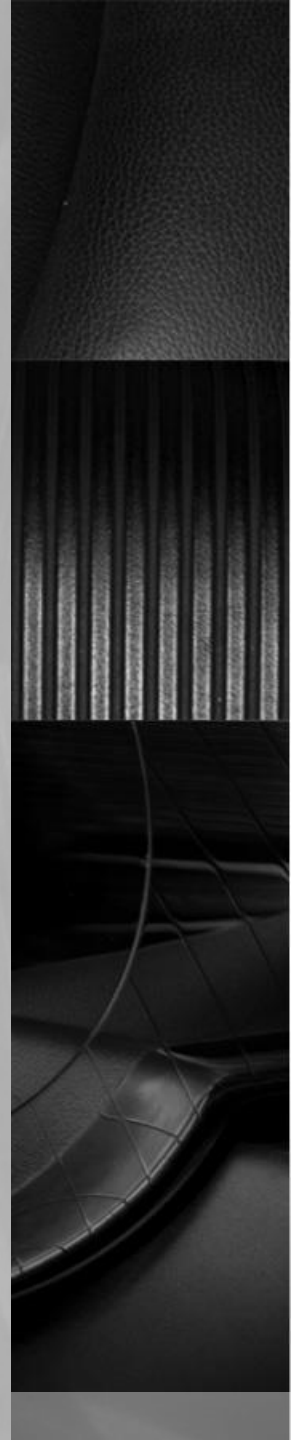
On-Site Technical Support

Troubleshooting for Common Processing Issues

Feliciano (Sonny) Bejosano

Allied Blending & Ingredients



Sources of Processing Issues

- Process and Equipment
- Raw Materials (Ingredients)
- Practices

Determine Priorities

Product Attributes	**Desired End Result**
Dimensions	uniform
Diameter, height	fit in box
Opacity, toast points, etc.	good consumer appeal
Storage Quality	
Shelf life (spoilage)	6 weeks or more
Shelf stability (flexibility)	6 weeks or more
Process efficiency	
Stress on equipment	low
Waste product	low
Down time	low
Sanitation	high

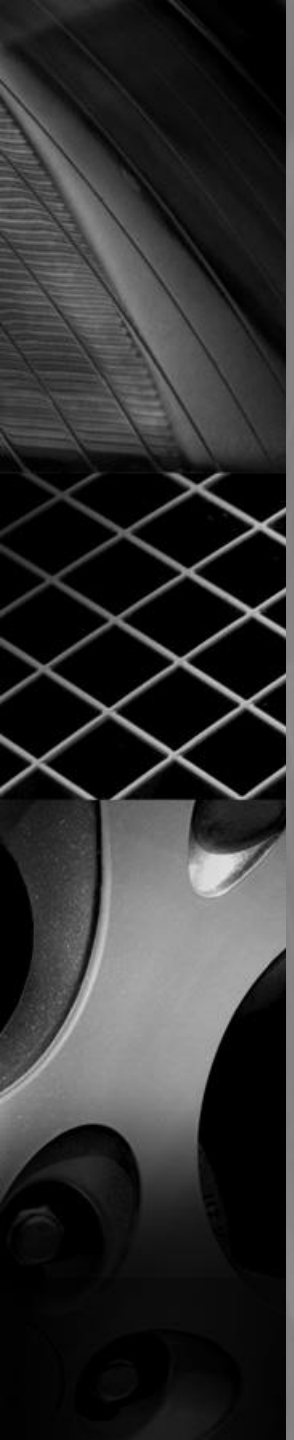
Select ingredients to match processing equipment conditions

- Flour – the most important ingredient
  - Determines the levels of other ingredients
- Batch Pack
- In-house formula (from scratch):
  - Modifiers of flour functionality

    Fat (oil, margarine, shortening, lard)

    Reducing agent (cysteine, metabisulfite)

    Emulsifiers (SSL, MG)
  - Preservative (sorbate, propionate) - shelf life
  - pH of tortilla (activity of preservative)
  - Baking powder (type and amount)
  - Gum, fiber, protein, nutraceuticals, etc.



Process and Equipment

Hot Press Tortilla Processing

Mixing

Horizontal

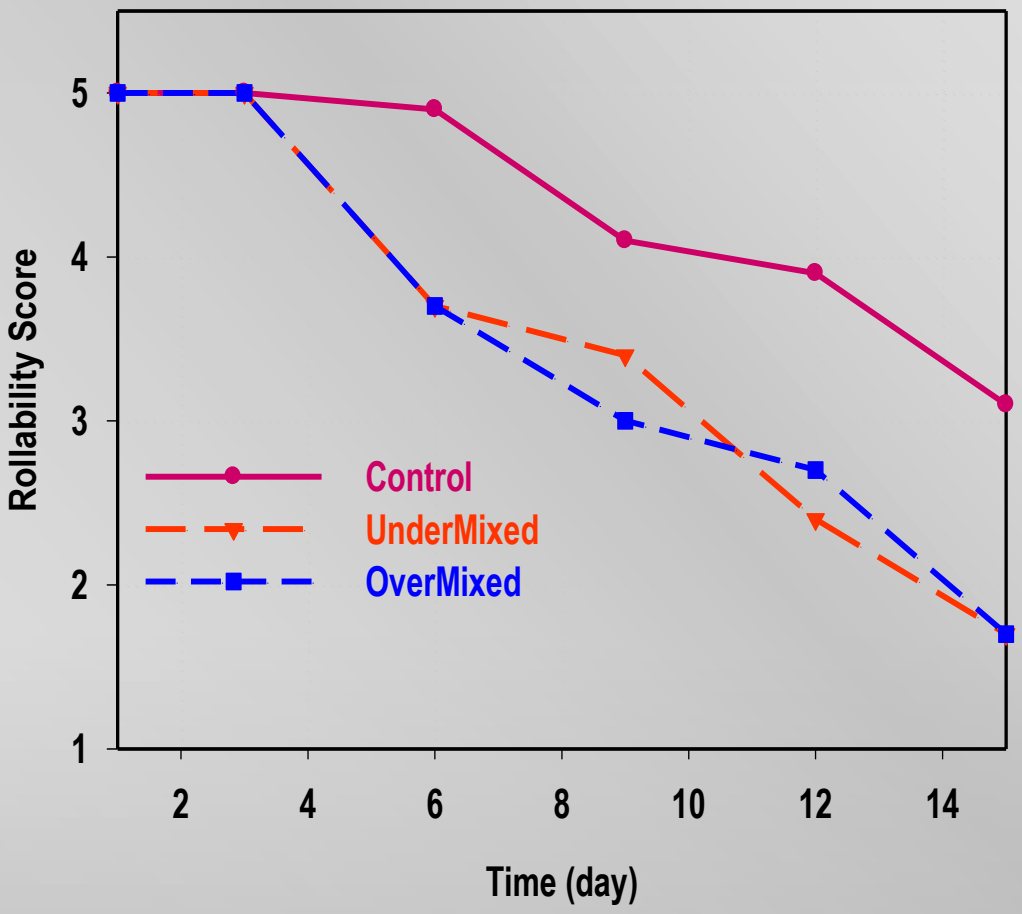
Spiral (High-Speed)

