Shelf-life Extension of Brown Rice

Engr. Rosemarie G. Garcia
Food and Nutrition Research Institute

Presented at the PCIEERD Technology Promotion Activity
Great Eastern Hotel Aberdeen Court
Makati City
December 19, 2013
National Year of Rice

- Presidential Proclamation No. 494
- Aims to encourage everybody to join in the government’s efforts towards rice self-sufficiency
- One of the key messages for the public is to “Eat brown rice for better health”
Filipinos love to eat rice
It is our staple food
Average consumption is 307g/capita/day (7th National Nutrition Survey, FNRI 2008)
The rice importation

- Based on the data from the Bureau of Agricultural Statistics, our top agricultural import in 2010 was well-polished rice.

- According to the National Food Authority, the Philippines imported 2 Million metric tons of rice in 2010 but in 2013, this went down to 350,000 metric tons.

- Our rice production in 2010 was 10.32 million metric tons which went up to 17.97 million metric tons in 2013.
The micronutrient deficiencies

- Iron deficiency anemia was highest (55.7%) among infants 6 to 11 months old based on the 2008 National Nutrition Survey.

- Overall anemia prevalence was 42.5% among pregnant women, classified as high public health significance.

- Zinc deficiency was noted in 21.6% of infants & pre-schoolers, 20.6% in female adolescents, 33.6% in male adults and 21.5% among pregnant women.
Effects of micronutrient deficiencies

- The presence of anemia is an indication of an individual’s iron status

- Iron deficiency anemia causes long-term cognitive impairment, poor-school performance, risk of low birthweight for infants and increased maternal mortality

- Zinc deficiency causes growth retardation and stunting, impaired reproduction and immune disorder
The emerging health problems

- Prevalence of high FBS (>126 mg/dL) increased from 3.4% to 4.8%, peaking at age 50-69 years old
- No. of overweight individuals had almost doubled since 1993
- Overweight and obesity affected 27 in every 100 adults
Our solution
If we take a closer look on brown rice

✓ we will know that production of brown rice has 10% higher recovery than white rice = economics

✓ we will realize that our rice importation in 2010 was 13% of our national consumption = savings

✓ we may be able to reduce the risk factors associated with certain lifestyle diseases = health

✓ we may be able to feed more with our current rice production = food security
Facts on brown rice

- Brown rice is more nutritious than white rice
- Bran layer is rich in fiber, minerals and B-vitamins
- Brown rice has low to moderate glycemic index
- There is shorter milling time and higher output volume when brown rice is produced
The problem with brown rice

- Shelf-life of brown rice is short
- Consumers are not aware of the health benefits of brown rice
- Brown rice is expensive and not readily available
- These had to be addressed to increase utilization of brown rice
What has been done?
“R&D Program for the Optimization, Utilization and Promotion of Brown Rice in the Philippines”
(Dec 2010 – Apr 2012)

- Proj. 1 Optimization studies for the improvement of shelf-life of brown rice
- Proj. 2 Mineral availability, dietary fiber and fermentability characteristics of optimized brown rice
Objectives

General:
- To improve the shelf-life of brown rice through process optimization

Specific:
- to determine optimum processing parameters
Objectives

• to determine the retention of nutrients, microbiological safety, and sensory properties of brown rice after processing and during storage and

• to estimate shelf-life of optimized brown rice
Methodology

- Screening experiments
- Optimization experiments using Response Surface Methodology
- Standardization runs
- Chemical, microbiological and sensory evaluation of optimized brown rice
- Verification experiment
<table>
<thead>
<tr>
<th>Run</th>
<th>Lag time</th>
<th>Variety</th>
<th>Microwave</th>
<th>Steaming &amp; drying</th>
<th>Drying</th>
<th>Packaging</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24 hrs</td>
<td>mixed</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>vacuum</td>
<td>open</td>
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<tr>
<td>2</td>
<td>6 hrs</td>
<td>mixed</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>vacuum</td>
<td>shaded</td>
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<td>3</td>
<td>24 hrs</td>
<td>pure</td>
<td>no</td>
<td>no</td>
<td>yes</td>
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<td>4</td>
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<tr>
<td>6</td>
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<td>7</td>
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<td>no</td>
<td>vacuum</td>
<td>open</td>
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<tr>
<td>8</td>
<td>6 hrs</td>
<td>mix</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>vacuum</td>
<td>shaded</td>
</tr>
</tbody>
</table>
Sample collection in commercial rice mill
Screening experiment
Results of screening experiments:

