Understanding and Addressing Phosphorus in Convenience Foods

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Outline

• Hyperphosphatemia
• Common phosphorus food additives and their uses
• Phosphorus containing additives in foods, an educational approach
• Phosphorus additives in fast food and acceptable choices for dialysis patients
• Implications and questions
Hyperphosphatemia

- Major contributor to poor outcomes among dialysis patients
- Increases both all-cause and cardiovascular mortality rates
Hyperphosphatemia cont’d

• Excess phosphorus combines with calcium and deposits in arteries and other soft tissues

• Leads to atherosclerotic heart disease
Hyperphosphatemia *cont’d*

- Stimulates parathyroid hormone
- Contributes to secondary hyperparathyroidism and renal bone disease
Calcium deposits in tissue

Bone disease

Calcium removed from bones

PTH increases

Low blood calcium

Decreased Vitamin D

Calcium in blood binds with phosphorus

Phosphorus builds up in blood
Phosphorus Additives

- Amount of phosphorus in the American diet has increased considerably

- Primarily from phosphorus containing additives in convenience and fast foods
Phosphorus Additives cont’d

- Depending on individual food choices, additives add as much 1000 mg/day of phosphorus to the diet (Calvo MS, 1996)

- Additives are almost entirely absorbed while 60% of naturally occurring phosphorus is absorbed
Phosphorus Additives cont’d

• Education is a key component of hyperphosphatemia management

• Use of phosphorus containing additives makes it difficult to accurately estimate the phosphorus content of foods
What are Phosphorus Additives?
Common Phosphorus Additives

- Dicalcium Phosphate
- Hexametaphosphate
- Monocalcium Phosphate
- Phosphoric Acid
- Pyrophosphate
- Sodium Acid Pyrophosphate
- Sodium Aluminum Phosphate
- Sodium Phosphate
- Sodium Tripolyphosphate
- Tricalcium Phosphate
Common Uses Of Phosphorus Additives

- Leavening
- Acid
- Suspension/ dispersion agent
- Anti caking
- Decrease cooking time
- Emulsifier
- Stabilizer
- Moisture binding
- Improve texture
- Maintain color or firmness
Which Foods Contain Phosphorus Additives?
Additives | No Additives
Additives

No Additives
Additives

No Additives

New Boston Creme Rolls

Apple Flips

Zebra Cakes

Pecan Pinwheels
How do you know if a food has phosphorus additives?
Ingredients: ENRICHED MACARONI PRODUCT (WHEAT FLOUR, Niacin, Ferrous Sulfate [Iron], Thiamin Mononitrate [Vitamin B1], Riboflavin [Vitamin B2], Folic Acid), Cheese Sauce Mix (Whey, Milkfat, Milk Protein Concentrate, Salt, Calcium Carbonate, Sodium Tripolyphosphate, Contains less than 2% of Citric Acid, Sodium Phosphate, Lactic Acid, Milk, Yellow 5, Yellow 6, Enzymes, Cheese Culture).
How much phosphorus do additives add to total phosphorus?
Chicken Analysis

• 38 chicken samples from a variety of store types, products, and brands.

  – Boneless chicken 8 samples
  – Breaded breast strips 6
  – Breast nuggets 7
  – Mixed nuggets 6
  – Breast patties 6
  – Mixed patties 5
Chicken Analysis, cont’d

• Prepared per package directions

• Sent to Medallion Laboratories for analysis

• One sample analyzed per product
Chicken Analysis, cont’d

- Presence of additives determined from product ingredient list

- ESHA Food Processor used to determine expected phosphorus content
Actual minus expected content of 38 chicken products. For each category of chicken products, thick line represents mean value, while top and bottom of gray lozenge represent maximum and minimum values, respectively.
## Actual and Expected Phosphorus Contents of a Variety of Chicken Products

<table>
<thead>
<tr>
<th>Category</th>
<th>Product</th>
<th>Phosphorus containing additives*</th>
<th>Serving size (g)</th>
<th>Actual phosphorus (mg/100g)</th>
<th>Expected phosphorus (mg/100g)</th>
<th>Difference (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boneless breast</td>
<td>Giant Eagle fresh chicken breast</td>
<td>None</td>
<td>112</td>
<td>205</td>
<td>228</td>
<td>-23</td>
</tr>
<tr>
<td></td>
<td>Townsend quick frozen chicken breast</td>
<td>1</td>
<td>113</td>
<td>250</td>
<td>228</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Tyson quick frozen chicken breast</td>
<td>1</td>
<td>112</td>
<td>317</td>
<td>228</td>
<td>89</td>
</tr>
<tr>
<td>Breast patties</td>
<td>Tyson breast patties</td>
<td>1,3</td>
<td>73</td>
<td>185</td>
<td>126</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Banquet chicken breast patties</td>
<td>2,4,5</td>
<td>76</td>
<td>291</td>
<td>126</td>
<td>165</td>
</tr>
</tbody>
</table>
Phosphorus Improvement Pilot Study
Specific Aim