Mixing

- Mixers have either vertical or horizontal shaft(s), while the container is a circular bowl for vertical shaft mixers or a horizontal cylinder for horizontal shaft mixers.
- The purpose of mixing is to uniformly disperse the ingredients and allow them to hydrate and associate into a “dough” structure.
- The extent of mixing is determined by the mixer design, time at each speed of rotation, temperature profile of dough, and the formula. These factors affect the dispersion and hydration of ingredients, the formation and breakdown of gluten, and the physical properties of the dough.
- Dough properties are dramatically affected by the extent of mixing. Dough properties include stickiness, cohesiveness, and appearance.

Effect of Mixing on Product Stability

- Optimum mixed dough yielded tortillas with improved stability
- Under and Over-Mixed dough yielded tortillas with shorter shelf stability

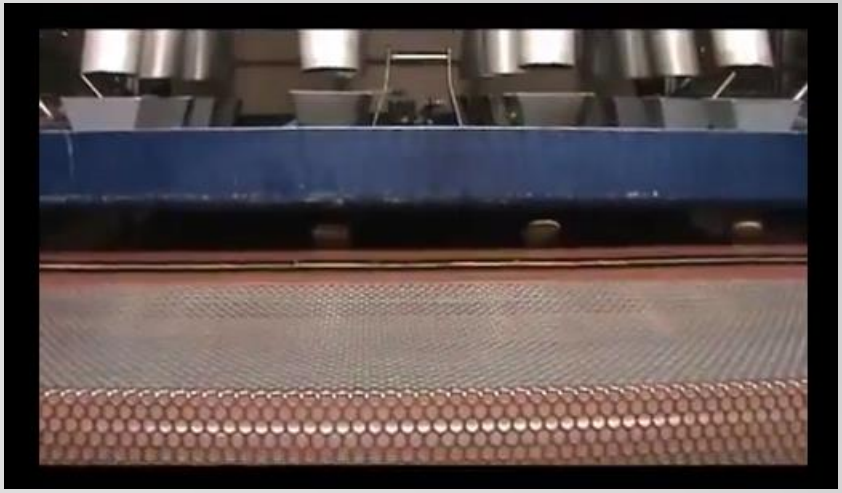


Dividing, Rounding

Dividing/Rounding

- Tortilla dough is firmer or stiffer due to less water in the formula than yeast-leavened dough. This causes problems in how the dough enters the proportioning devices and subsequent processes.
- Three styles of dough rounding equipment are being used in the tortilla industry. The motion of rounding a dough ball in the cup of the hand is used in each method.
- The Union divider and rounder was common in many bakeries fifty years ago and was initially used in the semi-automated, hand-stretch lines and later in the hot-press lines.
- A similar mechanism of rounding the dough unit is accomplished by the surfaces of a horizontal, moving belt and the cupped rails placed at an angle to the direction of the belt motion. The advantage is that several (2-8) dough units can be rounded simultaneously.
- Another way to round dough units is by series of cups that oscillate on a horizontal belt as the dough moves along the belt.

Hot Press



Hot Press

Hot Press

- The plates of many hot-presses are heated by electrical heating rods, while preheated oil is used in some press. Pumping a preheated oil through the plates provides a more uniform temperature profile and tortilla diameters.
- All plates utilize mechanical force or hydraulic pressure to deliver sufficient force to the dough ball to form large diameter, thin disks during compression.
- Mechanisms have been devised to reduce or eliminate the need to align the plates, i.e., to add shims to maintain equal distances between plates during compression cycles.
- The plates may also bend or deform during the compression cycle which causes tortillas in the center of the plate to be thinner and tortillas near the outer edge of the plate to be thicker. Thin disks that have received more heat, release quicker from the plates and are more easily transferred to the next conveyor.
- The hot-press conditions of pressure, time and temperature directly affect the dimensions (thickness, diameter) of the thin disk. A larger diameter and thinner disk is formed by greater pressure, longer time of compression and/or higher temperature of plates.

Hot Press

- Typical operating conditions for hot-presses range from 300-2000 psi, 0.7-3.5 sec and 300-450F.
- These conditions depend on equipment variables
  - diameter of the hydraulic cylinder (pressure)
  - insulating capacity of the belt
- Raw materials
  - Flour protein and damaged starch contents
  - Composition of the formula
- Size of the tortilla
- Level of automation in the line

Hot-Press Conditions Affect Tortilla Quality

- Optimal thick tortillas were yielded by a low pressure for a long dwell time
- Optimal thin, large diameter tortillas were yielded by high pressure for an intermediate dwell time
- Intermediate time and pressure yielded optimum flour tortillas

Large diameter, better opacity and longer shelf stability were attained using higher pressures ($\geq$1150 psi) for an intermediate hot-press time (1.35 sec).

