Technological Challenges in the Production of Whole Grain Products

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Whole Grain *Challenges*

- Context
  - Can they be produced?

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  - Can they be produced?

  OF COURSE THEY CAN BE!
    - Originally all baked products were W.G
    - Companies have been & are producing high quality W.G. baked products

Whole Grain *Challenges*

- Reality
  - Creation/Production requires
    - ADAPTATIONS
    - MODIFICATIONS
    - *TRANSFORMATIONS*
  - Formulations & Processes

Whole Grain *Challenges*

- Process & Formulation Adaptations
  - Refined Flour Formulations
    - Optimized to a different base ingredient
    - Different intermediate product (dough)
  - Refined Flour
    - Endosperm
      - Starch & protein

Whole Grain *Challenges*

- Process & Formulation Adaptations
  - Whole Grain Formulations (@best)
    - Different optimization basis
    - Includes the bits removed in refined flour milling
      - Bran
      - Germ
  - @ most challenging
    - Adds non-wheat grains
    - Large pieces of the caryopsis

Whole Grain *Challenges*

- Effects?
  - Dilution and Addition
  - Dilutes *GLUTEN Protein*
    - Responsible for dough & crumb structure
  - Bran & to a lesser extent, germ
    - Interferes with its creation
    - Disrupts it

Whole Grain *Challenges*

- Effects?
  - Dilution and Addition
  - ADDS
    - Large carbohydrate polymers (Pentosans)
      - Arabinoxylans
      - Beta Glucans
      - Quite hydrophyllic
      - Compete for formula water
      - When hydrated – large effects on DOUGH properties

Whole Grain *Challenges*

- Effects?
  - Dilution and Addition
    - Net result:
      - A different system
        - » Physical properties
        - » Processing requirements
        - » Final product properties

Whole Grain *Challenges*

- Effects & Adaptations
  - Model: Bread
  - Process: Straight Dough
  - By Process Step

Whole Grain *Challenges*

- Straight Dough Process
  - Scale
  - Mix
  - Ferment/punch
  - Divide/Round
  - Make-up (incl sheeting)
  - Pan
  - Proof
  - Bake

Whole Grain *Challenges*

- SCALING
  - Additional major ingredient(s)
  - Additional minor ingredient(s)
  - Additional or different micro ingredient blends

Whole Grain *Challenges*

- MIXING
  - Obligate first step
  - Creates the gluten matrix
  - Mixing *optima do exist*
    - Water content
    - Work input (time)
    - Little Red Riding Hood's situation

Whole Grain *Challenges*

- MIXING: WG Challenges
  - Bran & etc are hydrophilic
    - Hydrate @ diverse rates
    - Competes with protein for water
  - Formula water must go up
  - If no adjustment
    - “ok” @ mixer
    - Underabsorbed (bucky) @ divider/rounder
      - Processing problems

Whole Grain *Challenges*

- *ADJUSTMENTS & Consequences*
  - Increased absorption (up to 20%)
    - Must be removed @ baking: time & temp. changes
  - Slack out of the mixer
    - But better later in the process
  - Reduced mixing requirements
    - f(water content, gluten)
  - Mixing optimum: narrow & cryptic
    - Easy to under or overmix

Whole Grain *Challenges*

- W.G. dough (w. no other adjustments)
  - WEAK
    - More viscous
    - Less elastic
    - Sticky
  - WHY?
    - Less gluten to create the matrix (structure)
    - More “stuff”
      - Interferes with gluten creation & continuity

Whole Grain *Challenges*

- W.G. dough (w. no other adjustments)
  - Does the bran '*cut*' the gluten strands?
    - Probably NOT the major mechanism
    - Does cause it to fail
      - More stuff to stretch over

Whole Grain *Challenges*

- WEAK DOUGHS
  - Machine Poorly
    - Dividing/rounding
    - Sheeting
  - Retain Leavening Gas Poorly
  - Lack Processing Tolerance

Whole Grain *Challenges*

- WEAK DOUGHS
  - Morel likely
    - Lower volume
    - Poor loaf shape
    - Cripples

What to be done?

Whole Grain *Challenges*

- ADAPTATIONS
  - Supplement the protein
    - *Vital* wheat gluten
    - 8% to 15% or > possible
  - Issues
    - Cost
    - Mixing requirements

Whole Grain *Challenges*

- ADAPTATIONS, ctd
  - STRENGTHEN the Protein Matrix
    - Oxidizing Improvers
    - Used in non-W.G. applications
    - Different Chemistries
  - Increase cross-links between gluten polymers
    - Cys-Cys linkages (disulfides)
    - More elastic behavior
      - Vulcanized rubber

Whole Grain *Challenges*

- Oxidizing Improvers
  - Ascorbic Acid
    - Dosage limit: none
    - Usage: 0- ~200 ppm
    - Rate: medium to fast
    - Rxn timing: proof thru early oven spring

Whole Grain *Challenges*

- Oxidizing Improvers
  - Azodicarbonamide (ADA)
    - Dosage limit: 45 ppm
    - Rate: Fast & extended
    - Rxn timing: mix thru proof
  - Potassium Bromate
    - Dosage limit: 75 ppm
    - Rate: Slow (heat triggered)
    - Rxn timing: oven (early bake)
    - Note food safety concerns!

Whole Grain *Challenges*

- Formula Adaptations, ctd.
  - Increase Abuse Tolerance
  - Dough *Strengtheners* (emulsifiers)
    - Sodium Stearoyl Lactylate (SSL)
      - Legal limit: 0.5% (FWB)
      - Gas cell stabilization
      - Proof Collapse & the ‘drop’ test
      - Additional Benefits

Whole Grain *Challenges*

- Low Volume Adaptations
  - FORMULA
    - Emulsifiers (SSL)
    - Add'l Yeast (1-3%
    - Alpha Amylase*
  - PROCESS
    - Extend Proof time
      - Risk of over proofing & collapse
    - Higher dough:pan ratio
    - Both require line & equipment modifications

Whole Grain *Challenges*

- Dough Handling Adaptations
  - Problems
    - Weak
      - Gluten dilution
    - Sticky
      - Non-starch Polysaccharides
      - Some cereals more so than others
  - Poor Tolerance
    - Dividing/rounding
    - Sheeting
    - Make-up

Whole Grain *Challenges*

- Dough Handling Adaptations
  - Slow down
    - Divider, etc
  - Requires upstream & downstream compensation

Whole Grain *Challenges*

- Baking: WG products at the oven
  - Higher Dough Moisture
  - Hydrophilic ‘stuff’
  - Denser Doughs
- Adaptations
  - Longer bake times
  - Oven profiles to prevent burning but achieve final moisture requirements

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