• To determine the effect of a phosphorus containing additives educational intervention on serum phosphorus levels among hemodialysis patients
Hypothesis

• Educating hemodialysis patients about phosphorus containing additives will result in improved serum phosphorus levels
• **Intervention**: Education regarding food additives
  – **Outcome**: lower serum phosphorus
  – **Usefulness**: patient assessment of tools and materials

• **Control**: Test phosphorus specific food frequency questionnaire
  – **Reliability**: done every month
  – **Validity**: serum phosphorus level
<table>
<thead>
<tr>
<th>SUBJECT INCLUSION CRITERIA</th>
<th>SUBJECT EXCLUSION CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most recent phosphorus and mean phosphorus last 3 months &gt; 5.5 mg/dL</td>
<td>Mentally incompetent</td>
</tr>
<tr>
<td>Age $\geq$ 18 years</td>
<td>HIV/AIDS</td>
</tr>
<tr>
<td>On chronic HD $\geq$ 6 months</td>
<td>Active malignancy</td>
</tr>
<tr>
<td>English speaking</td>
<td>Terminal illness</td>
</tr>
<tr>
<td></td>
<td>Pregnancy</td>
</tr>
<tr>
<td></td>
<td>Nursing home resident</td>
</tr>
<tr>
<td></td>
<td>No telephone access</td>
</tr>
<tr>
<td></td>
<td>In another phosphorus related study</td>
</tr>
</tbody>
</table>
Study Timeline

• 3 month study
• 1\textsuperscript{st} month – education regarding phosphorus additives
• 2\textsuperscript{nd} and 3\textsuperscript{rd} month - phone follow up for questions and evaluation of usefulness of materials
Intervention

• Educating subjects about phosphorus additives

• Reading food labels and ingredient lists

• Fast food better choices
Reading Food Labels and Ingredient Lists
Reading Food Labels

• What are phosphorus additives?

• Show where to find ingredient list

• Practice on food packages
Kellogg’s®
Nutri-Grain®
Apple Cinnamon

### Nutrition Facts

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount Per Serving</th>
<th>% Daily Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>140</td>
<td>2%</td>
</tr>
<tr>
<td>Calories from Fat</td>
<td>10</td>
<td>2%</td>
</tr>
<tr>
<td>Total Fat</td>
<td>3g</td>
<td>5%</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>0.5g</td>
<td>3%</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
<td>0%</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
<td>0%</td>
</tr>
<tr>
<td>Sodium</td>
<td>105mg</td>
<td>5%</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>26g</td>
<td>9%</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>1g</td>
<td>4%</td>
</tr>
<tr>
<td>Sugars</td>
<td>13g</td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>1g</td>
<td></td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

### Ingredients
- Brown rice flour
- Sugar
- Sunflower oil
- Soy lecithin
- Natural flavors
- Vitamin A palmitate
- Niacin
- Calcium pantothenate
- Zinc
- Pyridoxine hydrochloride
- Thiamin hydrochloride
- Riboflavin
- Folic acid

Contains wheat, milk and soy ingredients.

NLI#01986

**Phosphorus additive**
Reading Food Labels  cont’d

• Provide magnifier and lists of additives to look for

• Check foods purchased from the grocery store
Pocket sized magnifier
Fast Food
Why is this important?

- Hemodialysis patients age 18-44 years consume an average of 2.1 fast food meals per week
- Phosphorus containing additives are commonly added to fast foods
- Patient to determine which foods are high in phosphorus
Fast Food

- Subjects given handouts identifying menu items without phosphorus additives
### McDonald's Better Choices

**Main Dish**
- Hamburger (no cheese)
- Quarter Pounder (no cheese)
- Big N Tasty (no cheese)
- Warm cinnamon roll
- Deluxe warm cinnamon roll

**Sides**
- Side salad with ½ packet of Caesar or ranch dressing
- Snack size fruit & walnut salad

### Subway Better Choices

**Main Dish**
- 6” Veggie delight sub (no American cheese or cheese bread)
- Tuna deli sandwich (no American cheese)
- Veggie delight salad with Atkins honey mustard dressing
- Tuna salad (no dressing or American cheese)
Fast Food Guidelines

• Identified fast food chains that had ≥10 restaurants in the greater Cleveland area

• A restaurant was considered as a fast food establishment if it met at least 2 of the following 4 criteria:
  – Permanent menu board
  – Customers pay for food before consumption
  – Self-service condiment bar
  – Most main course food items are prepackaged

• Unable to obtain ingredient lists or nutrition facts information for 5 chains
Components of Menu Evaluation