Baking

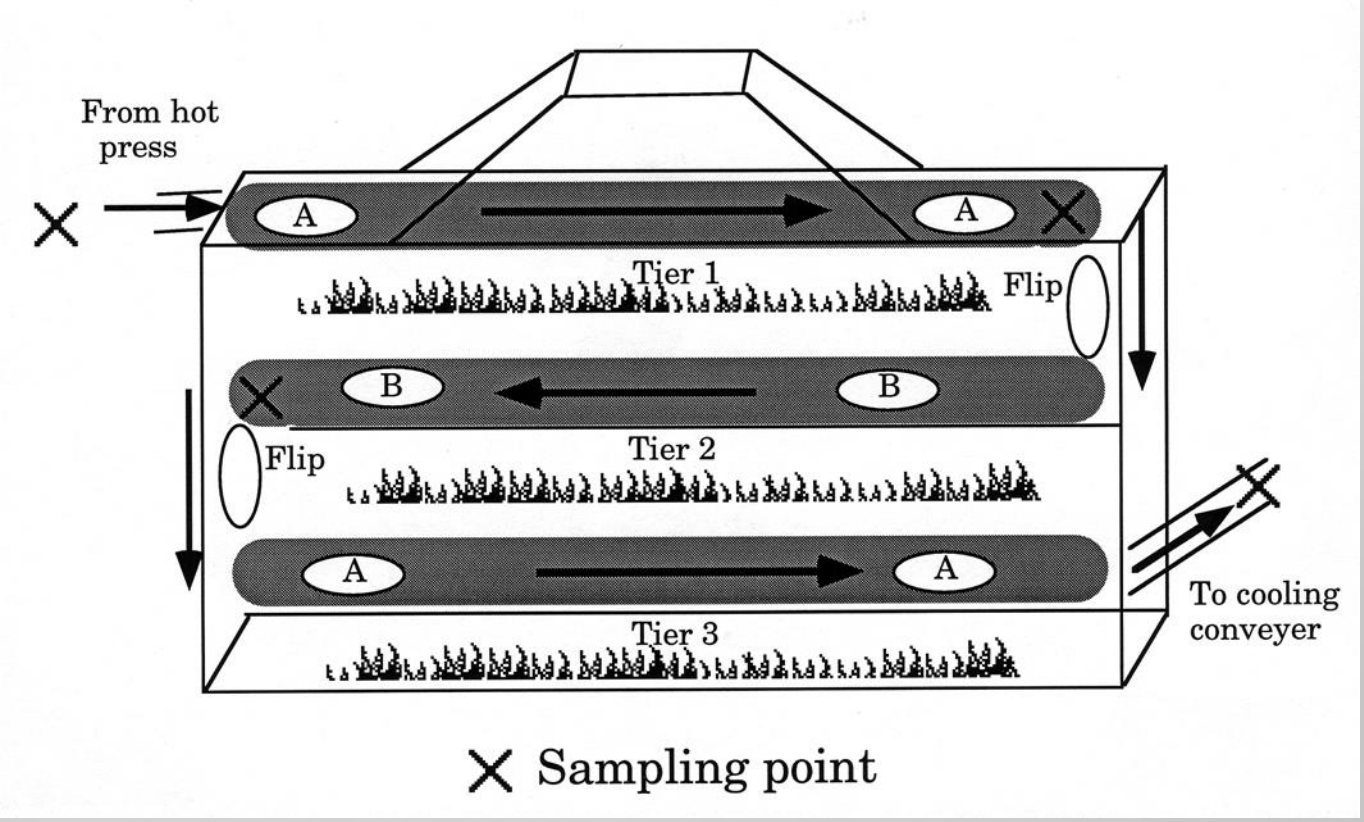
Baking

- After hot press, the flattened (partially cooked) dough balls are transferred to the oven to be baked.
- Thin, pressed disks with large diameters have more problems during transfers.
- Thicker disks with smaller diameters remain flat during transfers. Thinner and larger ones have tendency to fold and form pleats.
- If pressed unevenly (with thick and thin parts), the thicker areas will not touch the oven slats as well and will not bake at the same rate as the thin areas. Thus, will cause uneven cooking (may cause sticking later on).

