Rice Fortification Technologies & Quality Challenges

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Chief Innovation Director-The Wright Group
RMTC 2018
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WHO WE ARE

For generations, rice has been a way of the life for our Company

• Creator:
  Blue rose rice variety (1907)

• Pioneer:
  Rice fortification coating technology (1956)

• Global leading manufacturer:
  *Rinse Resistant*® rice premixes (fortified kernels)
  Micronutrient premixes (powder/Liquid)
WHERE WE ARE

Wright Pharma Inc. 
Modesto, CA

Wright Enrichment Inc. 
Crowley, LA 
(USA Rice Capital)

Wright Nutrition Inc. 
Plain City, OH

HQ 
Lafayette, LA

Serving and Supporting Food Fortification Globally
WHAT WE DO

--- PROVIDE VALUE ADDED NUTRIENT DELIVERY SOLUTIONS

- Custom Nutrient Premixes
- Direct Compressible Granulations
- Microencapsulated Nutrients
- Vitamin Fortification
Rice Milling/Polishing – Nutrient Loss

✓ Hull and bran layers removed
✓ Milled rice represents 70 percent of the weight of rough rice
✓ Loss of nutrients:
  Thiamin (B1)
  Riboflavin (B2)
  Niacin (B3)
  Iron
  Zinc
RICE FORTIFICATION

A practice of deliberately increasing the content of an essential micronutrient, i.e. vitamins and minerals (including trace elements) in food (rice) to improve the nutritional quality of the food (rice) supply and provide a public health benefit with minimal risk to health.

----WHO
Rice Fortification Technologies

- Dusting Technology
  - Nutrient powder added to rice after milling
  - Based on electrostatic force between rice and nutrient powder
  - Nutrient segregation from rice may occur
  - Limited application due to nutrient loss during washing before or draining after cooking

----*Not recommended if rice is commonly washed before cooking or cooking water drained out after cooking*
Rice Fortification Technologies

- **Dusting Technology**
  - Practiced in USA (21CFR137.350 Enriched Rice)
  - Nutrients: B1, B3, Folic Acid & Iron (Since 1956, Wright has been servicing US rice mills with this powder enrichment premix)
  - Waning statement required on each packaging labels

![Rice Fortification Technologies Image]
Rice Fortification Technologies

✓ Extrusion Technology

✓ Resembled rice or rice analogues or extruded rice
✓ Hot (80-110°C), Cold (30-40°C) and warm (60-90°C)
✓ Single or twin extruder
✓ Wright is one of the approved providers of the nutrient premix...

Rice flour, Nutrients, Binders, Emulsifier, Water, Steam...

(KSU Workshop: Extrusion-Based Rice Fortification-Aug 2015)

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Coating Technology

- Old technology with continuous innovation
- Use natural rice kernels
- Nutrients applied to rice with coating at room temperature
- Simple process: spraying and drying
- Wright is the leading provider of coated fortified kernels

Nutrients + Coating

(Wright Product)
Wright Coating Technology

Rinse Resistant® Rice Premixes

(Fortified Kernels)

Regulated by 1958 law:
21CFR137.350

Created in 1956
Improved over
62 years
Wright Coating Technology Capabilities

✓ Match any variety of rice on a global scale
✓ Long Grain, Short grain, Medium Grain
✓ Broken Grain
✓ Parboiled
✓ Instant
✓ Basmati

✓ Custom Formulation/R&D expertise with quick turn-around time
✓ USA
✓ Philippines
✓ Costa Rica, Panama, Nicaragua
✓ Asia Pacific Countries
✓ USAID for WFP
Wright Coating Technology Capabilities

✓ 40,000MT/Year
✓ 400 acres Land for expansion
✓ Equipment design technology
✓ Wide range of
  R&D & production scale—
  grams to truckloads
✓ Custom packaging

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New Product: USAID Fortified Rice for Food Aid

✓ Specification Effective Date: Dec 31, 2017
✓ Based on WFP’s Nutritional Profile Requirement:
  Vit A, B1, B3, B6, Folic Acid, B12, Iron & Zinc

