



Gluten-free and High Fiber Formulations

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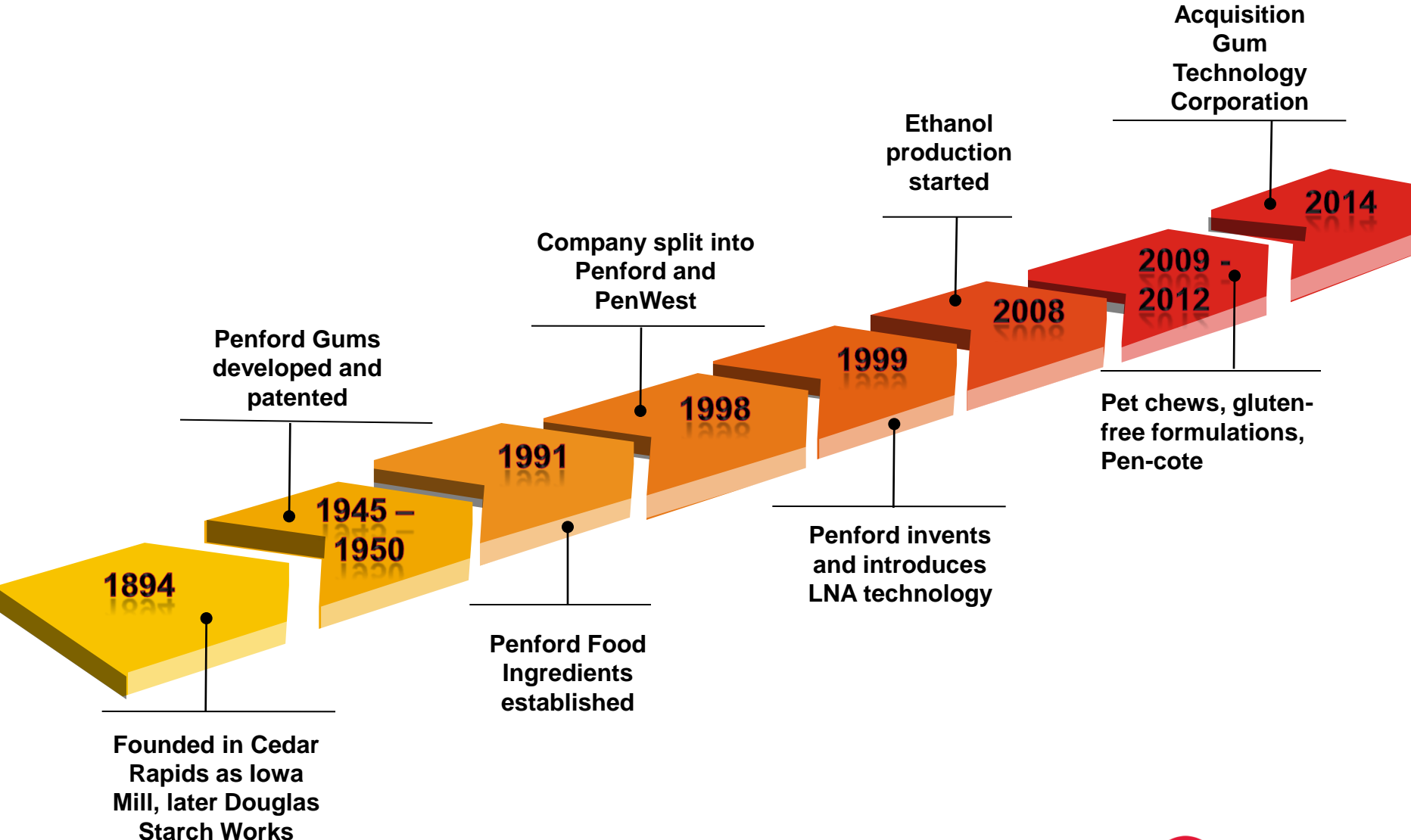
Smarter Ingredients...Smarter Solutions

Agenda

- Who is Penford
- Gluten-free
 - Market
 - What is gluten-free
 - Formulating gluten-free tortillas
- Fiber
 - Market
 - Types of fibers
 - Formulating tortillas with fiber



Selected Milestones



Needs Addressed by Penford Technologies

Functional Attributes

- Enhanced taste and texture
- Shelf Life extension
- Viscosity/mouth feel
- Particle suspension