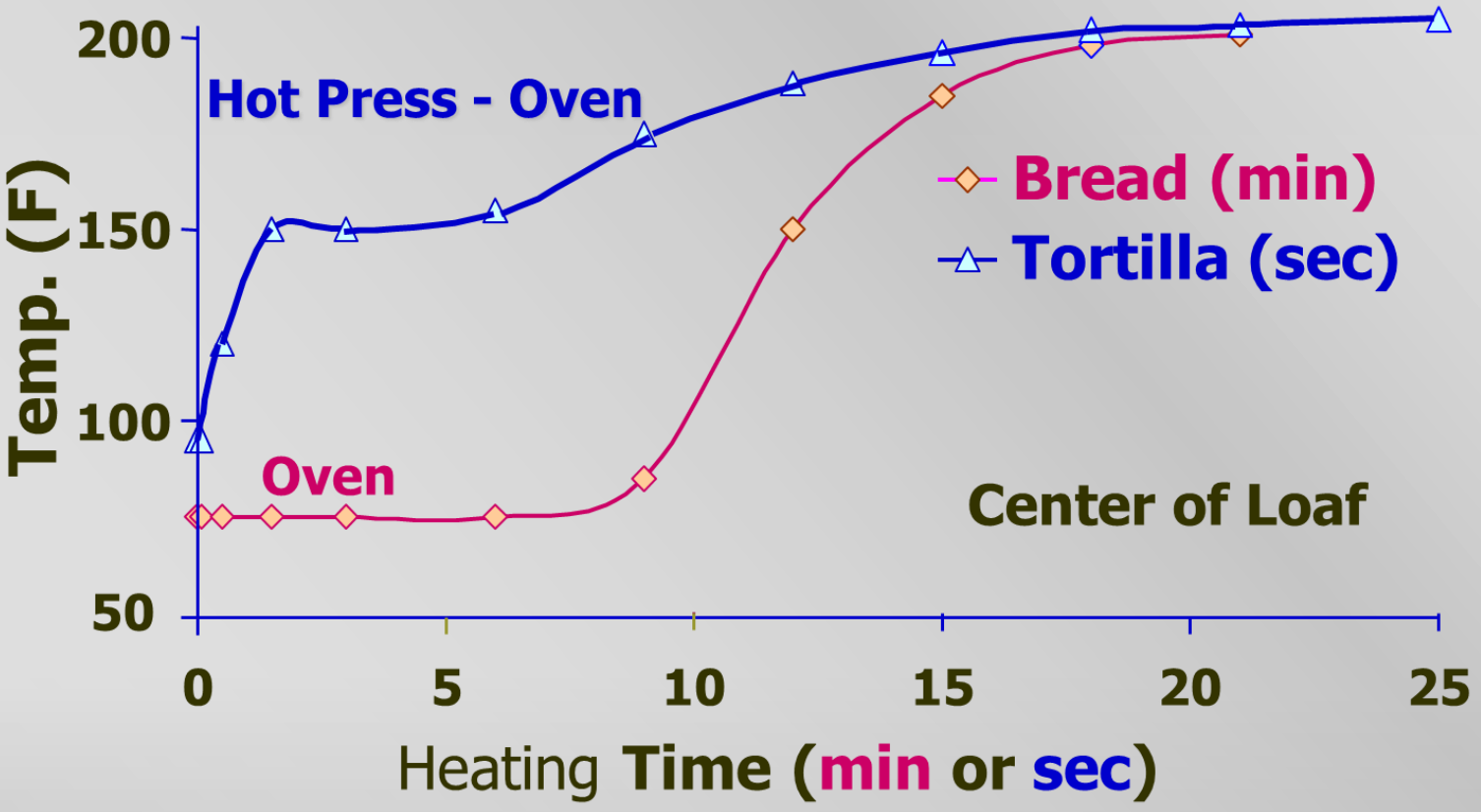
Baking

- Tortilla ovens are usually gas-fired and made of three tiers. Oven conveyor is composed of metal slats.
- Tortillas are heated by conduction on the bottom surface as it is conveyed on the slats. They are also heated to some extent by convection (air currents in the oven) and radiation (from interior surfaces in the oven).
- In the transfer of tortillas from one tier to the next, they are flipped in the process. Thus, the side that was not touching the slats on the first tier, touches the slats on the next tier. One side touches the slats twice (more cooked; opaque), other side only once (less cooked; translucent).
- Tortillas are baked at 350-500F (177-260C) for 18-50s. Oven conditions vary depending upon tortilla thickness, type of conveyor (slat or wire), and forming operation. Hot press helps pre-cook the dough which shortens the time to attain near water boiling temperature in the oven.
- Baking conditions will either cause completely puffed tortillas, or those with smaller sized blisters uniformly distributed on the surface.
- The internal temperature of tortillas is around 100C while the exterior temperature approaches 200C as they exit the oven.

Baking


From hot press
A
A
Tier 1
Flip
B
B
Flip
Tier 2
A
A
To cooling conveyer
Tier 3
Sampling point

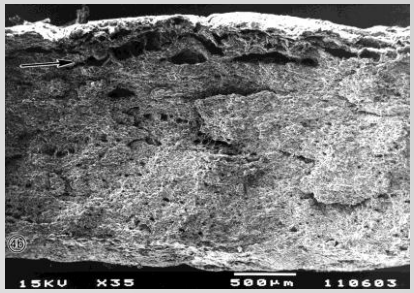
Baking


200
150
100
50
Temp. (F)
Hot Press - Oven
Oven
Bread (min)
Tortilla (sec)
Center of Loaf
0
5
10
15
20
25
Heating Time (min or sec)

Baking – ESM Tortilla Structure x 35

Side A

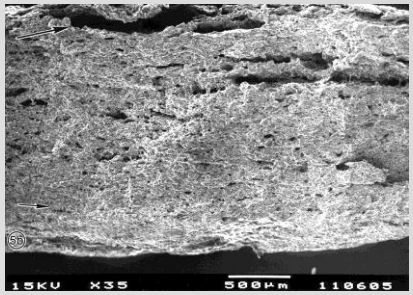
Side B



Tier 1 - Expansion from steam and gases begins at the top of the disk (side A), small interior air cells are forming

Side B

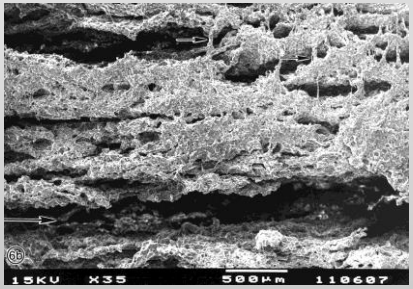
Side A



Tier 2 - The disk flips over and side A collapses because not set, side B (now top) begins expansion, with more extending to the middle (thin disk), dehydration beginning on side B

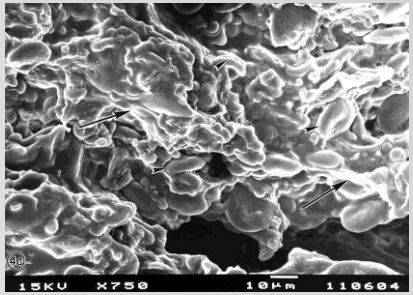
Side A

Side B

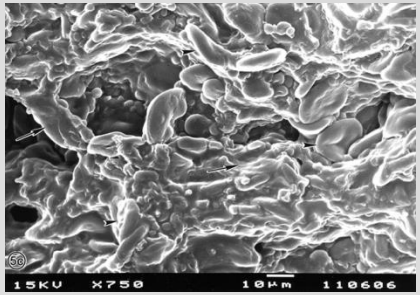


Tier 3 - Side A expansion continues, B holds because of dehydration, and center expands because surfaces are now only semi-permeable, disk doubles in thickness, small air cells in center