Two addition rates available: 1:100 or 1:200

Three varieties available: Long Grain, Medium Grain & Parboiled Long Grain
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>mg/100g</th>
<th>Chemical Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit A</td>
<td>0.15 (500IU)</td>
<td>Vit A Palmitate</td>
</tr>
<tr>
<td>Vit B1</td>
<td>0.50</td>
<td>Thiamine Mononitrate</td>
</tr>
<tr>
<td>Vit B3</td>
<td>7.00</td>
<td>Niacinamide</td>
</tr>
<tr>
<td>Vit B6</td>
<td>0.60</td>
<td>Pyridoxine Hydrochloride</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>0.13</td>
<td>Folic Acid</td>
</tr>
<tr>
<td>Vit B12</td>
<td>0.001</td>
<td>Cyanocobalamin</td>
</tr>
<tr>
<td>Iron</td>
<td>4.00</td>
<td>Ferric Pyrophosphate</td>
</tr>
<tr>
<td>Zinc</td>
<td>6.00</td>
<td>Zinc Oxide</td>
</tr>
</tbody>
</table>
## Wright Coating Technology

### Compliance with USAID Fortified Rice Specifications

<table>
<thead>
<tr>
<th>Rice Premix (Fortified Kernels)</th>
<th>Fortification Ratio: 1:99 or 1:199</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory Specs</td>
<td>Rinsing Retention: &gt;90% (US Reg.: 85%)</td>
</tr>
<tr>
<td>Similar size, shape, color, &amp; density to the raw rice variety to be fortified</td>
<td>Cooking Retention: &gt;80%</td>
</tr>
<tr>
<td>Similar texture, taste, color, appearance of cooked regular rice</td>
<td>24-month shelf life at 30°C (86°F)</td>
</tr>
<tr>
<td></td>
<td>Vit A loss during storage: &lt;5%/m at 30°C/65%RH</td>
</tr>
</tbody>
</table>

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QUALITY & COMPLIANCE

✓ GFSI compliant: FSSC22000 Certified
✓ Certified K kosher facilities & Halal Certified products
✓ HAACP quality control and FSMA food safety program
✓ Separate allergen processing facility and warehouse
✓ GMO-Free ingredients sourcing protocol
✓ GAIN audited & approved nutrient premix supplier
✓ Certificate of Analysis (COA) for each order
Quality Challenges

Coating & extrusion are viable technologies. Quality Variation within technology is still a challenge.

Cooking Retention
B. Coated/iron/6 cooking methods) Losso etc. BBA Clinical 2017

Acceptance Study (2Tx2P, 8 Nutrients) In Cambodia. De Pee 2017 (Conference Presentation)

Absorption Study
B. (1T, Coated iron) Losso etc. BBA Clinical 2017


Storage Stability (3Tx2P/Iron, Zinc, A) Kuong etc. Nutrients 2016

Wright’s coated products participated in all the above studies

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Physical Properties: Color

- Yellowish from folic acid (coated fortified rice kernels)
Physical Properties: Color

- Yellowish from folic acid (extruded fortified rice kernels)

(KSU Workshop: Extrusion-Based Rice Fortification Aug 2015)
Physical Properties: Appearance (shape)

• Coated (process variation)
Physical Properties: Appearance (shape)

- Extruded (process variation)

(KSU Workshop: Extrusion-Based Rice Fortification Aug 2015)
Physical Properties: Density

- Coated: very similar to regular rice
- Extruded: designed to match

<table>
<thead>
<tr>
<th>Density</th>
<th>Regular LGWG</th>
<th>WE20852 LGWG</th>
</tr>
</thead>
<tbody>
<tr>
<td>g/mL</td>
<td>0.82</td>
<td>0.83</td>
</tr>
</tbody>
</table>

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Physical Properties: Density Issues

- Blending Separations
- Floating during cooking
  - More applicable to extruded

(KSU Workshop: Extrusion-Based Rice Fortification Aug 2015)
Physical Properties: Density

- Dispersion Test
  Applicable to both coated or extruded

<table>
<thead>
<tr>
<th>Dispersion Test</th>
<th>% Coefficient of Variation (3 tests)</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>15g FRK/3kg FR (3 x 5g FRK/1 kg FR results)</td>
<td>1.805</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

Data: courtesy of NFA Philippines using Wright Iron Rice Premix
Rinse Resistance Properties

• Rinse test
• 21 CFR 137.350.(e)
• Can select water soluble nutrient(s) as marker(s)
• Applicable to both coated or extruded
• Poorly coated rice kernel product:
  • 97% nutrient washed off has been found
• Earlier designed extruded rice kernels
  • 46% nutrient washed off has been reported
Rinse Resistance