Convenience

- Freeze-thaw-cook stability
- Extended hold times
- Yield and purge control

Health & Wellness

- Gluten-free
- GMO-free
- Resistant starch – dietary fibers
- Caloric reduction
- Fat replacement
- Pet nutrition

Market Segments

- Coating systems
- Protein: meats, poultry, fish
- Soup, sauce, gravy
- Bakery, noodles, snacks
- Pet food, treats, chews
- Confections
- Dairy & cheese

Product Lines

- Modified potato, corn, rice, and tapioca starches
- Gluten-free
- GMO-free
- Dietary fibers – resistant starches
- Pre-gels
- Starch and starch/gum blends
- Gums & gum blends

Gluten Intolerance & Celiac Disease

- One of the most under-diagnosed chronic health conditions
- An autoimmune disorder
 - Only available treatment is complete avoidance of gluten
 - Gluten – protein found in wheat, rye, barley and spelt
- Growing global health issue
 - One in 133 people estimated to be celiacs in U.S. and Canada
 - One in 100 in the UK
 - One in 200 in Germany
 - One in 300 in Europe

Why Gluten-free

- Globally, 15 million consumers are gluten-intolerant
 - 3 million U.S. consumers remain undiagnosed
 - 6% to 8% of U.S. population
- U.S. gluten-free market = \$4.2B¹
- U.S. growth = \$6.2B by 2018²
- Gluten-free was one of the top 10 culinary trends for 2013³

