

# ***Tortilla Mold Spoilage: Assessment and Prevention***



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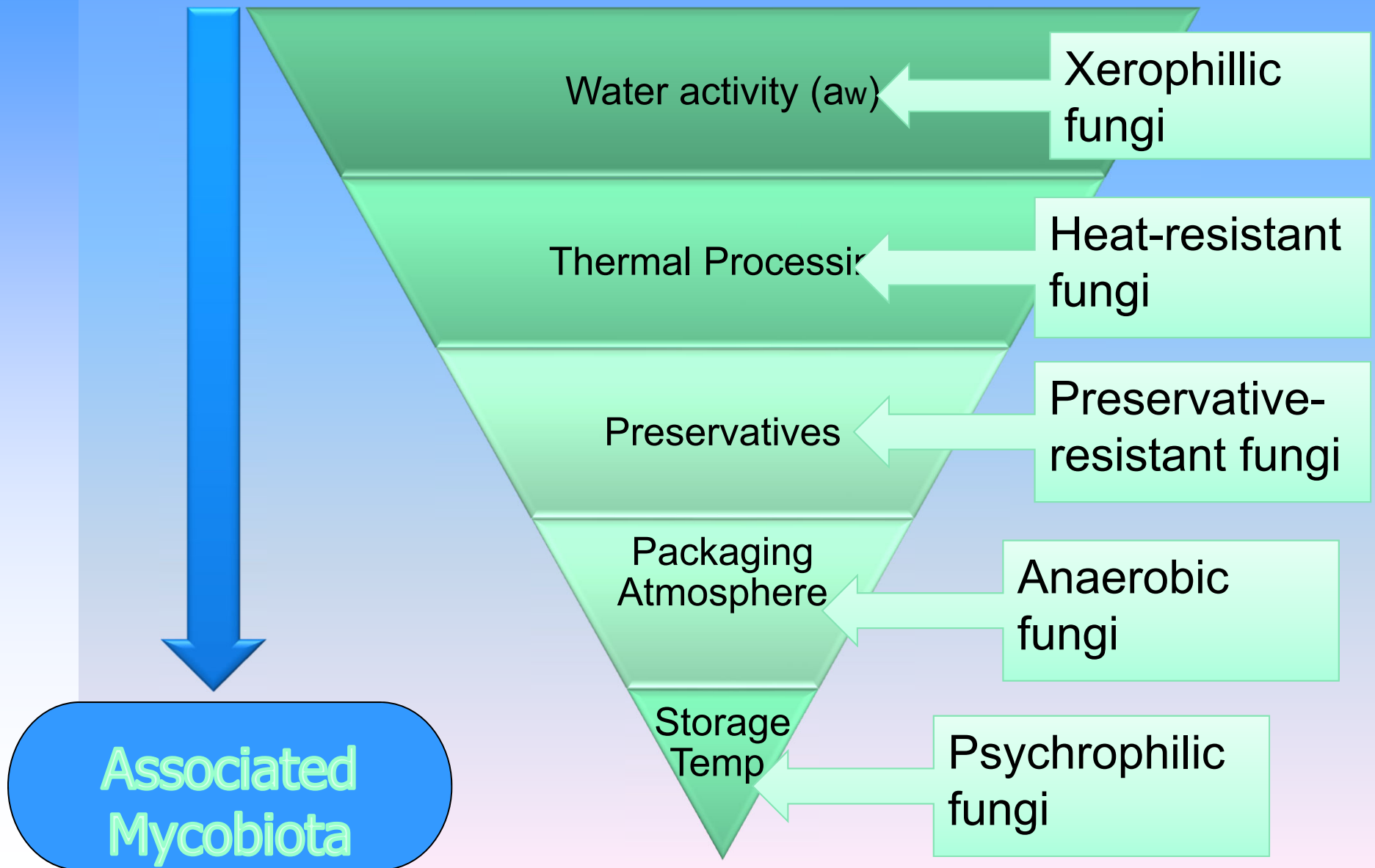
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# Agenda

- **The Hurdle concept**
- **Heat-sensitive mold (HSM) spoilage**
  - **Preservative-resistant molds (PRM)**
  - **Preserved tortilla mold spoilage factors**
  - **Non-preserved tortilla mold spoilage factors**
  - **How to prevent HSM tortilla spoilage**
  - **Other recommendations**
- **Heat-resistant mold (HRM) spoilage**
  - **How to prevent HRM tortilla spoilage**
- **Conclusions**