- Among the three heat treatments the combination of steaming and drying has the largest reducing effect on the FFA.
- Steaming and drying contributes to the reduction of off odor.
- Steaming and drying contributes to the increase in the over-all liking of the product.
- Variety affects the over-all acceptability.
### 3 Factor Box-Behnken Design

<table>
<thead>
<tr>
<th>Standard Run</th>
<th>Steaming Time</th>
<th>Drying Temp</th>
<th>Drying Time</th>
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<td>55</td>
<td>60</td>
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<tr>
<td>2</td>
<td>90</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>90</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
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<td>30</td>
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</tr>
<tr>
<td>6</td>
<td>90</td>
<td>65</td>
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<tr>
<td>7</td>
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<td>65</td>
<td>75</td>
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<td>9</td>
<td>60</td>
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<tr>
<td>10</td>
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<td>75</td>
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</tr>
<tr>
<td>15</td>
<td>60</td>
<td>65</td>
<td>60</td>
</tr>
</tbody>
</table>
Fitted Surface; Variable: QDA-C OA

3 3-level factors, 1 Blocks, 15 Runs; MS Residual=.6385166

DV: QDA-C OA

> 10
< 10
< 9
< 8

20 30 40 50 60 70 80 90 100

X_1

40

45

50

55

60

65

70

75

80

X_3

40

45

50

55

60

65

70

75

80
Responses considered in optimization

- The FFA should be as low as possible
- The peroxide value should be as low as possible
- The off odor should be as low as possible
- The over-all liking should be as high as possible
Overlayed plots of dependent variables showing the optimum region.
Verification runs
(storage studies)
Actual storage in commercial mill

- Optimized parameters were applied to four (4) rice varieties
- Samples were stored in actual storage facility of a commercial rice mill in San Leonardo, Nueva Ecija
% FFA of brown rice during the storage period
Acceptability rating of odor of raw brown rice during storage
<table>
<thead>
<tr>
<th>Variety</th>
<th>Treatment</th>
<th>Observations during storage</th>
<th>Shelf-life (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B Variety</td>
<td>Control</td>
<td>Presence of rice weevils, and rancid odor on the fourth month of storage</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Presence of rice weevils and rancid odor on the eighth month of storage</td>
<td>7</td>
</tr>
<tr>
<td>C Variety</td>
<td>Control</td>
<td>Presence of rice weevils, and rancid odor on the 4&lt;sup&gt;th&lt;/sup&gt; month of storage</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Presence of rice weevils and rancid odor on the seventh month of storage</td>
<td>6</td>
</tr>
<tr>
<td>D Variety</td>
<td>Control</td>
<td>Presence of rice weevils and drop of hedonic rating to 6.5 on odor on the fifth month of storage</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Rancid odor perceived by the panelists on the tenth month of storage</td>
<td>9</td>
</tr>
<tr>
<td>E Variety</td>
<td>Control</td>
<td>Presence of molds on the second month of storage</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Rancid odor and drop of hedonic score to 6.0 on raw samples on the fifth month of storage</td>
<td>4</td>
</tr>
</tbody>
</table>
The heat treatment did not affect the acceptability in terms of sensory qualities; the texture was even improved.

Nutrients such as vitamin B1 & B3, including phosphorus were retained after the heat treatment.

There were no significant changes in the color of brown rice due to treatment done.
### Nutrition Facts

**Serving Size:** 67 g  
**Servings per pack:** 7

<table>
<thead>
<tr>
<th></th>
<th>Amount per Serving</th>
<th>Amount per 100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy (Calories)</strong></td>
<td>250</td>
<td>370</td>
</tr>
<tr>
<td><strong>Total Fat (g)</strong></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Carbohydrates (g)</strong></td>
<td>53</td>
<td>79</td>
</tr>
<tr>
<td><strong>Total Dietary Fiber (g)</strong></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Protein (g)</strong></td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td><strong>Sodium (g)</strong></td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

| **Calcium (mg)** | 19 | 3 |
| **Iron (mg)**    | 1  | 5 |
| **Zinc (mg)**    | 1  | 18 |

Based on RENI for Male 19 years old and above
Brown rice recipes developed

- Arroz con Leche
- Everlasting Turon
- Kalamay Balls in Ginger Ale
Suman Duo in Dulce de Leche Dip

Pahiyas Fried Rice

Rice Adobo Wrap
First adoptor of the FNRI brown rice technology with DOST Sec. Mario G. Montejo, FNRI Director- Dr. Mario V. Capanzana and brown rice study project leader