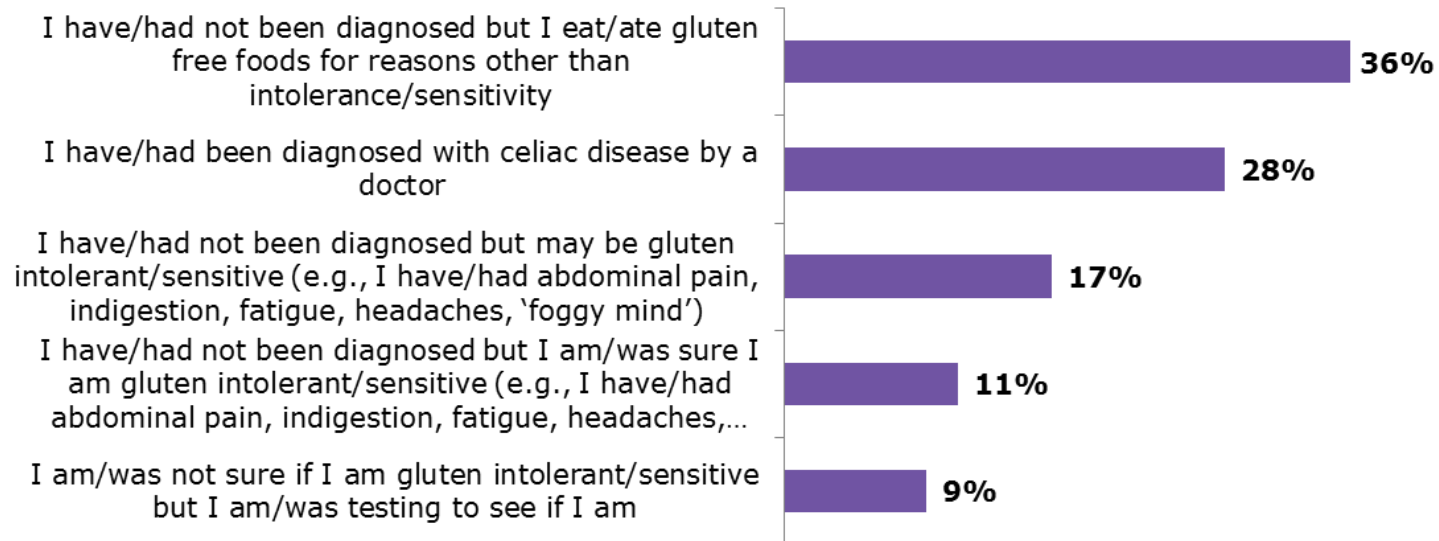
Sources: (1) Packaged Facts, 2012

(2) Markets and Markets, 2013

(3) National Restaurant Association, 2010

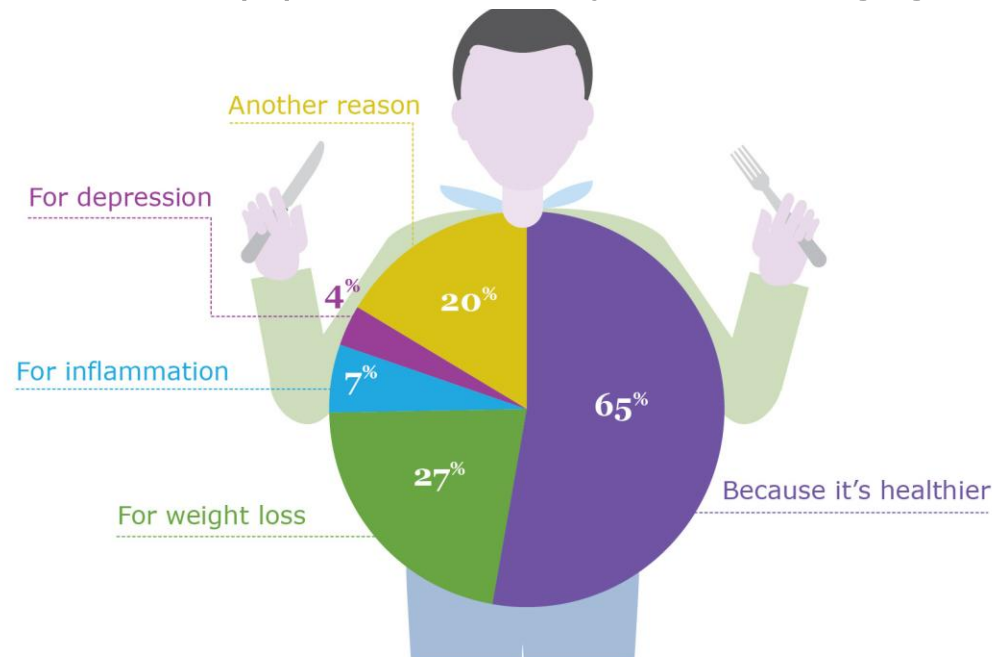
Why Gluten-free

- Three quarters of those who eat gluten-free foods in the US have not been diagnosed with celiac disease.
- “Why do you/did you eat gluten-free versions of foods that typically contain gluten?”



Market Drivers: Healthy Lifestyle

- One-third of US adults overall agree that gluten-free products are beneficial for everyone, not only those with a gluten allergy, intolerance, or sensitivity
- “For what reason(s) are/were you eating gluten-free foods?”



Base: 247 internet users aged 18+ who eat gluten-free foods or used to eaten gluten-free foods for reasons other than intolerance/sensitivity
SOURCE: Mintel

Source: Mintel

Market Drivers: Healthy Lifestyle

- Gluten is increasingly being seen in the same 'bad for you' category as additives and sugar/fat.
- Gluten-free products are positioned as more natural and healthier:

	Gluten-free	Non GF
No Additives / Preservatives	32.6%	14.9%
Organic	20.7%	8.9%
Low / No / Reduced sugar	10.3%	2.8%
Low / No / Reduced fat	9.8%	4.4%
GMO-Free	8.7%	3.7%
Low / No / Reduced Sodium	4.8%	1.0%
High / Added Fiber	3.8%	2.0%

In Europe, a GF product is much more likely to be organic, reduced in sugar and fat, with no additives or preservative than a regular product.

Top health claims in GF and non GF food – Europe (2011-2013)

Source: Mintel GNPD

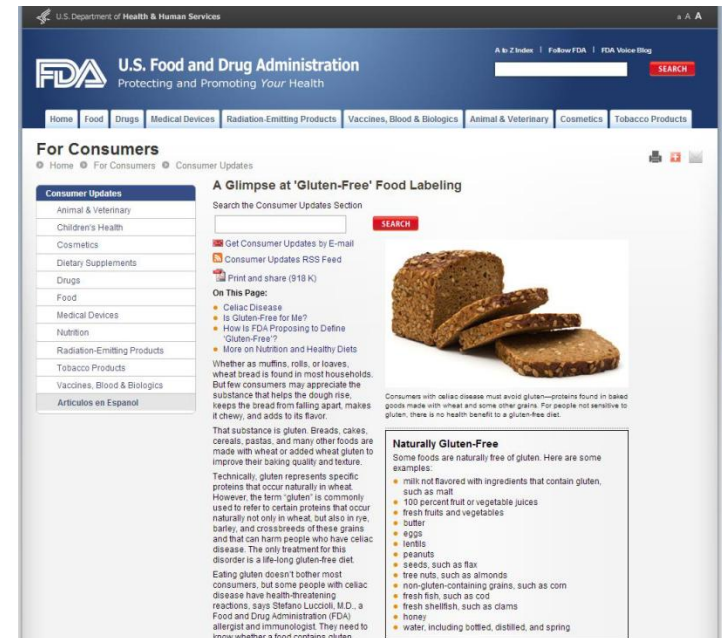
What is the Real Market Opportunity?

