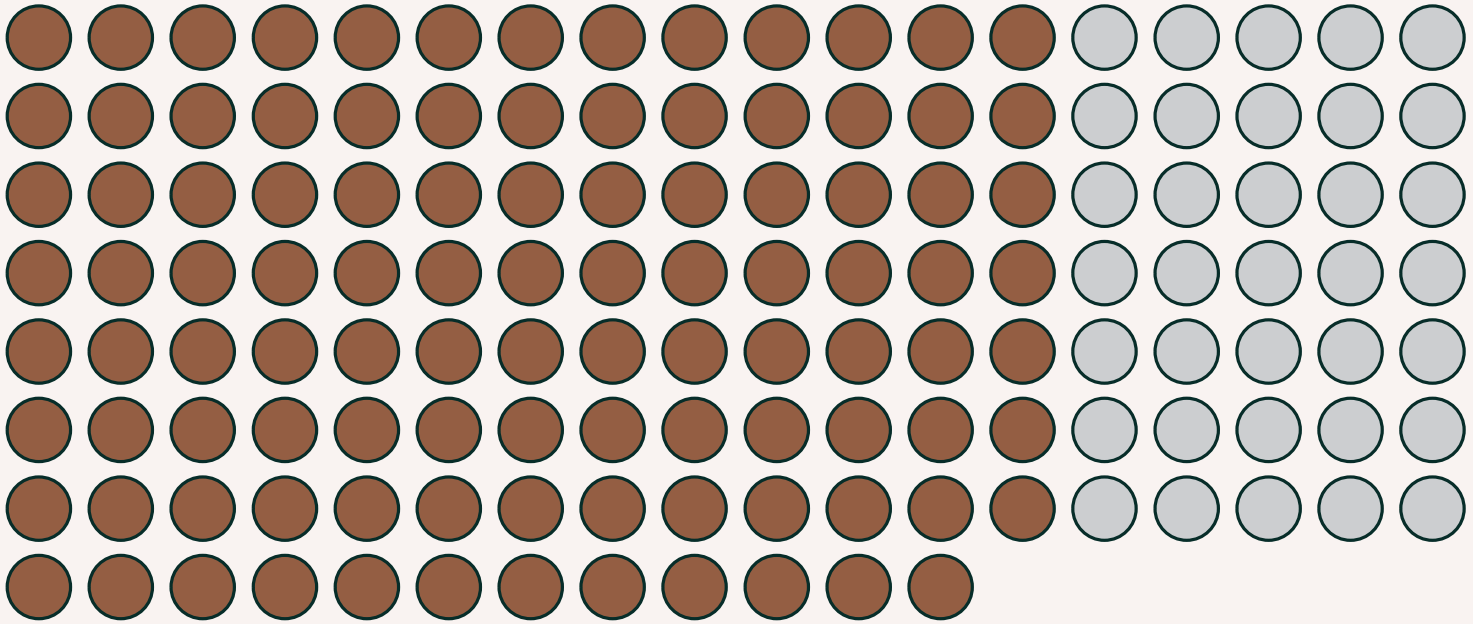

103 Wheat

Results

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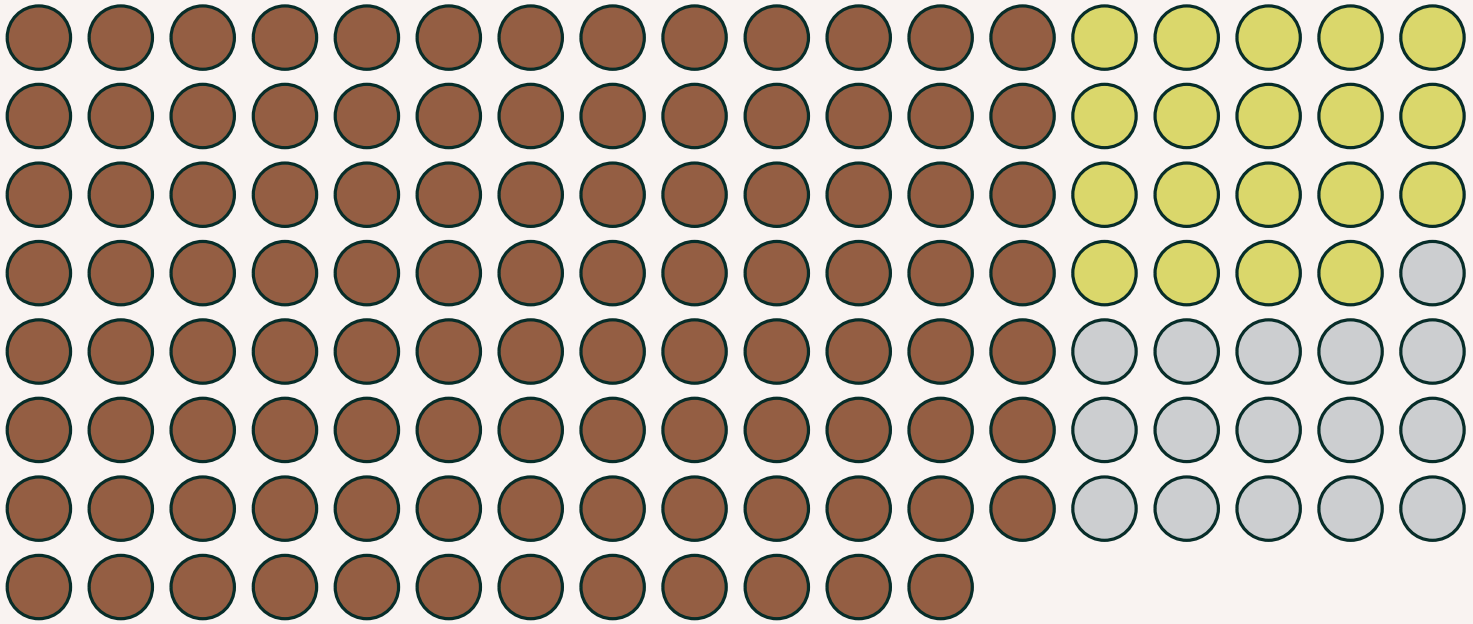