# The Hurdle Concept (Multiple Barriers)



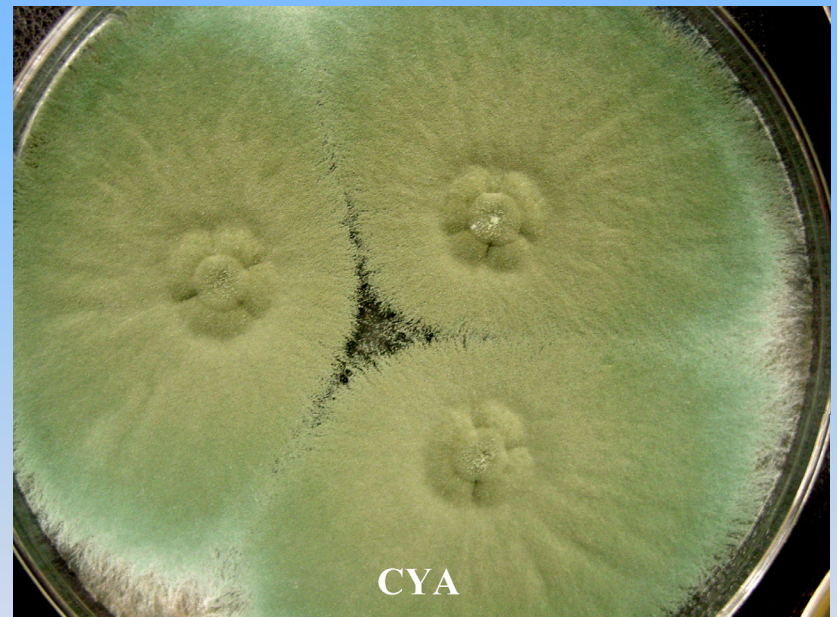


# Spoilage by Heat-sensitive Molds

**Preservative-resistant and not resistant**

# Preservative-resistant Molds (PRM)

- PRM are resistant against sorbate, benzoate and propionate
- Sorbate-resistant molds form *trans*-1,3-pentadiene by decarboxylation – plastic-like or kerosene odor
- Typical preservative resistant species are *Monascus ruber*, *M. pilosus*, *Paecilomyces variotii*, *Penicillium roqueforti*, *P. paneum*, *P. carneum*.
- *The three species of Penicillium can grow under refrigeration and under vacuum*