- Not just celiacs...celiacs' families
- Average family size is 3.14
- 3 million celiacs = 9.4 million potential family members
- A healthy diet alternative for broader population

Source: <http://factfinder.census.gov/servlet/SAFFFacts>

FDA Defines Gluten-Free for Food labeling

- FDA limits gluten to 20 ppm in gluten-free foods. Also applies to “without gluten”, “free of gluten,” or “no gluten” claims
- Analytical testing for levels below 20 ppm are not scientifically validated to reliably detect gluten
- Regulation in effect as of August 5, 2014



The screenshot shows the FDA's consumer update page for 'A Glimpse at 'Gluten-Free' Food Labeling'. The page includes a search bar, navigation tabs for various FDA categories, and a sidebar with 'Consumer Updates' for different product types. The main content area features a search bar, a 'Get Consumer Updates by E-mail' button, and a list of 'On This Page' links. The article text discusses the definition of gluten-free, the health implications for celiac disease, and lists naturally gluten-free foods.

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Protecting and Promoting Your Health

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Consumer Updates
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A Glimpse at 'Gluten-Free' Food Labeling
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On This Page:
Celiac Disease
Is Gluten-Free for Me?
How Is FDA Proposing to Define 'Gluten-Free'?
More on Nutrition and Healthy Diets

Whether as muffins, rolls, or loaves, wheat bread is found in most households. But few consumers may appreciate the substance that helps the dough rise, keeps the bread from falling apart, makes it chewy, and adds to its flavor.

That substance is gluten. Breads, cakes, cereals, pastas, and many other foods are made with wheat or added wheat gluten to improve their baking quality and texture.

Technically, gluten represents specific proteins that occur naturally in wheat. However, the term 'gluten' is commonly used to refer to certain proteins that occur naturally not only in wheat, but also in rye, barley, and crossbreeds of these grains and that can harm people who have celiac disease. The only treatment for this disorder is a life-long gluten-free diet.

Eating gluten doesn't bother most consumers, but some people with celiac disease have health-threatening reactions, says Stefano Luccoli, M.D., a Food and Drug Administration (FDA) allergist and immunologist. They need to know whether a food contains gluten.

Naturally Gluten-Free
Some foods are naturally free of gluten. Here are some examples:

- milk not flavored with ingredients that contain gluten, such as malt
- 100 percent fruit or vegetable juices
- fresh fruits and vegetables
- butter
- eggs
- lentils
- peanuts
- seeds, such as flax
- tree nuts, such as almonds
- non-gluten-containing grains, such as corn
- fresh fish, such as cod
- fresh shellfish, such as clams
- honey
- water, including bottled, distilled, and spring

How Gluten Works

- Gluten is a composite of the proteins gliadin and glutenin
 - These proteins, along with starch, are found in the endosperm of cereal grains such as wheat, rye and barley
- Viscosity and elasticity
 - When dough is kneaded, glutenin cross-links with itself and then associates with gliadin to form gluten strands
 - This is what provides the viscosity and elasticity to dough
 - More kneading = more gluten development = chewier texture (bagels, pizza crust)
 - Less kneading = less gluten development = more tender texture (breads)



How Gluten Works

- Leavening
 - In leavened products, the gluten network traps CO₂ bubbles
 - Enables the dough to swell or rise
- Stabilization and texture
 - Baking the dough coagulates the gluten
 - Along with starch, this stabilizes the structure and texture of the finished product



Development Challenges

- Broad market acceptance means products must have the organoleptic attributes of a full gluten product
- Gluten-free ingredients are subject to contamination if they are processed in facilities that process gluten-based ingredients
- Opportunities for processing at dedicated gluten-free facilities are limited



Formulating to Achieve Success



Gluten-free Ingredients

Primary Flours	Specialty Flours	Starches	Protein	Fiber	Hydrocolloids
Brown Rice	Amaranth	Corn	Corn	Bamboo	Cellulose
Rice	Buckwheat	Pea	Egg	Bran	Guar
Sorghum	Chia	Potato	Hemp	Chia	Konjac
Tapioca	Legume	Rice	Legume	Flax	Pectin
Waxy Rice	Millet	Tapioca	Pea	Inulin	Tara
	Nut		Soy	Psyllium	Xanthan
	Quinoa		Whey	Resistant Starch	
	Teff			Sugarcane	