103 Wheat
19 Soft Corn

Results

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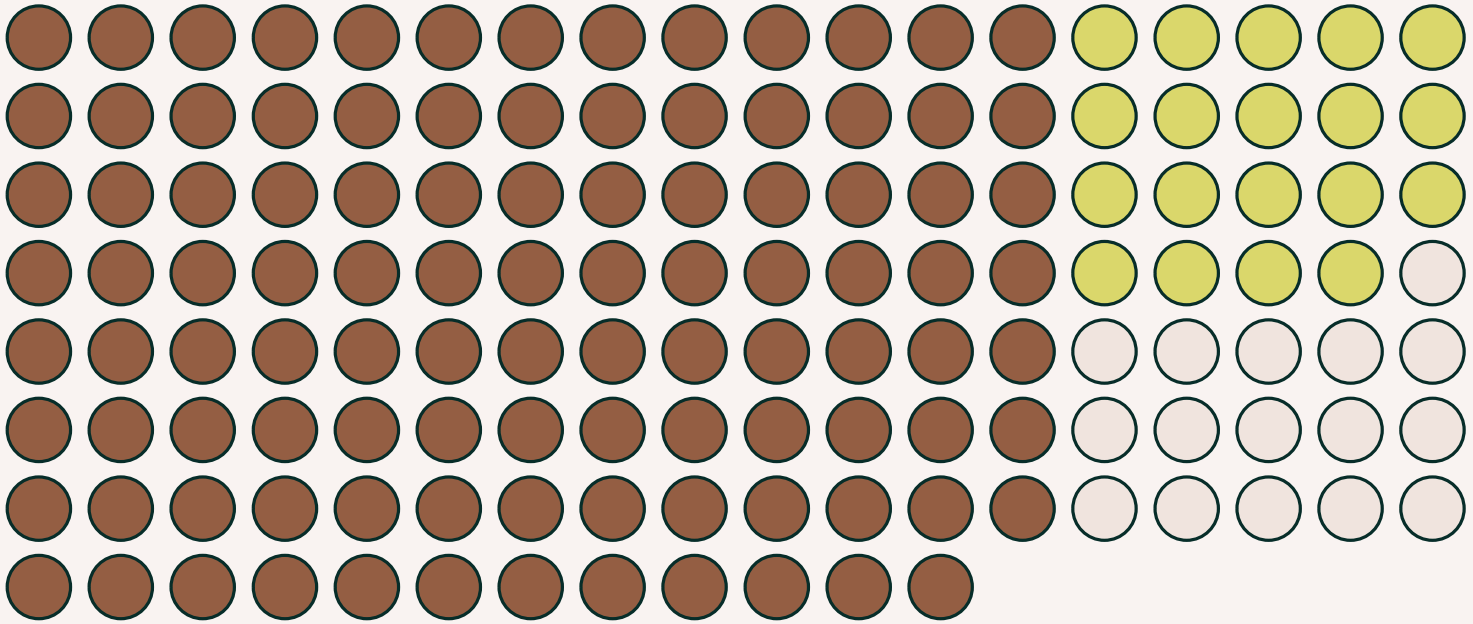
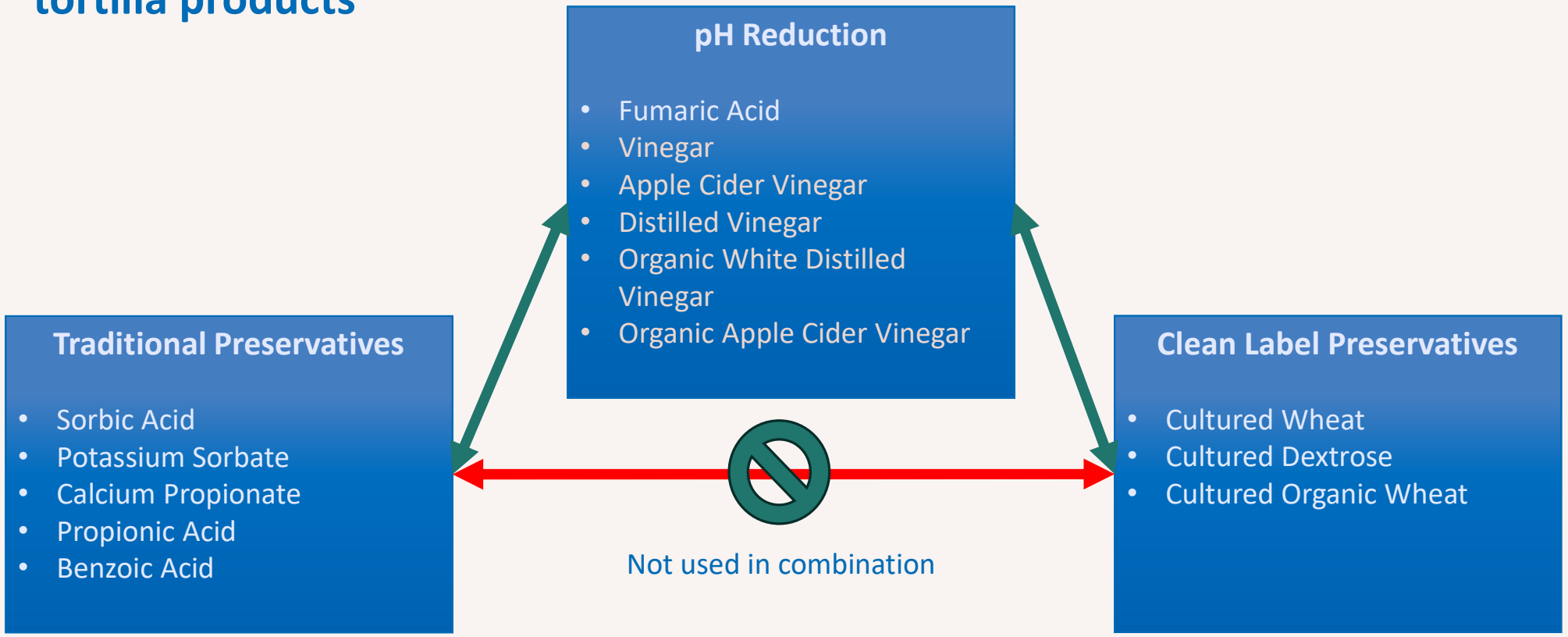


103 Wheat
19 Soft Corn
16 Other*

*Other = Did not contain wheat or corn flour (i.e.. Almond or rice flour)
Hard tortillas, chips, tostadas and egg-based wraps were not included in the survey

Preservative strategies based on the ingredient lists of retail tortilla products