***Penicillium roqueforti***

# Preserved Corn Tortillas Spoilage

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*Cold month  
spoilage*

*P. roqueforti,*  
preservative resistant



*Warm month  
spoilage*

*Monascus ruber,*  
preservative/heat resistant

# Tortilla Spoilage Factors: Formulation



## Formulation

- preservatives
- pH

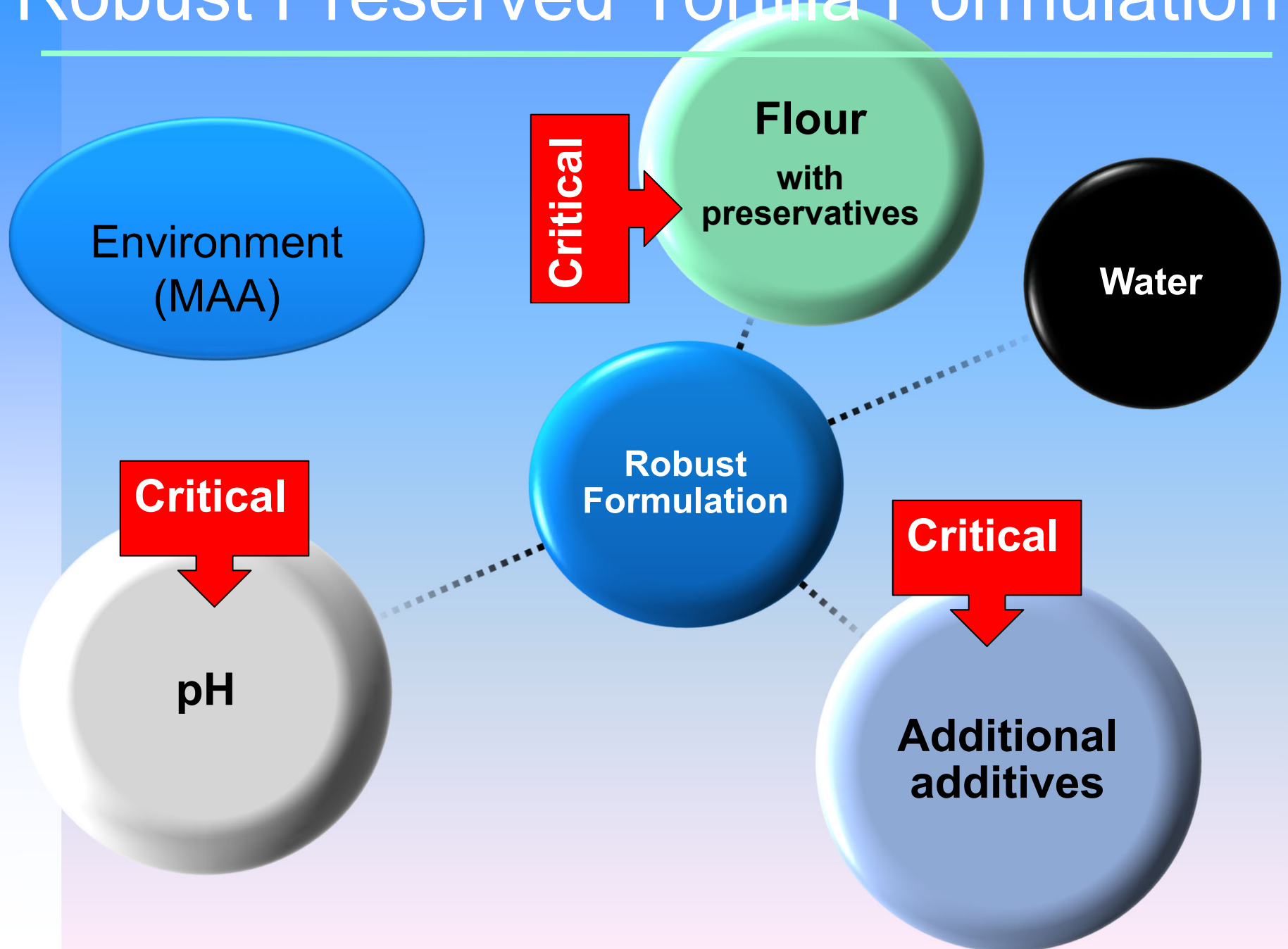
## Environment

- equipment
- air

## Storage

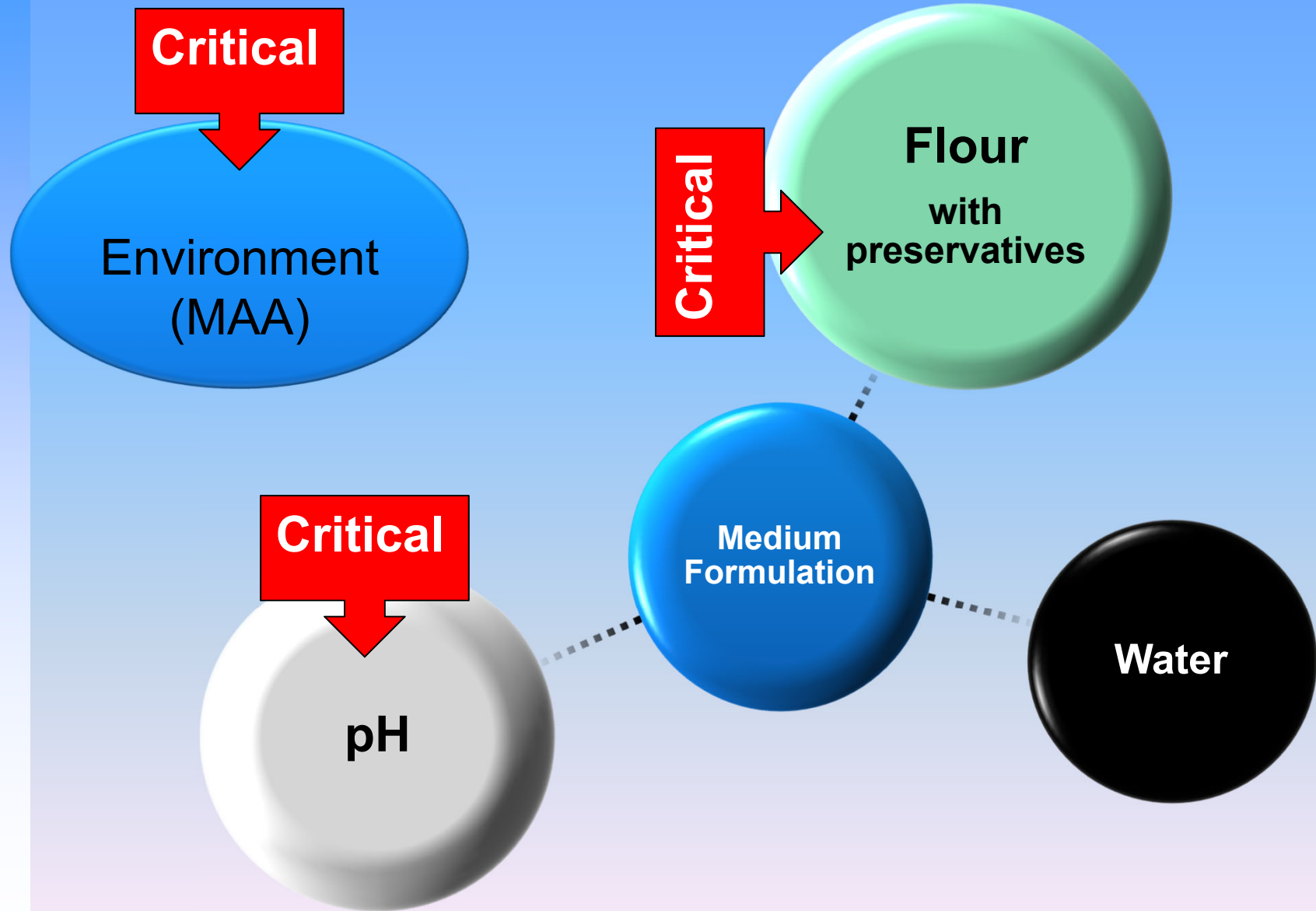
- temperature
- time

# Robust Preserved Tortilla Formulation

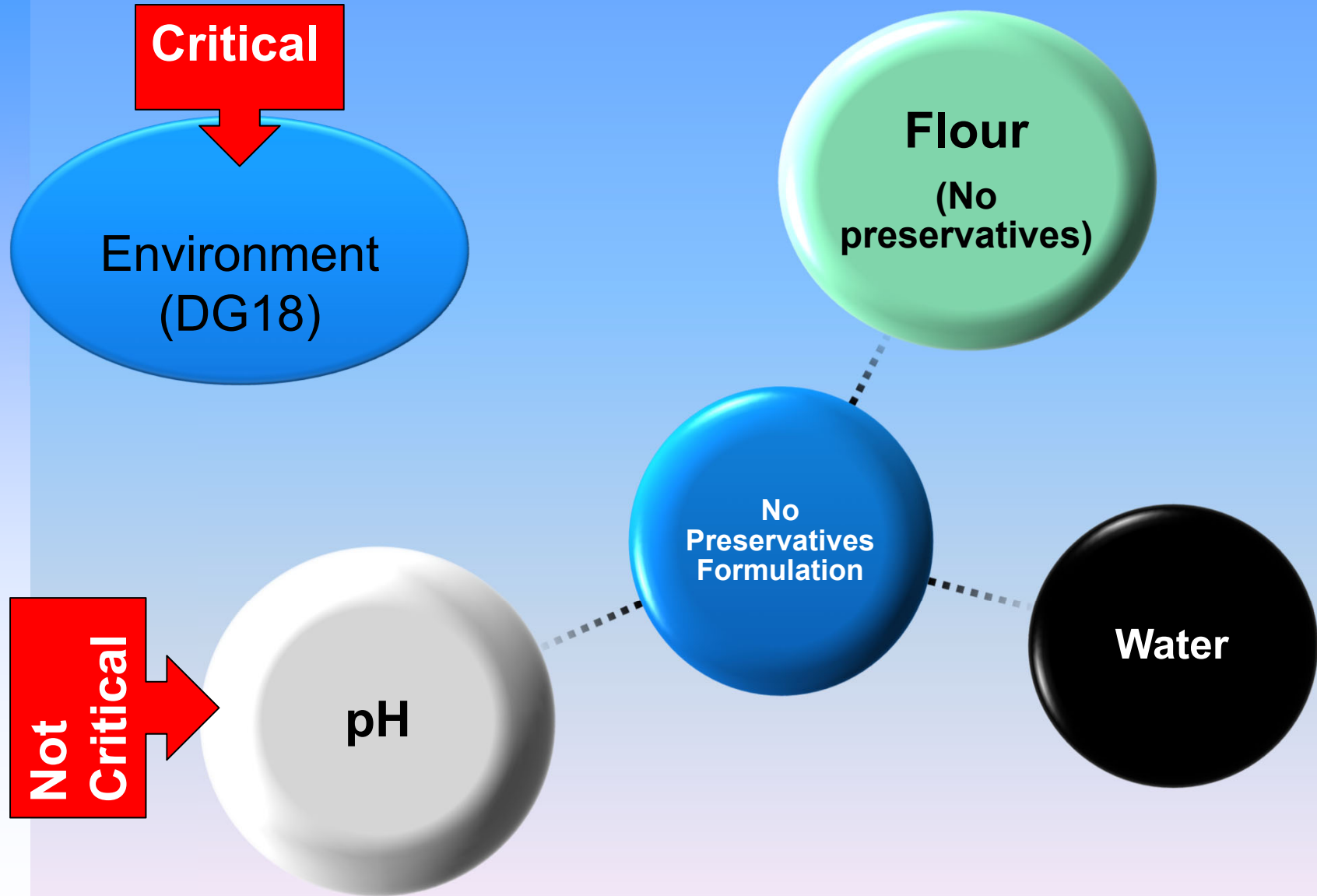




# Medium Preserved Tortilla Formulation



# Not Preserved Tortilla Formulation



# Preservative Issues

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1. Acids like benzoic acid are not very water soluble – their salts are highly soluble.
2. In our studies, benzoate was the most inhibitory preservative followed by sorbate and propionate (the least inhibitory – rope bacteria).
3. In the tortilla formulation, the distribution of the benzoic acid may be not uniform due to the low solubility in water of benzoic acid which is the key preservative to inhibit *P. roqueforti*.
4. Sodium benzoate should be use in the flour and tortilla formulation.

# Preservative Issues

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5. Sorbate can be broken down to 1,3 pentadiene by PRM – kerosene smell -- other molds can grow after this happens.
6. Once exposed to preservatives, PRM can grow at a higher preservative concentration – PRM in flour
7. Consumers are looking toward natural products
8. Natural preservatives are not as effective against PRM and are more expensive