Gluten-free Food Starches

- Tapioca

- Native
- Modified
- Pregelatinized

- Potato

- Native Extract
- Modified
- Pregelatinized

- Rice

- Native
- Pregelatinized

- Corn

- Native
- Modified
- Pregelatinized

Starches Improve Gluten-free Systems

- Starches work synergistically with one another and other protein sources to create the ideal texture and chewiness
- Starches deliver superior bakery products without gluten that:
 - Provide “chewy” texture
 - Enhance volume and open cell structure
 - Exhibit a tender bite and moist texture
 - Provide viscosity



Flour vs Starch

- Difference between flour and starch

- Flour

- Contains protein – higher protein relates to stronger structure
- Contains fat
- Gives cold viscosity

- Starch

- No protein or fat
- Very little flavor from botanical source

- When replacing flour with starch

- Use combination of pregel, cookup starch and gums to match the cold viscosity
- Use combination of starches, gums and proteins to match the structure

Example Gluten-free “Wheat” Tortilla Ingredients

- Water
- Rice flour (Waxy and regular)
- Modified starch (Tapioca and potato)
- Native starch (Tapioca and potato)
- Oil
- Stabilizer (CMC, guar, xanthan gums)
- Dextrose
- Salt
- Emulsifier (Mono/di-glycerides)
- Dough Conditioner (Enzyme or SSL)
- Leavening (Baking power, baking soda)

Gluten-free Tortilla Challenges

- Challenge: Elasticity

- Stretch
- Roll/machinability
- Solutions: modified potato and modified tapioca starch, rice starch, CMC, guar, xanthan gums

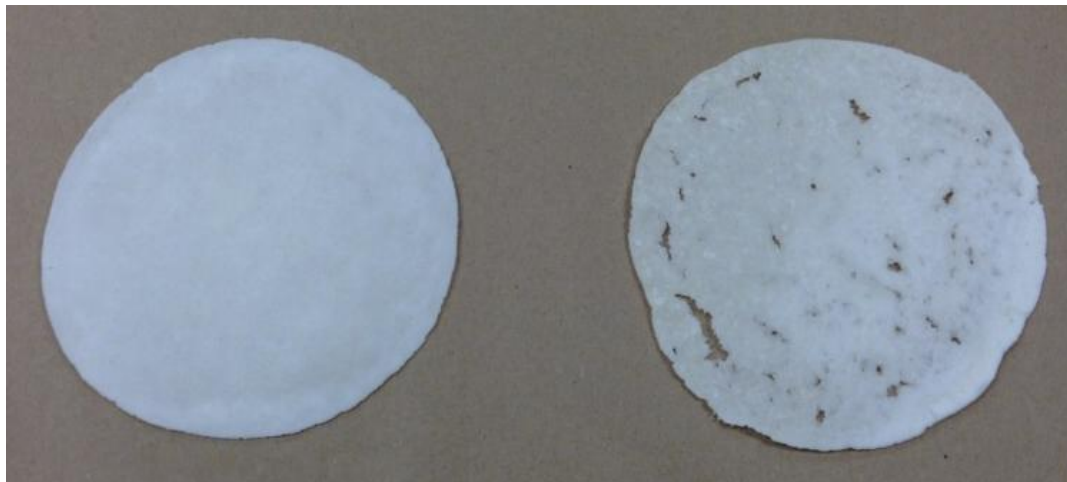


- Challenge: Shelf Life

- Moisture control
- Solutions: modified potato and modified tapioca starch, rice starch, CMC, guar, xanthan gums, dough conditioner