In over 90% of the products, combinations of preservative strategies were used

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Preservative Combinations

#	Traditional	pH Reduction	Clean Label	%
1	Sorbic Acid, Ca Propionate	Fumaric Acid		46.4
2	K Sorbate, Ca Propionate	Fumaric Acid		13.8
3				11.6
4		Fumaric Acid	Cultured Wheat	8.0
5	Benzoic Acid, Propionic Acid			5.1
6		Vinegar		4.3
7		Vinegar	Cultured Wheat	2.9
8			Cultured Wheat	1.4
9		Fumaric Acid		1.4
10		Vinegar	Organic Cultured Wheat	1.4
11	Benzoic Acid, Ca Propionate, Propionic Acid			1.4
12			Cultured Dextrose	0.7
13	Sorbic Acid	Fumaric Acid		0.7
14	Ca Propionate	Fumaric Acid		0.7

Preservation strategies using organic acids

Preservation

Traditionally used organic acids for preservation:

Propionic acid/propionate

Sorbic acid/sorbate

Benzoic acid/benzoate

Mode of action:

Inhibiting microbial growth by lowering the intracellular pH (acid penetration into the cell) and influencing the enzyme (and protein) functions.

pH adjustment using acidulants

Commonly used acidulants for pH adjustment:

Fumaric acid

Acetic acid

Mode of action:

Inhibiting microbial growth by creating a pH environment hostile to micro-organisms.

By reducing the pH using acidulants, the preservative efficacy of organic acids is enhanced

Use of traditional preservatives vs clean label preservatives

	Traditional	Without Traditional Preservatives*
Wheat	79	21
Corn	9	2
Other	6	5
Total	94	28

No clear differentiation based on type of tortilla.

23% of tortillas with preservatives are using clean label strategy.

There were no brands that used both traditional and clean label

*Includes all preserved products that do not have traditional preservatives (cultured and/or vinegar)

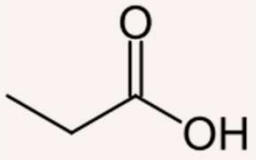
What are the differences between traditional and clean label preservatives used in tortillas?

Traditional preservatives: Propionates, sorbates, benzoates

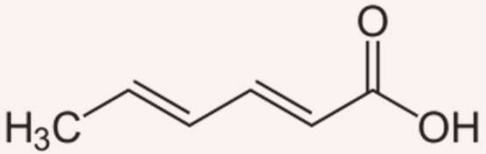
All were discovered in nature, in some form.

Produced through chemical synthesis from basic chemical building blocks.

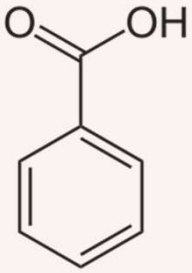
- Highly purified with well known and controlled impurities.
- Long history of safe use - 75 to 125 years
- “Chemical” and/or “synthetic” image



Propionic Acid



Sorbic Acid



Benzoic Acid

Clean label preservatives – cultured wheat/dextrose

Cultured wheat and cultured dextrose are the result of fermenting a sugar source which produces propionic acid and a host of other acids and compounds.

Bacteria from the *Propionibacterium* genus have been shown to be effective at producing high levels of propionic acid*.

- Labeling more appealing to consumers
- Cost is higher than chemically synthesized propionic acid*
- Not well characterized by-products

*Piwowarek, K., Lipińska, E., Hać-Szymańczuk, E. *et al. Propionibacterium* spp.—source of propionic acid, vitamin B12, and other metabolites important for the industry. *Appl Microbiol Biotechnol* **102**, 515–538 (2018).

Other clean label – rowanberry extract

Sorbic acid was first obtained from rowanberries.

Currently rowanberry extract is offered as a clean label and/or natural alternative to sorbic acid.

To consider:

- An estimated **100.000 trees are needed** to produce 1000 kg of sorbic acid
- Rowanberry is not a cultivated crop

How sustainable is this?

Are initiatives like Wild Harvest Sustainability Assessment taken into consideration to assess the human and ecological impact of wild harvest?

Clean label: Transparency to consumers?

- Cultured Wheat = Propionic Acid
- Rowanberry Extract = Sorbic Acid

When a clean label preservative is added to a product, in fact a traditional preservative is added to the product in disguise.

This reduces the consumer's visibility to what they are consuming.

Enriched Bleached Flour (Flour, Niacin, Reduced Iron, Thiamine Mononitrate, Riboflavin, Folic Acid), Water, Vegetable Shortening (Interesterified and Hydrogenated Soybean Oils), Contains 2% or Less of: Salt, Sugar, Baking Soda, Sodium Acid Pyrophosphate, Distilled Monoglycerides, Fumaric Acid, and Calcium Propionate and Sorbic Acid (to Maintain Freshness).