- Entrée and Side Dishes
- Traditional Criteria
- Phosphorus Containing Additive Component
Traditional Criteria

- Developed by a panel of 4 renal dietitians
- \( \leq 900 \) mg of sodium for entrees and \( \leq 300 \) mg of sodium for side dishes
- No dry beans, high potassium fruits, or high potassium vegetables listed as the first, second, or third ingredient
Traditional Criteria, cont’d

• No whole grain flour listed as the first ingredient

• A calcium content of $\leq 20\%$ of the daily value
  – Note that the calcium content was used as a proxy for milk and other dairy products that are likely to have substantial amounts of naturally occurring phosphorus
Phosphorus Containing Additive Criteria

- Ingredient lists were used to determine the presence of a phosphorus containing additive
Example

- **Crispy Chicken Breast Filet:**
  Boneless, skinless chicken breast filets with rib meat, water, seasoning (salt, modified potato starch, spices, carrageenan gum, spice extractives), and **sodium phosphates**. Battered and breaded with: wheat flour, water, food starch-modified, bleached wheat flour, salt, spice, dextrose, egg whites, wheat gluten, and yeast, leavening **(sodium acid pyrophosphate, baking soda, and monocalcium phosphate)**. Prepared in vegetable oil ((may contain one of the following: Canola oil, corn oil, soybean oil, hydrogenated soybean oil, partially hydrogenated soybean oil, partially hydrogenated corn oil with TBHQ and citric acid added to preserve freshness), dimethylpolysiloxane added as an antifoaming agent). CONTAINS: WHEAT AND EGG
<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Total Offerings</th>
<th>Entrees</th>
<th>Side Dishes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Acceptable by Traditional Criteria</td>
<td>Also Lack Phosphorus Additives</td>
</tr>
<tr>
<td>Arby's</td>
<td>21</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Boston Market</td>
<td>17</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Bruegger's</td>
<td>57</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>Burger King</td>
<td>47</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Dairy Queen</td>
<td>22</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Domino's</td>
<td>96</td>
<td>88</td>
<td>10</td>
</tr>
<tr>
<td>Dunkin' Donuts</td>
<td>100</td>
<td>82</td>
<td>13</td>
</tr>
<tr>
<td>KFC</td>
<td>40</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>McDonald's</td>
<td>54</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Panera</td>
<td>72</td>
<td>36</td>
<td>20</td>
</tr>
<tr>
<td>Papa John's</td>
<td>56</td>
<td>26</td>
<td>14</td>
</tr>
<tr>
<td>Pizza Hut</td>
<td>84</td>
<td>45</td>
<td>29</td>
</tr>
<tr>
<td>Subway</td>
<td>43</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Taco Bell</td>
<td>73</td>
<td>32</td>
<td>0</td>
</tr>
<tr>
<td>Wendy's</td>
<td>22</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>804</strong></td>
<td><strong>415</strong></td>
<td><strong>128</strong></td>
</tr>
</tbody>
</table>
Results

• Entrees:
  – 52% acceptable according to traditional criteria
  – 16% also free of phosphorus containing additives

• Side Dishes:
  – 23% acceptable according to traditional criteria
  – 17% also free of phosphorus containing additives

• Foods with phosphorus containing additives vary greatly
Results

• Most common menu items acceptable according to traditional criteria but contained phosphorus additives
  – Baked products
  – Chicken
  – Ham
Limitations

• Fast food chains from a single geographic region used

• Limited-time and regional menu items not included

• Assumed all fast food items with phosphorus containing additives were incompatible with renal diets
  – Unable to quantify actual phosphorus content
Study Results
# Baseline characteristics of intervention and control subjects

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=131)</th>
<th>Control (n=120)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, years</td>
<td>52</td>
<td>51</td>
<td>.65</td>
</tr>
<tr>
<td>Male, %</td>
<td>58</td>
<td>65</td>
<td>.26</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>69</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>26</td>
<td>19</td>
<td>.42</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Cause of renal failure, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>38</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>28</td>
<td>41</td>
<td>.25</td>
</tr>
<tr>
<td>Glomerulonephritis</td>
<td>21</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Mean years receiving dialysis</td>
<td>4.6</td>
<td>4.8</td>
<td>.68</td>
</tr>
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</table>
Baseline characteristics of intervention and control subjects

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=131)</th>
<th>Control (n=120)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean albumin, g/dL</td>
<td>3.9</td>
<td>4.0</td>
<td>.07</td>
</tr>
<tr>
<td>Mean calcium, mg/dL</td>
<td>8.9</td>
<td>9.0</td>
<td>.31</td>
</tr>
<tr>
<td>Mean phosphorous, g/dL</td>
<td>6.89</td>
<td>6.86</td>
<td>.91</td>
</tr>
<tr>
<td>PTH, mean pg/ml</td>
<td>621</td>
<td>767</td>
<td>.10</td>
</tr>
<tr>
<td>Urine output &gt;2 cups/day, %</td>
<td>16</td>
<td>26</td>
<td>.06</td>
</tr>
</tbody>
</table>
Baseline characteristics of intervention and control subjects