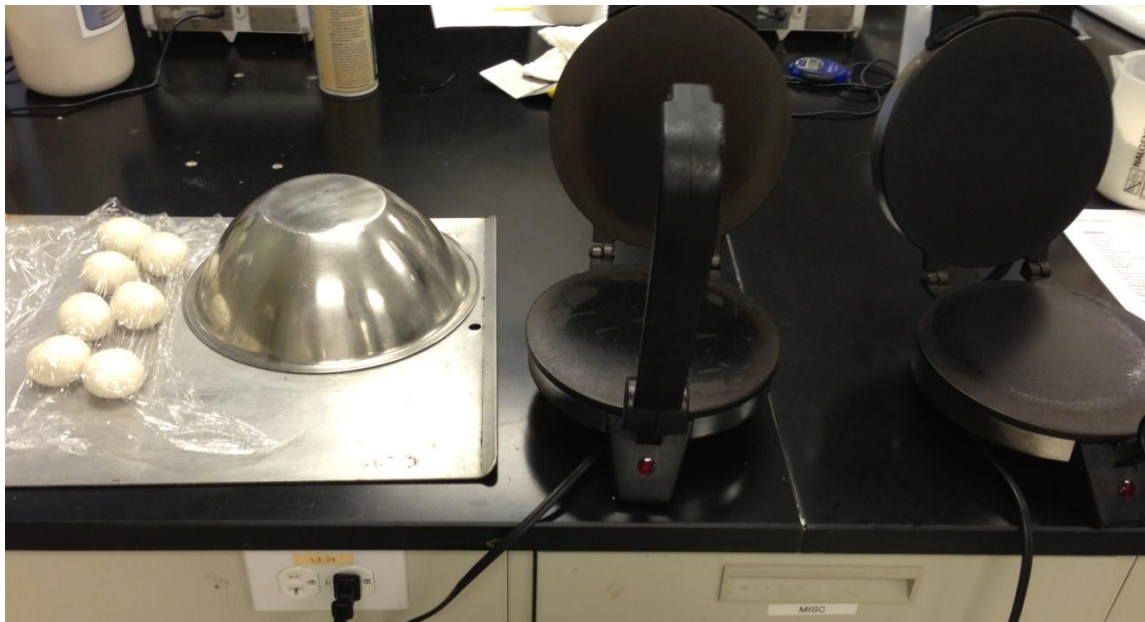
Processing

- Dough
 - Will not be as thick as regular tortilla dough
 - Will be stickier than regular tortilla dough
- Tortilla Press
 - Dough cannot be too firm or it will not flatten
 - Initial press temperature cannot be too hot (<200°F) or it will not flatten into a smooth shape



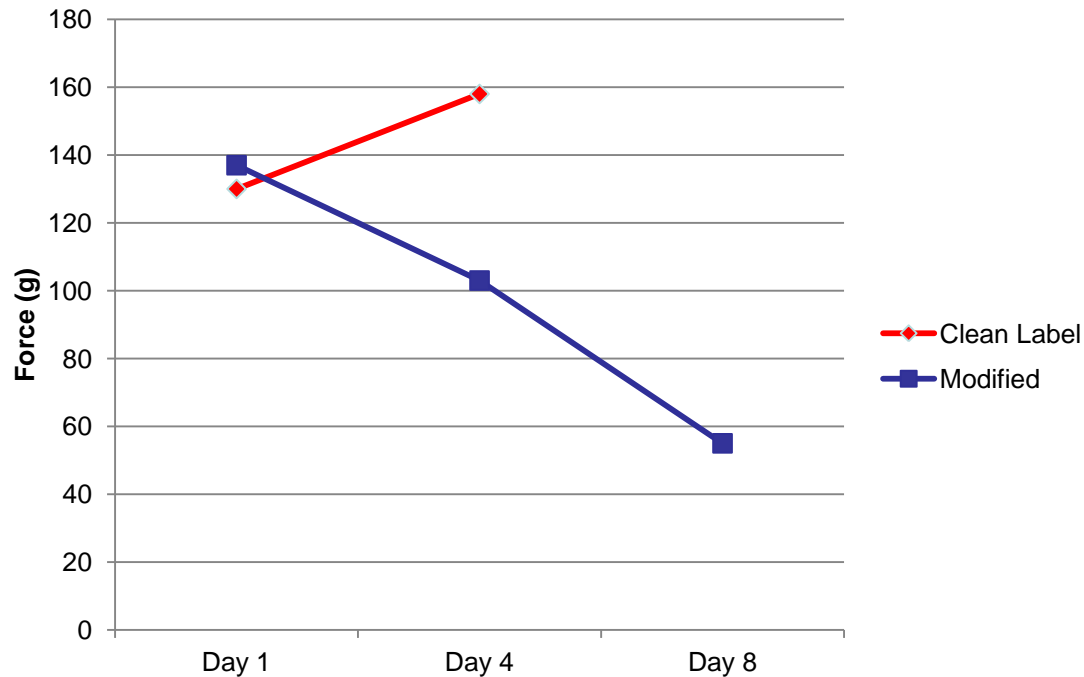
Processing

- 2 stage press system
 - Shape = $<200^{\circ}\text{F}$ – 4 to 6 presses of 3-5 seconds each
 - Cook = 350°F – 2 presses each side of 3-5 seconds each
- 35 gram dough balls – make 5" tortillas