Unbleached Enriched Flour (Wheat Flour, Malted Barley Flour, Niacin, Reduced Iron, Thiamin Mononitrate [Vitamin B1], Riboflavin [Vitamin B2], Folic Acid), Water, Canola Oil, Cultured Wheat Starch, Mono- and Diglycerides, Salt, Wheat Flour, Fumaric Acid, Sodium Acid Pyrophosphate, Sodium Bicarbonate, Yeast, Contains 2% or less of each: Soybean Oil, Monocalcium Phosphate, Enzymes.

Conclusions

- There is an array of preservatives used to control microbial spoilage of tortillas.
- Generally, preservatives are used in combination to better extend shelf-life and ensure the safety and sanitation of the products.
- In this limited market survey, over 20% of products evaluated utilized clean-label alternatives.
- While offering more attractive ingredient labels, these ingredients remove transparency for the consumer.

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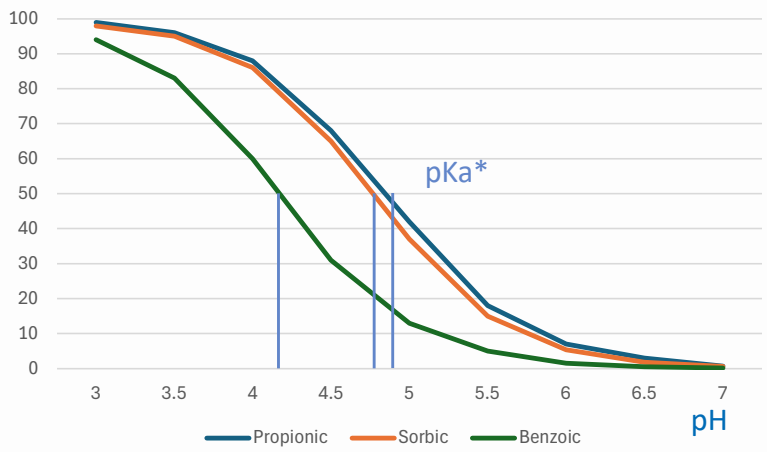
Back-up slides

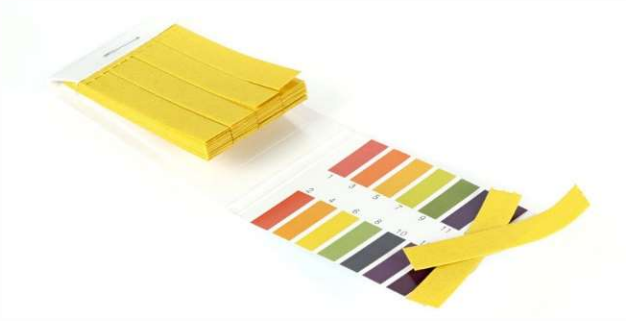
Role of pH

pH plays a critical role in the effectiveness of preservatives, lowering the pH slightly can greatly improve shelf-life

Undissociated Acid (%)



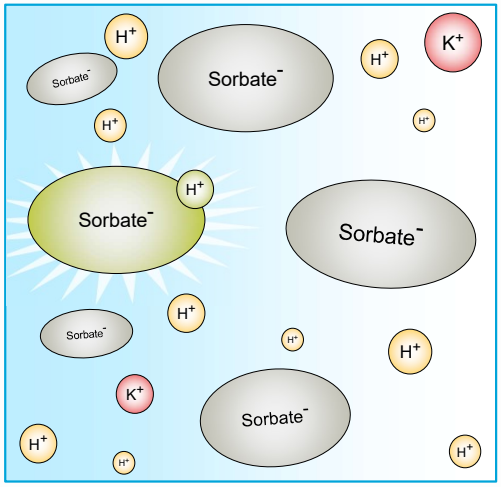
Organic acid	pKa (at 25 ˚C)	% of un-dissociated acid at different pH values								
		3.0	3.5	4	4.5	5	5.5	6	6.5	7
Propionic acid	4.90	99	96	88	68	42	18	7	3	0.7
Sorbic acid	4.76	98	95	86	65	37	15	5.4	1.8	0.6
Benzoic acid	4.20	94	83	60	31	13	5	1.5	0.5	0.15