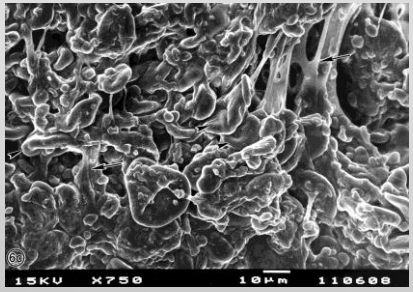
Baking – ESM Tortilla Structure x 750



Tier 1 - Gluten network begins to trap air, starch granules begin to gelatinize near surfaces, but not on surface (water has dehydrated)



Tier 2 - Gluten network continues to trap steam, starch granules are partially gelatinized near surface and begin to gelatinize in center, dehydration sets some air cells



Tier 3 - Gluten network is fully formed, amylose leached out of the granules, starch granules are fully gelatinized in the center (more water) and partial near the surface, none on the surface

Baking

- Underbaked - raw, high moisture, pale (no toast points)
  - Shelf-life
  - Sticking
  - Texture
- Overbaked – burnt; pillowing
  - Sticking
  - Texture
- Pillowing
  - Sticking

Cooling

Cooling

- Tortillas after baking are conveyed and cooled on wire or plastic mesh conveyors for 1.5-5 min. A vacuum-assisted conveyor permits the lifting of tortillas on a plastic belt at a 40-80 degree angle, i.e., in a much shorter distance.
- A gentle vacuum is applied to the inclined part of the belt to hold the hot tortillas onto the belt. The length of time the tortilla remains warm (above 65C) during conveying extends the effective baking time.
- The air flow, temperature and humidity in the space around the tortillas and conveyor, dynamically affect the temperature and moisture profiles of the tortilla. If the space is refrigerated and dehumidified with adequate air flow, the tortilla will achieve temperatures lower than 25C after several minutes.
- Otherwise, a longer time is needed and the tortilla may not attain temperatures less than 80F or continue to lose moisture after the tortillas are sealed in a plastic bag.
- Improper cooling causes tortillas to adhere or stick together and increases the moisture content and microbiological problems in the package.

Cooling

- Contamination
- Tortilla sticking (insufficient cooling)

Stacking/Packaging

Packaging and Storage

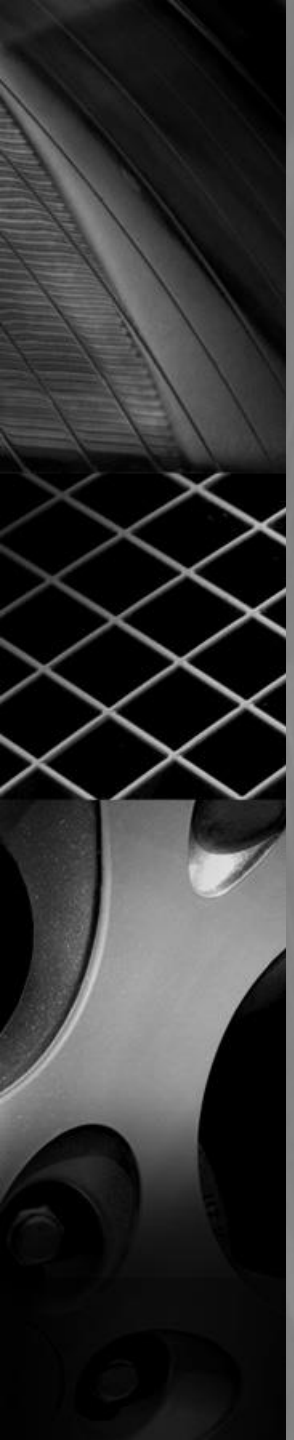
- Contamination
- Sweating
  - Tortilla sticking
  - Spoilage
- Oxidation
- Staling

Packaging

- Visual evaluation of tortilla quality has been used for many years by line workers. Tortillas not meeting specific appearance or size attributes are not picked-up, counted or packaged by line workers.
- For the automated equipment to operate efficiently the tortillas need to be in a linear orientation and not stacked or bunched together. Data from video cameras are now being utilized to analyze and accept or discard tortillas for color, appearance and dimensional properties.
- The tortillas are then placed in plastic bags and sealed. This is done by line workers in many facilities.
- Automated packaging equipment is utilized in larger manufacturing facilities.
- Uniform thickness and diameter of tortillas are necessary to not overfill the boxes.
- The tortillas boxes are placed on pallets and held at ambient temperature or refrigerated. The tortillas in the lower boxes on a pallet are compressed which contributes to adhesion, zippering and sticking of tortillas.

Packaging and Storage

- Packaging tortillas below or near 90^{o}F or as close to ambient temperature as possible prevents moisture migration and condensation in the tortilla package during storage.
- When tortillas are packaged too hot the moisture in the tortilla migrates to the surface and edges of the product and condenses on the bag.
- This greatly reduces shelf life due to increase of moisture content on the surface of the tortilla.
- It can also cause sticking problems in flour tortillas, which is commonly seen in warmer climates, were tortillas are not sufficiently cooled before packaging.
- Often manufacturers will use a dusting flour to eliminate the sticking problem only to exacerbate their shelf life problem. Adding dusting flour after the oven will increase the initial microbial load because spores in the dusting flour are not killed in the oven.