# Tortilla Spoilage Factors: Environment



## Formulation

- preservatives
- pH

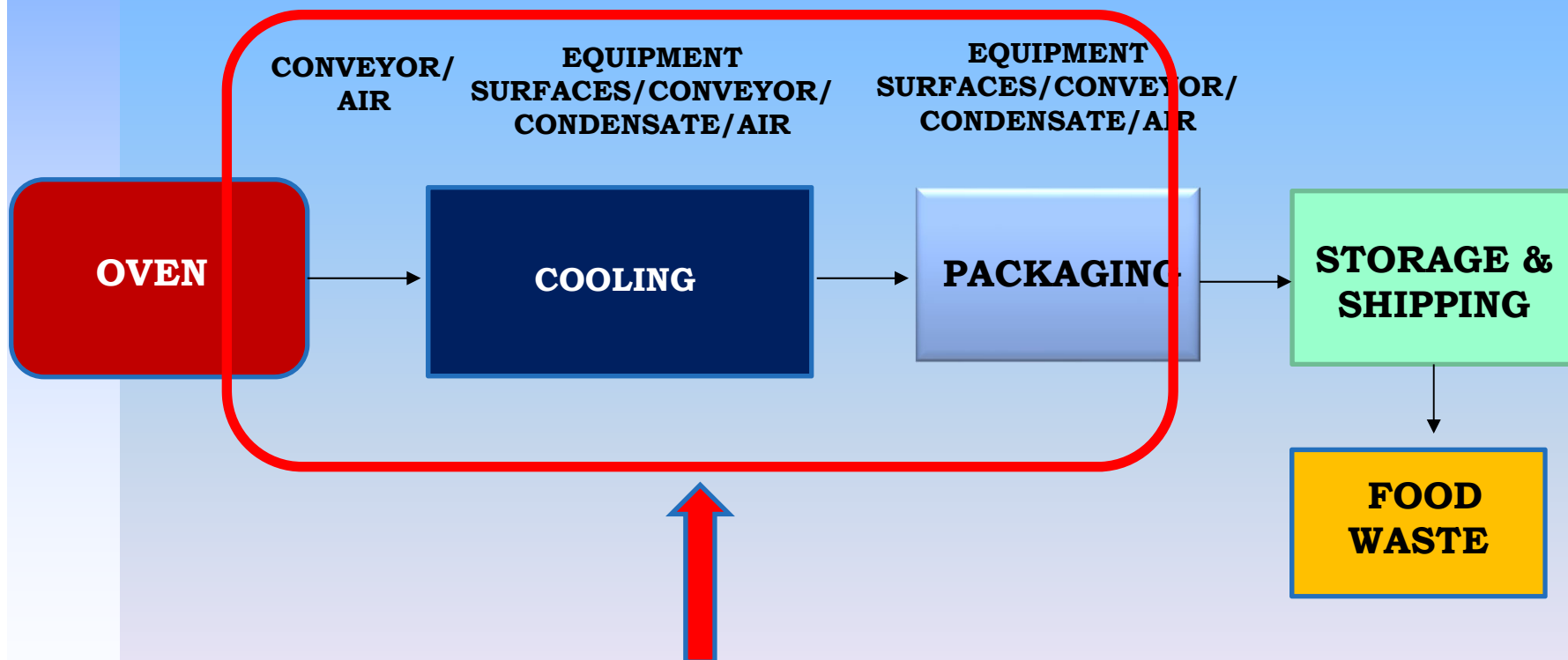
## Environment

- equipment
- air

## Storage

- temperature
- time

# FINISHED PRODUCT AREA -- PRM



**PRIMARY MICROBIAL CONTROL AREA (the area subsequent to the lethality step up to the packaging step)**

# HVAC SYSTEM

- There has to be enough air flow to prevent condensation.
- RTE product processing facilities often have 20 to 25 or higher air turns per hour.
- RH should be less than 70% -- Ideally < 60%
- Should maintain positive air pressure in the packaging area

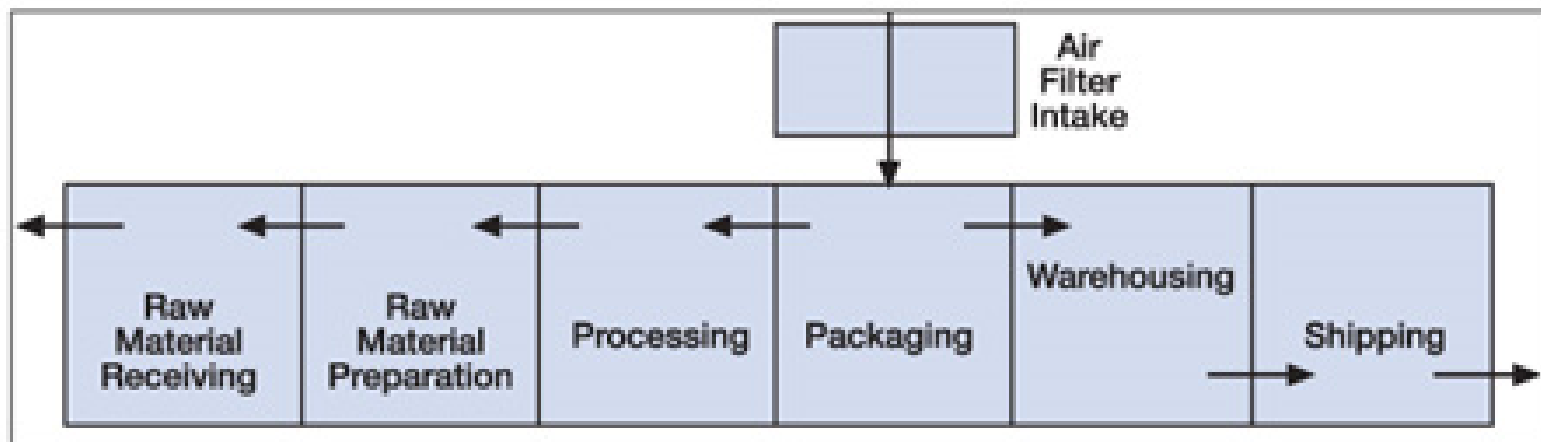


Figure 1: Plant Air Pressure/Flow



## Air handling issues

During cold months some units may be turned off – not enough air flow –high RH and condensation on walls, ceilings, overheads







**Vacuum cleaners issues**  
Vacuum cleaner – high PRM.



## Packaging materials issues

Wooden pallets, cardboard boxes and other packaging materials bring a lot of PRM spores to the packaging area– high PRM.