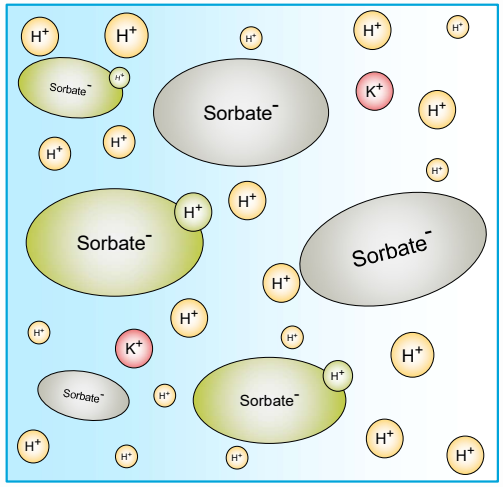
*The pKa of an acid is the pH at which 50% of the acid is in its dissociated form and 50% is in its undissociated form.

Source: Erich Lück, Sorbinsäure, p. 16, Behr's Verlag, Berlin, 1969

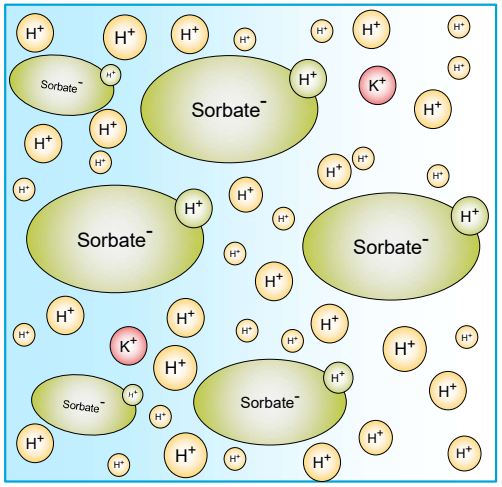
Role of pH



At pH 6.5
5.5% of the sorbate is “protonated” and in the effective sorbic acid form.



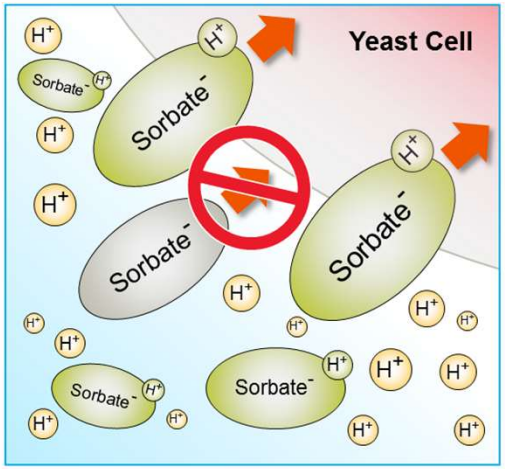
At pH 4.76 (the pKa)
50% of the sorbate is “protonated” and in the effective sorbic acid form.



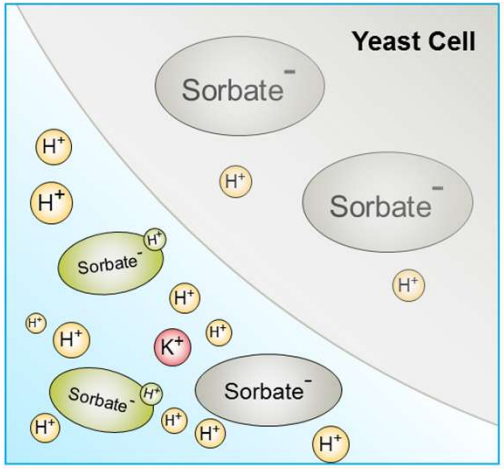
At pH 3.0
98% of the sorbate is “protonated” and in the effective sorbic acid form.

Mode of action

The exact mechanism of action of sorbic acid is not known and is most likely a combination of different mechanisms, that vary depending on the type of micro-organism and the conditions



1. Sorbic Acid (protonated form) can enter the yeast, mold or bacterial cell. The negatively charged sorbate ion can not enter.



2. Once inside the cell, the sorbic acid dissociates releasing protons and lowering the pH of the cell. This interferes with cellular processes and prevents growth.