Rigorously Rinsed 3 Times With Tap Water

Coated Fortified Kernel Properties

---Costa Rica 1:200

Water Soluble Nutrient Markers

<table>
<thead>
<tr>
<th>Nutrient Retention (%)</th>
<th>Coat</th>
<th>Fortified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit B1</td>
<td>96.82</td>
<td>97.25</td>
</tr>
<tr>
<td>Vit B3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Chemical Properties

- **Fat soluble vitamins**
  - Degradation during storage and cooking
  - Extraction issue during assay could be challenge

- **Water soluble vitamins**
  - Degradation during storage and cooking
  - Testing method sensitivity

- **Minerals**
  - Interactions trigger color changes
    ---- especially when heat and moisture involved

- **Affecting shelf-life of both coated or extruded kernels**
Quick Spot Test-**Iron** (field test)

- Hydrochloric Acid + Potassium Ferrocyanide (drops)
- **Iron in Rice?**  Yes: blue; No: no color change
Quick Spot Test - Vitamin A (lab test)

• USP method and reagents (drops)
• Vit. A in Rice? Yes: blue; No: no color change

(BASF Lab, 2015)
Our position:

With over 62 years coating technology nutrient delivery solution expertise and experience, the Wright Group will continue our innovation on high quality products and partnership with governments, organizations, institutes and industries to support the global rice fortification program.
## Rinse Resistant® Rice Premix (Fortified Kernels)

### Dominican Republic 1:200

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Rice Premix (mg/g)</th>
<th>Fortified Rice (mg/kg)</th>
<th>Chemical Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit B1</td>
<td>1.20</td>
<td>6.00</td>
<td>Thiamine Mononitrate</td>
</tr>
<tr>
<td>Vit B3</td>
<td>10.00</td>
<td>50.00</td>
<td>Niacinamide</td>
</tr>
<tr>
<td>Vit B6</td>
<td>0.80</td>
<td>4.00</td>
<td>Pyridoxine Hydrochloride</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>0.36</td>
<td>1.80</td>
<td>Folic Acid</td>
</tr>
<tr>
<td>Vit B12</td>
<td>0.002</td>
<td>0.01</td>
<td>Cyanocobalamin</td>
</tr>
<tr>
<td>Iron</td>
<td>4.80</td>
<td>24.00</td>
<td>Ferric Pyrophosphate</td>
</tr>
<tr>
<td>Zinc</td>
<td>5.00</td>
<td>25.00</td>
<td>Zinc Oxide</td>
</tr>
</tbody>
</table>
## Rinse Resistant® Rice Premix (Fortified Kernels)

### Panama/Nicaragua 1:200

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Rice Premix (mg/g)</th>
<th>Fortified Rice (mg/kg)</th>
<th>Chemical Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit B1</td>
<td>1.00</td>
<td>5.00</td>
<td>Thiamine Mononitrate</td>
</tr>
<tr>
<td>Vit B3</td>
<td>8.00</td>
<td>40.00</td>
<td>Niacinamide</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>0.20</td>
<td>1.00</td>
<td>Folic Acid</td>
</tr>
<tr>
<td>Vit B12</td>
<td>0.002</td>
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## Rinse Resistant® Rice Premix (Fortified Kernels)

**Costa Rica 1:200**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Rice Premix (mg/g)</th>
<th>Fortified Rice (mg/kg)*</th>
<th>Chemical Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit B1</td>
<td>1.06</td>
<td>5.3</td>
<td>Thiamine Mononitrate</td>
</tr>
<tr>
<td>Vit B3</td>
<td>7.00</td>
<td>35</td>
<td>Niacinamide</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>0.36</td>
<td>1.80</td>
<td>Folic Acid</td>
</tr>
<tr>
<td>Vit B12</td>
<td>0.002</td>
<td>0.01</td>
<td>Cyanocobalamin</td>
</tr>
<tr>
<td>Vit E</td>
<td>0.002</td>
<td>0.01</td>
<td>dl-α-Tocopheryl Acetate</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.021</td>
<td>0.105</td>
<td>Sodium Selenite</td>
</tr>
<tr>
<td>Zinc</td>
<td>1.5</td>
<td>7.5</td>
<td>Zinc Oxide</td>
</tr>
</tbody>
</table>

*Levels excluding intrinsic nutrients in unfortified rice
PARTNER FOR VALUE

Over 100 years of innovation.

Thank you!