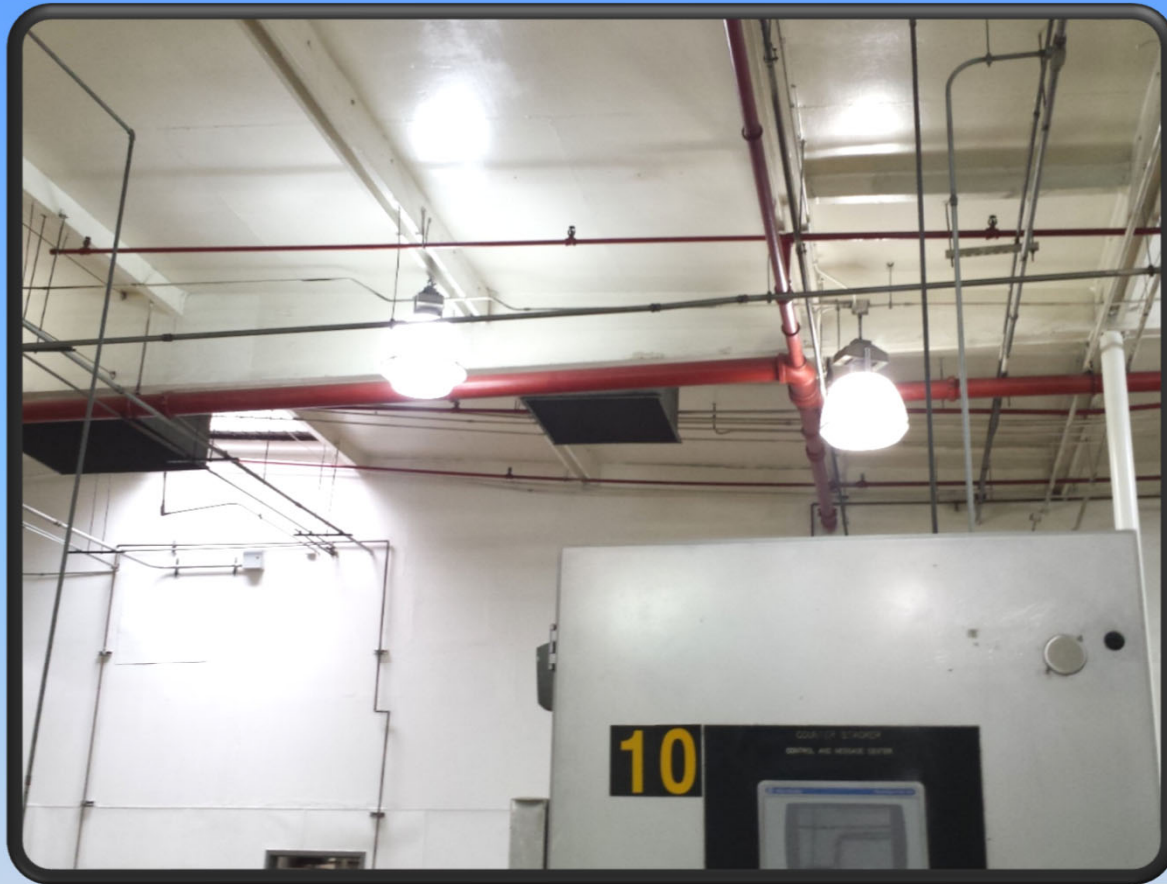
## **Packaging materials issues**

Pallet elevator in the packaging area –  
high PRM.



## Packaging room issues

Clutter in the packaging area – high PRM.



## Ceilings and overheads issues

Ceilings and overheads cannot be cleaned properly – high PRM.





## **Cleaning Utensils issues**

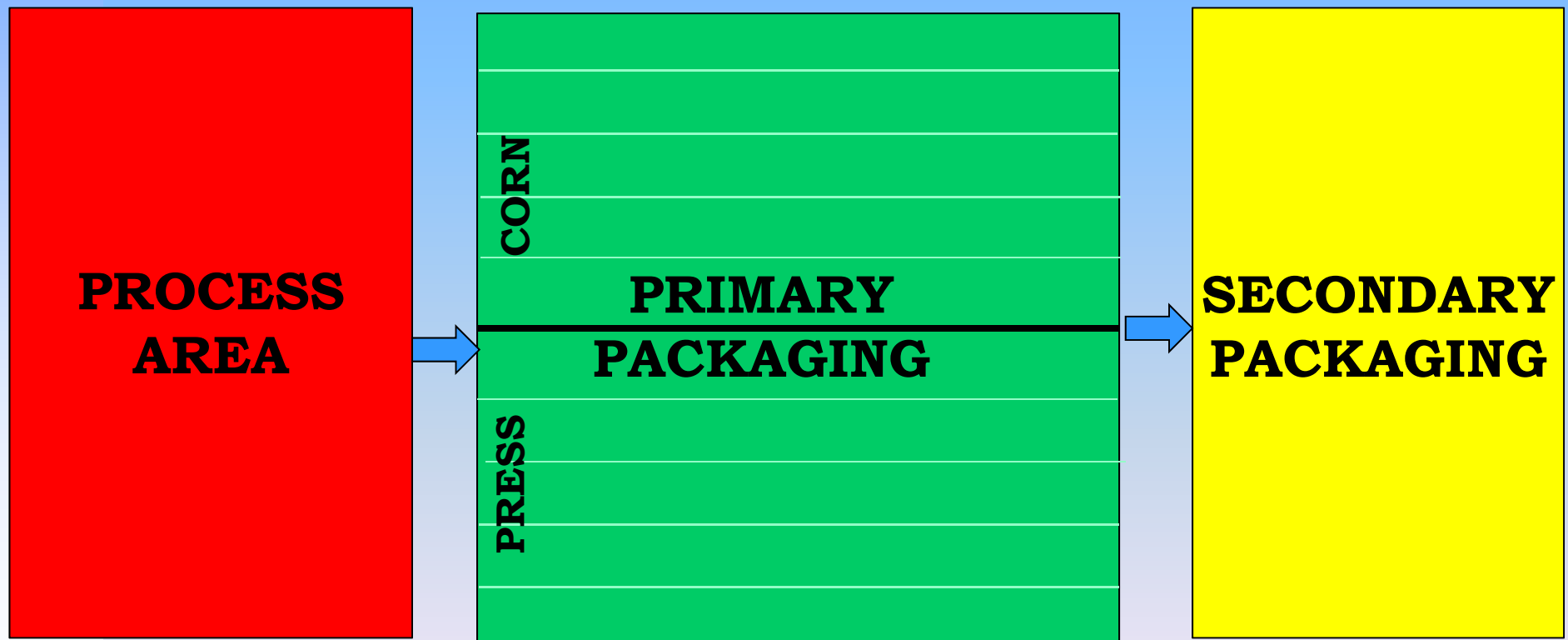
In the packaging area – high PRM.