In addition, sorbic acid has been found to affect several metabolic functions of micro-organisms, e.g. by inhibition of enzymes and interfering with substrate and electron transport mechanisms

Old slides

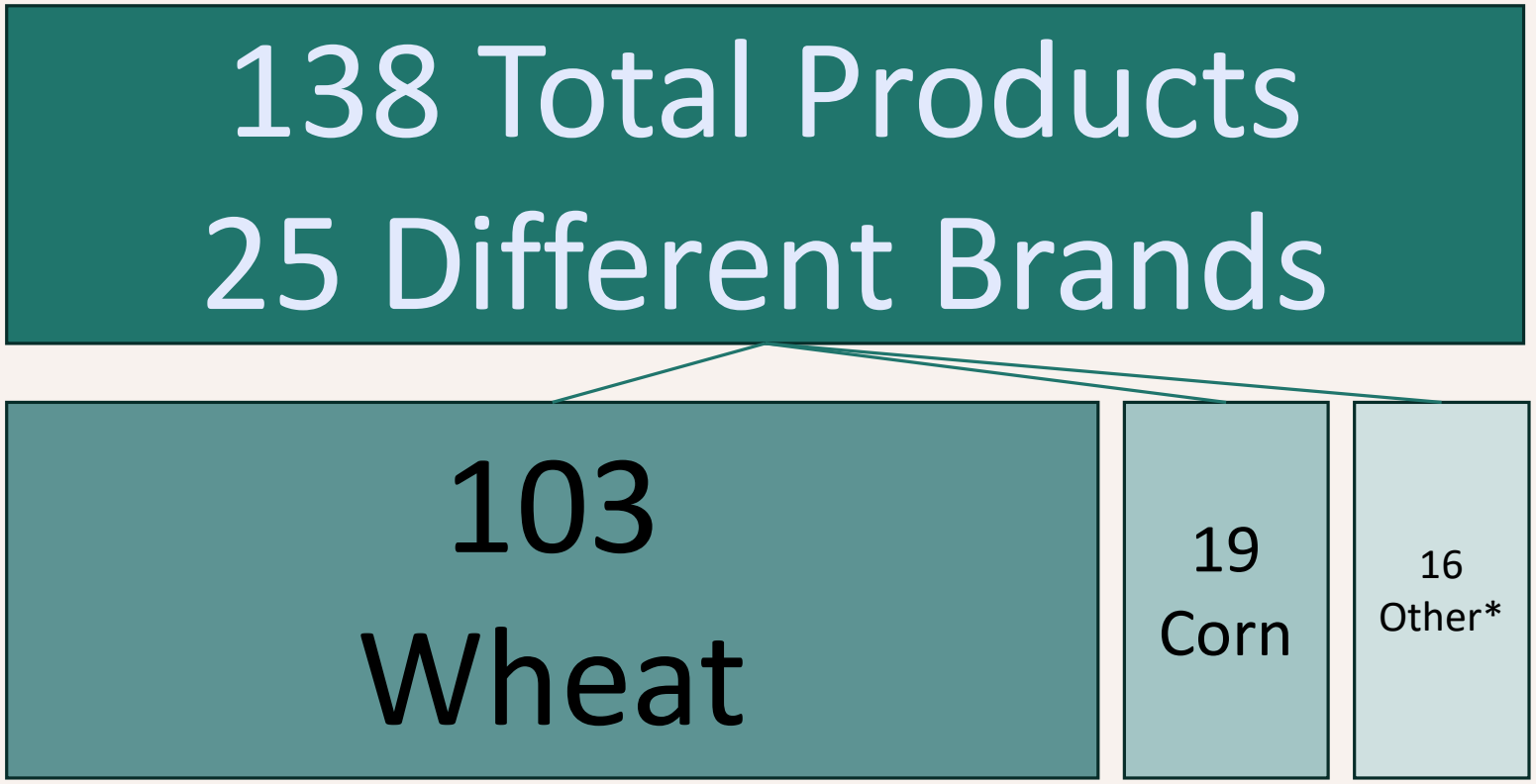
Results

Ingredient data was captured for:

- 138 products (soft flour, corn tortillas and gluten free)
  - 103 Wheat based
  - 19 Corn based
  - 16 Other (gluten free alternatives)
- 25 different Brands

Tortilla chips, tostadas and egg-based products not included.