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=131)</th>
<th>Control (n=120)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz % correct, mean</td>
<td>68</td>
<td>67</td>
<td>.56</td>
</tr>
<tr>
<td>Read nutrition facts label, %</td>
<td>66</td>
<td>67</td>
<td>.86</td>
</tr>
<tr>
<td>Read ingredient list, %</td>
<td>60</td>
<td>72</td>
<td>.04</td>
</tr>
<tr>
<td>Eat fast food &gt;1 time/week, %</td>
<td>48</td>
<td>48</td>
<td>.93</td>
</tr>
</tbody>
</table>
Baseline characteristics of intervention and control subjects, cont’d

• No difference in phosphorus binder type

• 13% on combined binder therapy

• No difference in vitamin D or cinacalcet use
Final characteristics of intervention and control subjects

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=131)</th>
<th>Control (n=120)</th>
<th>p value</th>
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</thead>
<tbody>
<tr>
<td>Albumin, g/dL</td>
<td>3.9</td>
<td>4.0</td>
<td>.19</td>
</tr>
<tr>
<td>Calcium, mg/dL</td>
<td>9.0</td>
<td>8.9</td>
<td>.55</td>
</tr>
<tr>
<td>Phosphorous, g/dL</td>
<td>6.2</td>
<td>6.8</td>
<td>.0018</td>
</tr>
<tr>
<td>Phosphorus ≤ 5.5, %</td>
<td>33</td>
<td>24</td>
<td>.01</td>
</tr>
<tr>
<td>PTH, pg/ml</td>
<td>672</td>
<td>846</td>
<td>.17</td>
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## Final characteristics of intervention and control subjects

<table>
<thead>
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<th>Intervention (n=131)</th>
<th>Control (n=120)</th>
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<tbody>
<tr>
<td>Quiz % correct, mean</td>
<td>75</td>
<td>71</td>
<td>.02</td>
</tr>
<tr>
<td>Read nutrition facts label, %</td>
<td>89</td>
<td>80</td>
<td>.06</td>
</tr>
<tr>
<td>Read ingredient list, %</td>
<td>92</td>
<td>77</td>
<td>.001</td>
</tr>
<tr>
<td>Eat fast food &gt;1 time/week, %</td>
<td>29</td>
<td>35</td>
<td>.31</td>
</tr>
</tbody>
</table>
Final characteristics of intervention and control subjects

• No difference in phosphorus binder type

• 15% of intervention and 12% of control subjects on combined binder therapy

• No difference in vitamin D or cinacalcet use
<table>
<thead>
<tr>
<th></th>
<th>baseline</th>
<th>final</th>
<th>% ≤5.5 final</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control</strong></td>
<td>6.9</td>
<td>6.8</td>
<td>24%</td>
</tr>
<tr>
<td>(n = 120)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
<td>6.9</td>
<td>6.2</td>
<td>33%</td>
</tr>
<tr>
<td>(n = 131)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>p value</strong></td>
<td>0.99</td>
<td>.002</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Serum Phosphorus (mg/dL)**
Mean Serum Phosphorus Level

**SERUM PHOSPHORUS LEVEL (mg/dL)**

**CONTROL**
- Baseline: 6.84
- Month 1: 6.52
- Month 2: 6.58
- Month 3: 6.86

**INTERVENTION**
- Baseline: 6.52
- Month 1: 6.18
- Month 2: 6.18
- Month 3: 6.16
What We Know
• Reading ingredient lists can help identify foods that contain additives

• There is no way to know how much additional phosphorus the additives contribute
Questions
• Is eliminating all foods containing phosphorus additives too restrictive?

• Is there too much variation in amount of additional phosphorus from additives to make generalizations for nutrient databases?

• If we knew how much phosphorus was in foods we could target the foods with the highest content.
Implications for Renal Dietitians

• Educate patients
  – Barriers:
    • Nutrition facts and ingredient lists are not always readily available
    • Time, energy, and nutritional knowledge necessary to read and understand information
    • Accurate estimation of actual phosphorus content is difficult
Legal Implications

• Food manufacturers and fast food chains should include a readily visible and easy to read nutrition facts label on each item.

• Food labels and fast food items should have phosphorus content on nutrition facts labels.
  
  – Requiring phosphorus content on nutrition facts labels may encourage manufacturers to limit the use of phosphorus additives.
Thank You!

“Let’s see... number of cheeseburgers eaten in a typical month? three... no, I’ll put down four.”