**Not realistic and too expensive!**

# SOLUTION: AREA SEGREGATION

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# Tortilla Spoilage Factors: Storage



## Formulation

- preservatives
- pH

## Environment

- equipment
- air

## Storage

- temperature
- time



### Storage issues

Too much condensation makes the molds grow faster – avoid temperature gradients.

**VERY DIFFICULT**



# How to Prevent HSM Spoilage



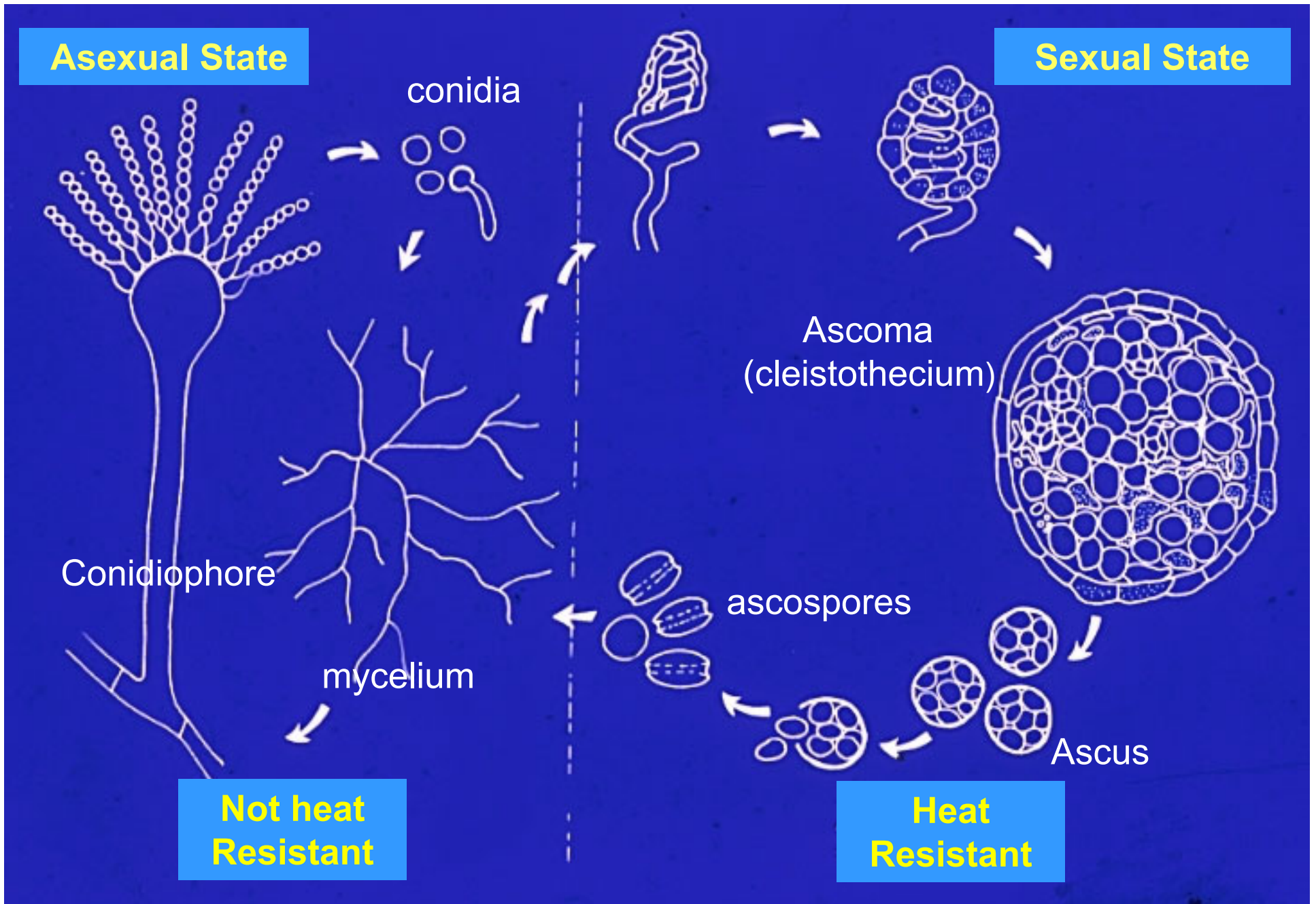
# How to Prevent HSM Spoilage



A close-up photograph of a stack of white, round tortillas. A circular mold, characterized by a reddish-brown outer ring and a darker, textured center, is growing on the top surface of the tortilla. The mold is positioned in the upper right quadrant of the frame. The tortillas are stacked, with the edges of several layers visible at the bottom. The background is dark, and a blue vertical bar is on the left side of the image.