Raw Materials/Ingredients

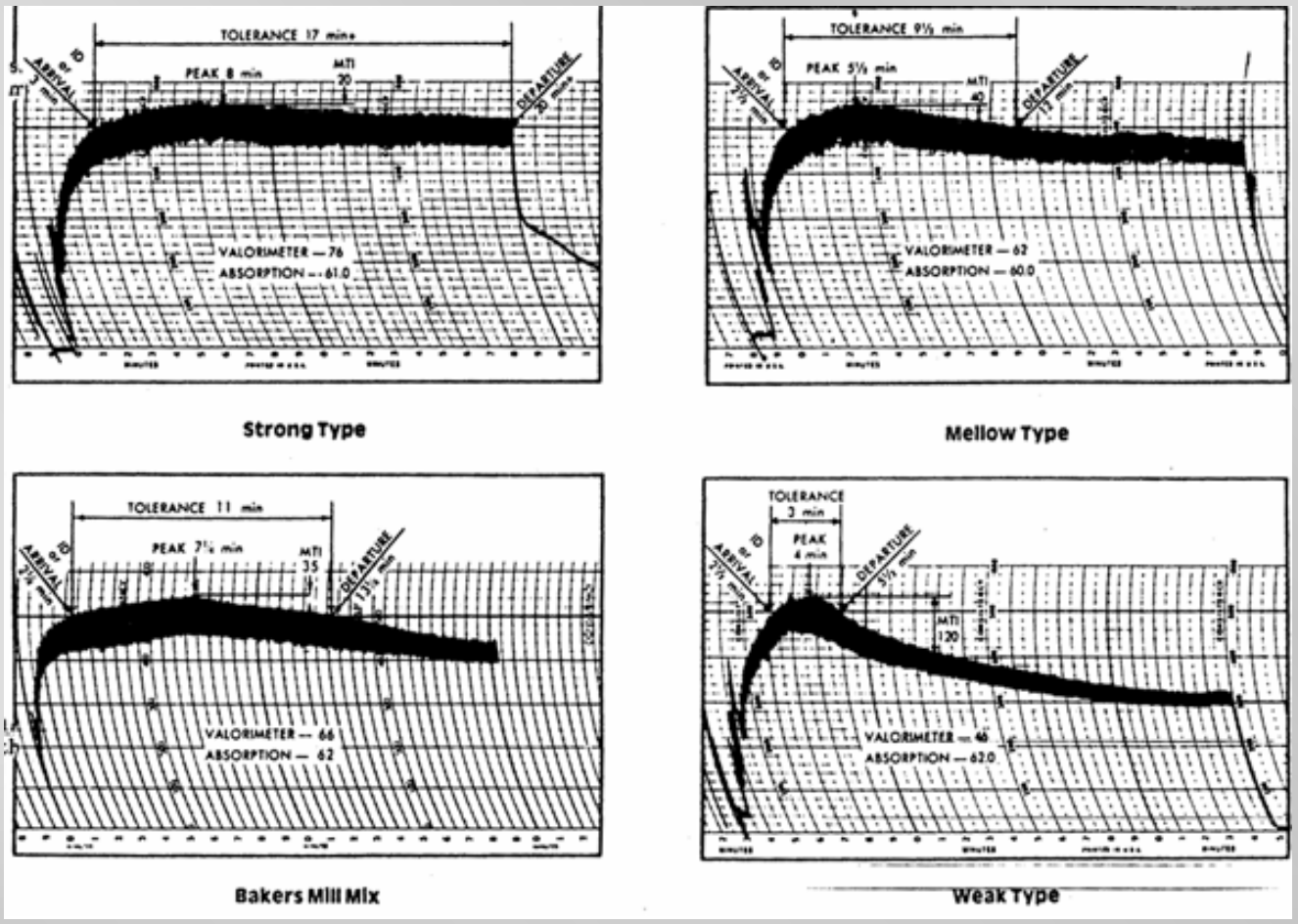
Flour

- All flours prepare into tortillas, but qualities of tortillas vary:
  - Diameter, Opacity, Stability
- Flour properties determine tortilla quality
  - Protein amount and quality
  - Damaged starch
- Additives "normalize" flour properties
  - Reducing agent, fat, emulsifier, etc.

Flour

- Fluffy texture depends on the retention of steam and leavening gases by the gluten matrix, so the formation of the matrix is of utmost importance
- Additives can make gluten matrix stronger or weaker
- Anything added to the dough will change the structure, and therefore affect the texture and quality of the tortilla

Flour Quality



Flour Quality

Tortilla Flour Certificate of Analysis

Moisture	13.8	13.7
Ash	0.440	0.420
Protein (N x 5.7)	11.3	11.2
Absorption	55.8	55.4
Peak	5.5	6.2
MTI	25	31
Stability	15.2	11.8

Also take note “change in crop” information.

Flour

- To attain dough that processes into tortillas - adjust:
  - Moisture content
  - Mixing time
  - Reducing agent (cysteine)

- Critical quality factors of tortillas
  - Diameter/Shape
  - Opacity
  - Shelf Stability (retention of freshness)

Water and Shortening

- Tough dough
  - Needs more water/shortening
- Sticky dough
  - Less water
- Uneven shape
- Broken edges
- High Moisture

Water

- Required for gluten complex (dough) formation
- Distribution and activation of other ingredients
- Compared to bread, tortilla dough has less water/more fat – gluten is not as fully developed
- Starch gelatinization
- Too much water creates steam pockets during baking that disrupts the tortilla structure
- Determines moisture content of finished product
  - Texture
  - Shelf-life

Oil/Shortening

- Solid shortening or liquid oil
- Dough machinability; tortilla texture and flavor
- Dough stickiness
- Interacts with starch and proteins; slows staling
- Reduces tortilla sticking

Salt and Sugar

- Overmixed dough
- Too tough dough
- Taste
- Toast Points

Salt and Sugar

Salt

- Flavor
- Ionic interactions with gluten; less sticky, increase strength
- Tightens up dough; increasing mix time
- Shelf-life

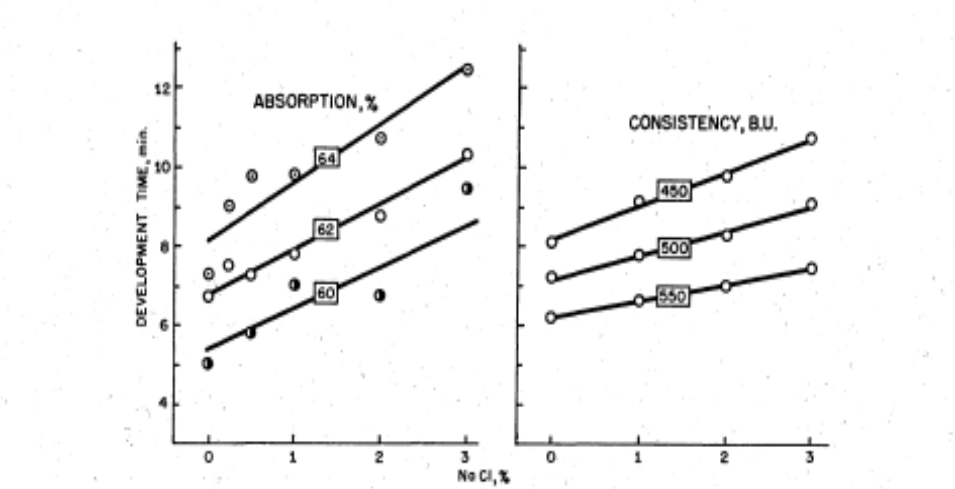


Fig. 19. Effect of salt on dough development time: left, with absorption constant; right, with consistency held constant.