Tensile Strength

- Clean label tortilla dries out and hardens over time
- Modified food starch tortilla retains moisture and softens over time



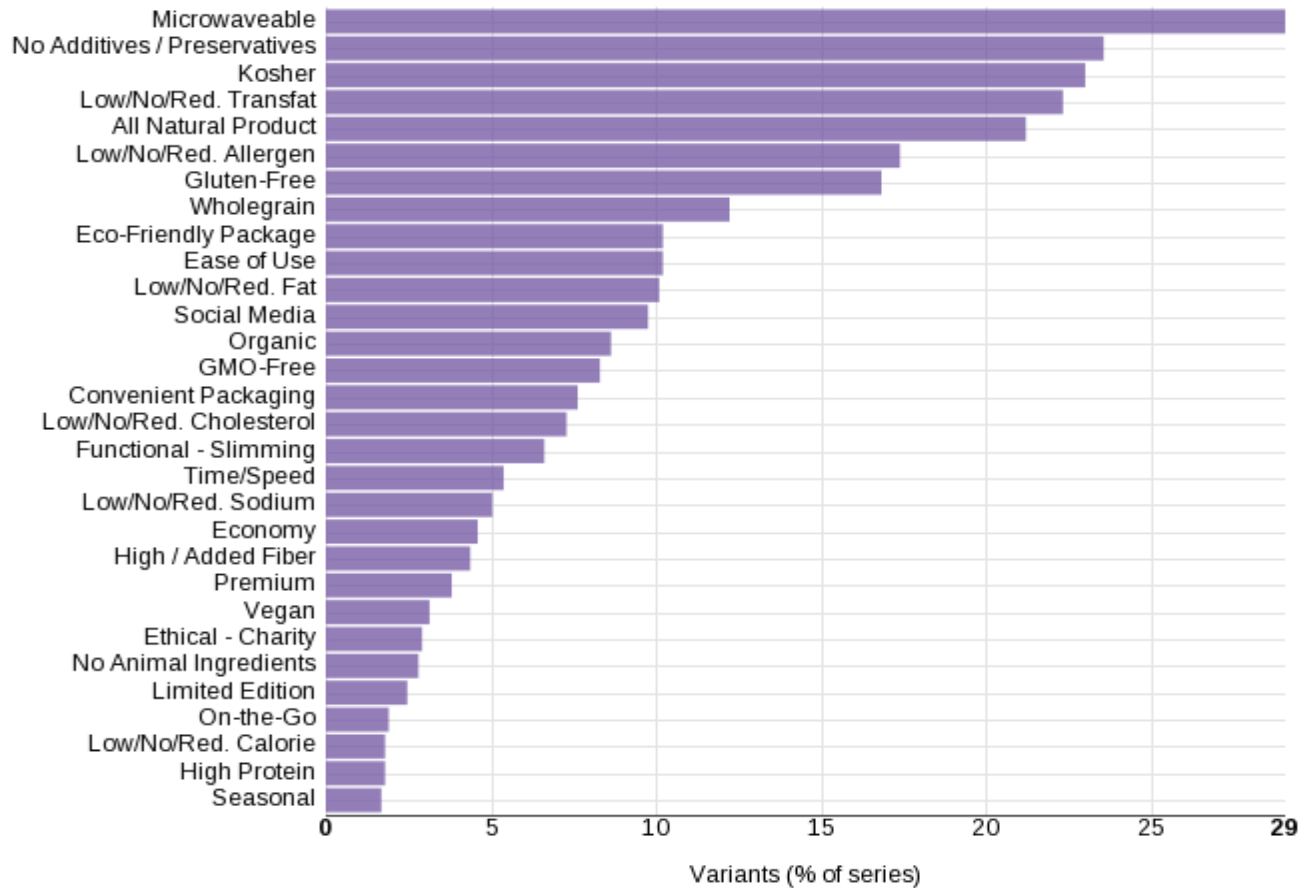
FIBER FORTIFICATION

Market Need

- Increase Fiber Consumption
 - Average American consumes only 12-15 grams/day
 - Recommended fiber intake is 20-35 grams/day
- Weight Management -Reduce Calorie Intake
 - About 34% of U.S. adults are overweight and 34% of U.S. adults are obese
- Blood Sugar Management (Diabetes Prevention/Maintain)
 - 25.8 million (8.3%) U.S. people has diabetes
 - 79 million U.S. people are pre-diabetic