# Spoilage by Heat-resistant Molds

**Preservative-resistant and not  
resistant**



## Life Cycle of HRM

Courtesy of Rob Samson, CBS, Utrecht, NH

# Ascospore Activation

Ascospores need to be activated to be able to germinate

Ascospores can be activated by the heating during pasteurization, hot filling or baking

After germination, they can grow and spoil the product during storage at room temperature or somewhat higher

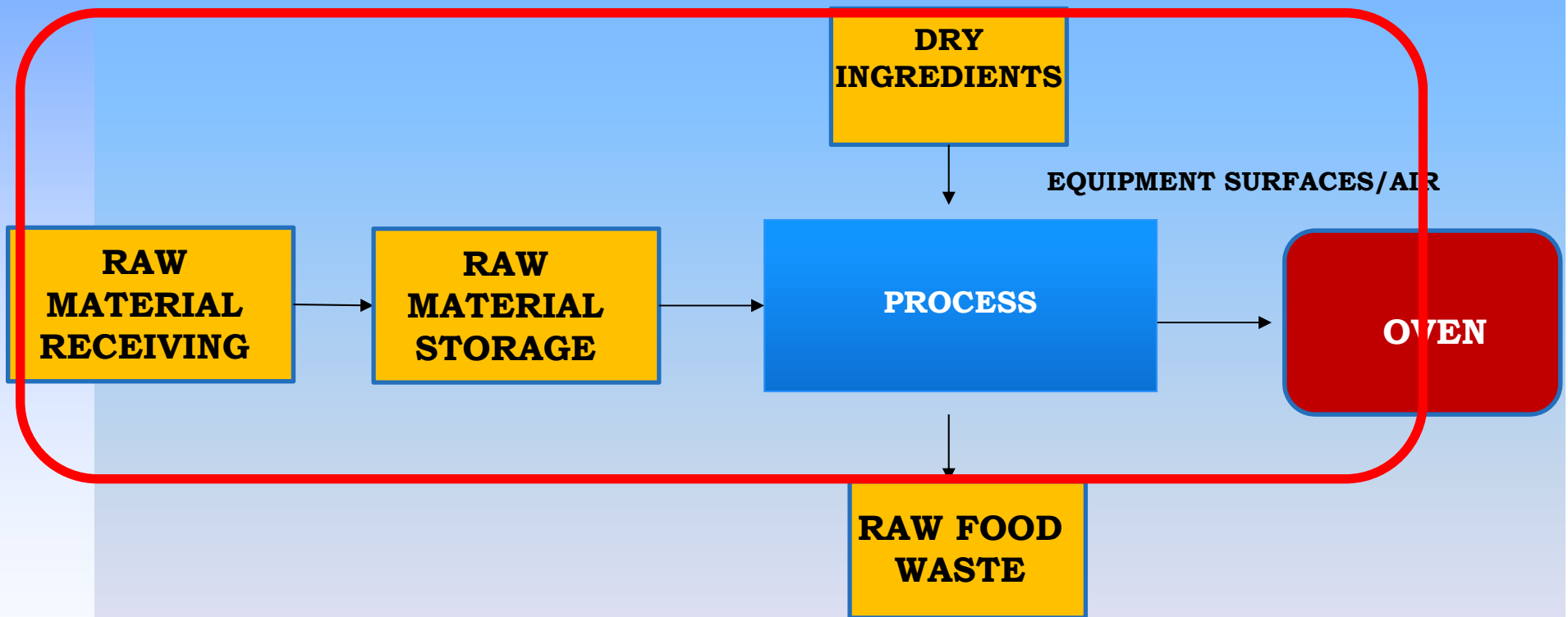
**DORMANT  
ASCOSPORE**

Extreme trigger/heat/high-pressure/chemicals?

**GERMINATING  
ASCOSPORE**

# RAW AREA -- HRM

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## *Monascus ruber*

- Brown to orange brown colonies
- Ascomata on pedicel
- Asci globose or subglobose
- Ascospores yellowish ovate-ellipsoidal
- Conidia ovate to pyriform with truncate base (aleuroconidia)
- Mycotoxins: citrinin
- Red pigments used as food colorants
- Preservative- and heat-resistant mold
- Foods: starch-rich foods and feeds, olives, beverages, soil, soft cheese, honey, spices, prunes, preserved corn tortillas, etc.

Courtesy of Rob Samson

**Isolated from samples of corn flour**

# Sources of HRM

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- Ingredients – flour (wheat and corn)
- Ingredient packaging -- bags, pallets, etc.
- Equipment before oven contaminated by flour
- Processing environment before oven contaminated by flour

# Surfaces can be contaminated by HRM

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# How to Prevent HRM Spoilage

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- Samples of flour, equipment and environmental samples should be monitored for HRM ascospores using the right methodology (heat-shock).
- Compressed air should not be used to clean the flour off the equipment – a vacuum cleaner should be used. The vacuum cleaner should have HEPA filters.
- There should be more environmental cleaning and sanitizing.

# How to Prevent HRM spoilage

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- Overheads, ducts, extractors, etc. should be cleaned and sanitized at least quarterly.
- Surfaces near the oven should be kept free of accumulated flour.
- An iodine sanitizer or solutions of chlorine dioxide should be used for sanitizing surfaces.
- Avoiding or reducing this type of contamination requires a continuous effort.

# Conclusions

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Ingredients and environment have to be monitored for HRM

The right formulation is essential to prevent PRM spoilage

The distribution of the preservatives have to be uniform through the tortilla

Use the right molds for the preservative challenge tests – *P. roqueforti*

# Conclusions

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The critical area for mold contamination after the oven should be segregated from the raw and packaging materials

The temperature and RH in the primary packaging area have to be regulated and maintained

The air pressure in the critical area should be positive – HEPA filtered air should be used – primary packaging

The accumulation of dust and clutter in the primary packaging area should be avoided

Thank you! Questions?

**BOOTH # 517**