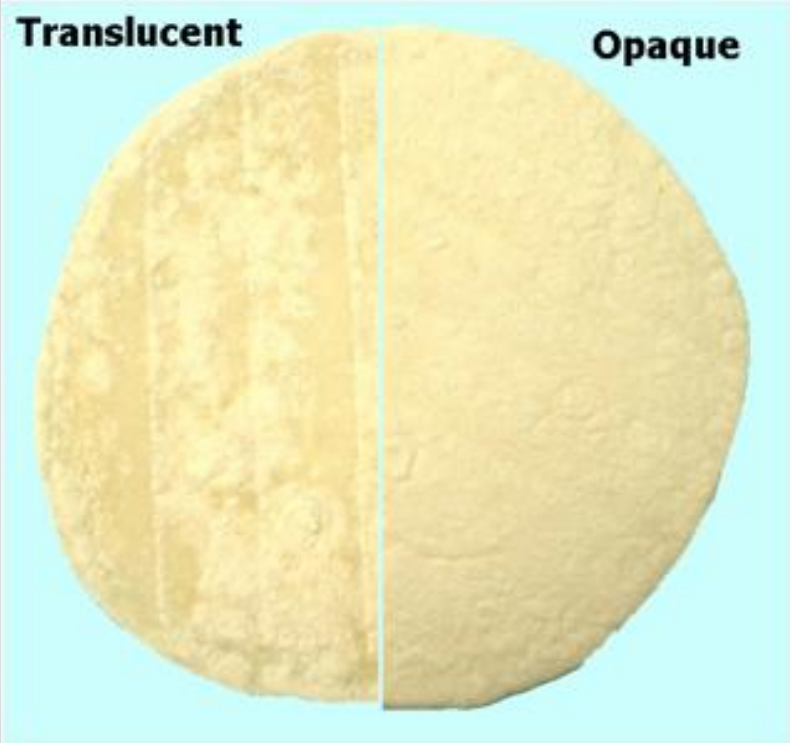
Sugar

- Flavor
- Toast points

Leavening

- Translucent
- Too fluffy
- pH
- Taste

Leavening



Fast- acting; low pH

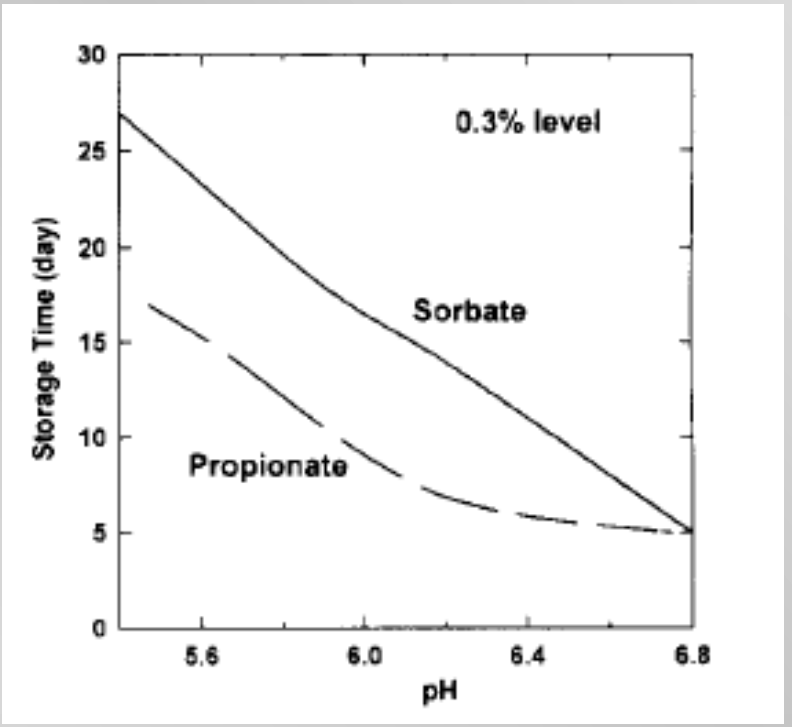
Slow-acting; high pH

Preservatives and Acidulants

- Taste
- Short shelf life
- Translucent
- pH

Preservatives and Acidulants

- The most common anti-mold agents used in tortillas are calcium propionate, sodium propionate, and potassium sorbate.
- The activity of these compounds are pH dependent.
- Therefore, to control molding of tortillas during storage, the use of these compounds is needed, as well as the necessary control pH so that these compounds will be effective.
- To attain the desired pH, acidulants are used.



Preservatives and Acidulants

- The pH of tortillas not only affects their shelf life, but also affects their quality. The ideal pH for flour tortillas is from 5.2 to 6.0. Tortillas outside of this range will either spoil very quickly (above 6.0) or have an acidic taste (below 5.2).
- Flour tortillas with a higher pH will tend to have better flavor, aroma and appearance.
- As the pH is reduced to increase activity of preservatives and extend the shelf life of flour tortillas, these tortilla attributes are lost. It is necessary to monitor tortilla pH and the shelf life of manufactured tortillas to achieve a product with the desired code date (shelf life) and consumer acceptability.
- The optimum pH for flour tortillas for many manufacturers is around 5.8 achieve most shelf life requirements and have a good quality tortilla.