Sources: 1. ADA, 2010 2. International Food Information Council, 2010 3. CDC, 2010 4. Diabetes.org, 2010

Tortilla Claims – High / Added Fiber



Source: Mintel

Fiber Choices

- Insoluble Fiber

- Brans and insoluble fractions

- Soybean, sugar beet, oat, corn, cellulose, bamboo, fruit (e.g. citrus, apple)

- Resistant starches

- Corn, tapioca and potato



Fiber Choices

- Soluble Fiber
 - Resistant starch
 - Inulin
 - Polydextrose
 - Fructo-oligosaccharides (FOS)
 - Resistant maltodextrin
 - Acacia gum (Gum Arabic)
 - Hydrolyzed guar gum (HGG)
 - Isomalto-oligosaccharide (IMO)
 - Arabinogalactan



Fiber Content of Various Botanical Sources

Fiber Type	% Fiber Content
Cellulose	99
Oat	96
Sugar cane	95
Inulin	93
Polydextrose	90
Insoluble potato resistant starch	85
Corn	80
Citrus	65
Soluble potato resistant starch	55
Chia	34
Flax	30

Fiber Selection Considerations

- Fiber Content
 - Total dietary fiber varies by products
- Botanic Source
 - Allergen-free
- Solubility
- Water Holding Capacity
 - Re-formulation issues
 - Shelf-life

Fiber Selection Considerations

- Sensory Characteristics
 - Mouthfeel
 - Flavor
 - Color
- Gut Tolerance
- Labeling
- Process Recovery

Resistant Starches

- Description

- Contains dietary fiber
- Type 4 resistant starch (RS)
- Resists digestion and passes through to the large intestine
- Some provide prebiotic effects
- Low caloric contribution
- Derived from varying botanical sources

Resistant Starches

- Health Benefits
 - Fiber fortification
 - Caloric reduction
 - Digestive health
 - Glycemic health

- Functionality Benefits
 - Bland taste / smooth mouth-feel
 - Good gut tolerance
 - Easy to use

Resistant Starches

- Insoluble resistant starch benefits
 - Low water binding capacity
 - Higher fiber content

- Soluble resistant starch benefits
 - Binds water

Fiber-enriched Tortillas with Resistant Starch

Nutrition Facts	
Serving Size (50g)	
Servings Per Container	
Amount Per Serving	
Calories 180	Calories from Fat 60
% Daily Value*	
Total Fat 7g	11%
Saturated Fat 1.5g	8%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 170mg	7%
Total Carbohydrate 24g	8%
Dietary Fiber 1g	4%
Sugars 0g	
Protein 3g	
Vitamin A 0%	• Vitamin C 0%
Calcium 0%	• Iron 8%
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:	
	Calories: 2,000 2,500
Total Fat	Less than 65g 80g
Saturated Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g
Calories per gram:	
Fat 9 • Carbohydrate 4 • Protein 4	

Nutrition Facts	
Serving Size (50g)	
Servings Per Container	
Amount Per Serving	
Calories 150	Calories from Fat 60
% Daily Value*	
Total Fat 6g	9%
Saturated Fat 1.5g	8%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 170mg	7%
Total Carbohydrate 26g	9%
Dietary Fiber 7g	28%
Sugars 0g	
Protein 2g	
Vitamin A 0%	• Vitamin C 0%
Calcium 0%	• Iron 6%
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:	
	Calories: 2,000 2,500
Total Fat	Less than 65g 80g
Saturated Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g
Calories per gram:	
Fat 9 • Carbohydrate 4 • Protein 4	

Ingredient	Control	Fiber
Flour	57.2	42.5
Salt	0.8	0.8
Water	30.2	29.6
Shortening	11.8	11.0
PenFibe® RS	---	12.0
PenFibe® RO 177	---	4.0
Total	100.0	100.0

Key Learnings

- **Gluten-free Market**
 - Consumers are perceiving gluten-free as a healthier way to eat, not as a diet restriction
- **Gluten-free Formulating**
 - Use a blend of non-wheat flours, cook up starches, pregel starches, gums to form tortilla dough
- **Gluten-free Processing**
 - Changes may need to be made to equipment to handle dough
- **High Fiber Market**
 - Average American is not consuming enough fiber
- **High Fiber Formulating**
 - Balance functional characteristics

Thank You

- Questions?
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Penford

Food Ingredients

Gum  Technology
Hydrocolloid Systems
A business unit of Penford Food Ingredients