Results



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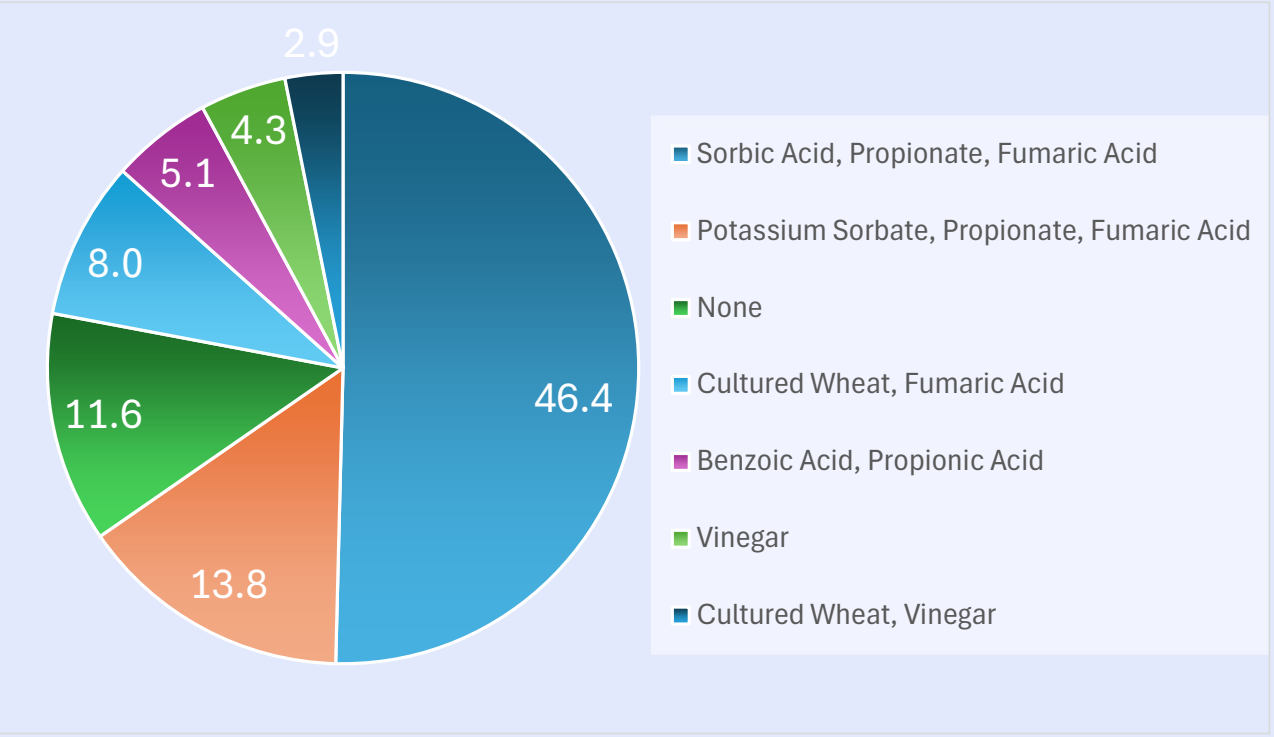
Most commonly occurring preservative combinations



Preservative system	Percent
Sorbic Acid, Propionate, Fumaric Acid	46.4
Potassium Sorbate, Propionate, Fumaric Acid	13.8
none	11.6
Cultured Wheat, Fumaric Acid	8.0
Benzoic Acid, Propionic Acid	5.1
Vinegar	4.3
Cultured Wheat, Vinegar	2.9
Cultured Wheat	1.4
Fumaric Acid	1.4
Cultured Organic Wheat, Vinegar	1.4
Benzoic Acid, Propionate, Propionic Acid	1.4
Cultured Dextrose	0.7
Sorbic Acid, Fumaric Acid	0.7
Propionate, Fumaric Acid	0.7

Clean label: Transparency to consumers?

- Cultured Wheat = Propionic Acid
- Rowanberry Extract = Sorbic Acid

When a clean label preservative is added to a product, in fact a traditional preservative is added to the product in disguise.

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Ingredients:
Enriched Bleached Flour, Water, Vegetable, Salt, Baking Soda, Sodium Acid Pyrophosphate**, Acetic Acid**, **Calcium Propionate and Sorbic Acid** (to maintain freshness)

Ingredients:
Enriched Bleached Flour, Water, Vegetable, Salt, Baking Soda, Sodium Acid Pyrophosphate, Cultured Wheat Flour, Apple Cider Vinegar, Rowanberry Extract.