Dough Conditioners

- Tough dough
- Too soft
- Uneven shape
- Sticking tortilla
- Loss of flexibility

Dough Conditioners

Reducing Agents

- Reducing agents weaken the gluten matrix by breaking bonds between proteins in the dough.
- Reduce the mixing times and reduce the dough elasticity.
- Can effectively shorten the time to process the dough.
- Facilitate mechanical production of tortillas.
- More reducing agent makes the dough sticky, and to avoid this, the amount of water in the formulation needs to be reduced.

Dough Conditioners

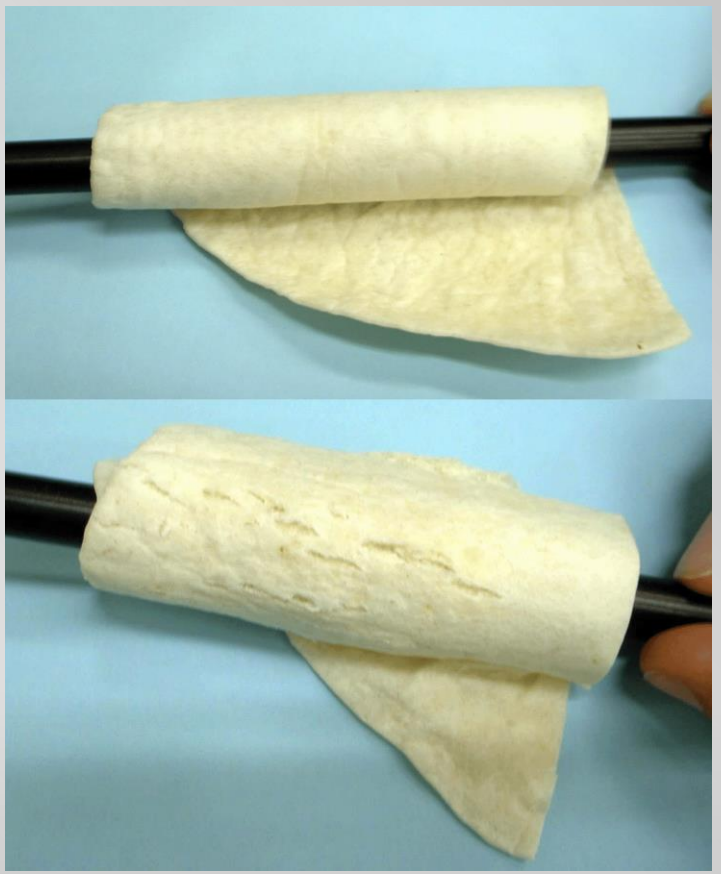
Emulsifiers

- Interact with gluten during mixing to improve dough machinability
- After baking, emulsifiers interact with starch which helps reduce the rate and extent of staling
- Certain type of emulsifiers provide fat-structuring property that helps prevent the occurrence of tortillas sticking with each other in the package

Gums

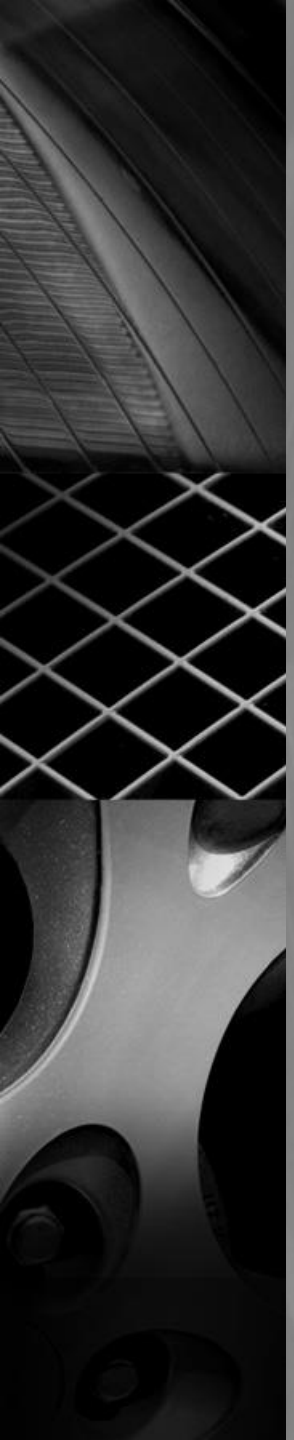
- Also improve dough machinability; decrease dough stickiness
- Improve tortilla texture/flexibility
- Contribute to prevent tortilla sticking
- Help reduce moisture loss

Enzymes – slow starch retrogradation (staling); keep tortillas flexible over extended storage period



With Enzyme

Without Enzyme



General Practices

Plant Sanitation and Equipment Maintenance

- Spoilage
- High microbial count
- Inconsistent quality
- Processing loss

Sanitation – extends shelf-life

- Clean facility, refrigeration, storage area, trucks, …
  - Remove trash, clean floors, ...
- Eliminate birds, rodents, insects
- Air quality – filter to remove dust (outside)
- Eliminate cross contamination of raw products with finished products
  - Dust (inside) from mixer on equipment and tortillas
- Process equipment – sanitize periodically
- Sanitize – hands before handling tortillas
- Use good manufacturing practices

Sanitation

Good manufacturing practices

- Store bags in a closed clean container
- Keep dry ingredients dry
- Avoid stirring up dust during production,
- Clean and sanitize all contact surfaces regularly
- Keep moldy tortillas and returns away from the production area
- Packaging tortillas below or near 90^{o}F, using ultraviolet lights in the cooling area.

Spoilage is generally caused by poor processing conditions, cross contamination, insufficient preservatives and improper pH, and/or temperature abuse of the finished product.

Warehouse, Shipping and Distribution

- Spoilage
- Tortilla sticking
- Physical damage

Technical Support

- Helps maximize equipment efficiency
- Choose the best ingredients (cost and quality)
- Advise on how make tortillas that meet your customer's specifications
  - Appearance
  - Taste
  - Shelf-life
  - Nutritional content
  - Regulatory requirements