Hidden Phosphorus: Sources & Implications for Dialysis Patients

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KEY SLIDES
Phosphate Food Additives are Widely Used

Prepared frozen food...... 72%
Packaged meat ............... 65%
Bread & baked goods ..... 57%
Soup .............................. 54%
Cereal ............................. 35%
Snacks ............................. 32%
Canned vegetables....... 0%

Prevalence of food with P additives
Data from analysis of 2394 best selling groceries in Ohio

Phosphate Additives: An Int’l Problem

Data from analysis of 2532 best selling groceries in Australia

Bread & baked goods ........ 93%
Prepared frozen food........ 75%
Other prepared foods.........70%
Cereals and Bars .............47%
Beverages........................33%
Snacks............................26%
Frozen vegetables...............9%

81% of phos additives listed by $E$ number not name

Impact of P Additives on Dietary P

Sample Daily Menu
(constructed using additive free and additive containing foods)

Examples
Cheerios versus Nature’s Path Whole O’s
Sunny Delight versus Tampico citrus punch
Schwebel’s versus Nickle’s Italian bread
Lay’s versus Ruffles cheddar sour cream chips
Hillshire kielbasa versus Johnsonville brat links
Ore Ida versus Cascadian Farms fries

Without Additives: 1053 mg
With Additives: 1788 mg

70%

Impact of P Additives on Dietary P

• Comparison of 4 days of meals: low additive (fresh and minimally processed) v additive enhanced w same foods, calories, nutrients

Low Additive: 1070 mg/d

Additive Enhanced: 1677 mg/d

Carrigan A. J Renal Nutr 24:13, ’14
A Useful Measure - The Phosphate: Protein Ratio

- Protein sources: about 70 - 80% of dietary phosphate

- Concern about low P resulting in low protein intake

- Target P: protein ratio for protein source: \(~10 \text{ mg P/gm protein}\)
  Achieving this requires no dairy
  - Pork chop = 9 mg P/gm protein
  - Pork chop + 8 oz skim milk = 15 mg P/gm protein

A 1.2 gm/kg protein intake @ 10 mg P/gm protein =
960 mg P for an 80 kg pt (+about 250 mg non protein P)
Phosphorus: Protein Ratio in Marine Fish

- Atlantic Croaker: 7.2
- Red Snapper: 10.1
- California butterfly ray: 11.9
- Small-tail shark: 12.9
- Spotted sea trout: 16.2
- Blue runner: 19.2
## Protein Ratios in Foods w and w/o Listed Phosphate

<table>
<thead>
<tr>
<th></th>
<th>P listed (N=15)</th>
<th>No P listed (N=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-cooked (N=26)</td>
<td>14.6</td>
<td>9.0</td>
</tr>
<tr>
<td>BallPark Franks, Gorton's Grilled Salmon, Louis Kemp Crab Delights, Tyson Seasoned Meatloaf, Oscar Meyer Balogna, Purdue Baked Chicken Breasts</td>
<td></td>
<td>Jones Sausage Links, Carando Salami, Hormel Meatloaf, Shady Brook Farms Turkey Meatballs, Purdue Short Cuts Carved Chicken Breasts</td>
</tr>
</tbody>
</table>

*Sherman RA. Am J Kidney Dis 54:18, ‘09*
The Label Omits Some P Additives

Lecithin no “phos” in the name but....

it contains phosphoric acid and a variety of phospholipids including phosphatidylcholine, phosphatidic acid and phosphatidylinosotol

It is the second most common phosphorus containing food additive

The Label Omits Some P Additives

**Modified Food Starch** a basket category that includes acetylated distarchphosphate, monostarch phosphate, hydroxypropyldistarch phosphate, phosphated distarch phosphate

**Flavorings** details of chemicals are not required on ingredient list for additives whose primary purpose is not nutritional
Phosphate : Protein Ratio in Enhanced Meats

- Pork Chops (1, 17)
- Pork Loin Ribs (5, 18)
- Strip Steak (6, 20)
- Sirloin (8, 21)
- Bacon (14, 13)
- Chicken Drumsticks (3, 16, 25)

**Meat Product**
- Sherman RA. CJASN 4:1370, 2009
The Label Omits Some P Additives

Eight of 25 enhanced meat/poultry products did not list specific additives (‘flavoring’, ‘natural ingredient’ exception)

Among the 8 was the product with the highest phosphate content measured.

Sherman RA. CJASN 4:1370, 2009
## Phosphate in Selected Beverages

*(per 12 oz)*

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Phosphate (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke</td>
<td>56</td>
</tr>
<tr>
<td>Pepsi</td>
<td>47</td>
</tr>
<tr>
<td>Diet Pepsi</td>
<td>36</td>
</tr>
<tr>
<td>Crystal Lt, Orange</td>
<td>151</td>
</tr>
<tr>
<td>Crystal Lt, Raspberry Ice</td>
<td>4</td>
</tr>
<tr>
<td>Tang</td>
<td>137</td>
</tr>
<tr>
<td>Hawaiian Punch, Fr Juicy Red</td>
<td>116</td>
</tr>
<tr>
<td>Starbucks, DSEnergy, Mocha</td>
<td>197</td>
</tr>
<tr>
<td>Lipton Brisk Iced Tea, Sweet</td>
<td>158</td>
</tr>
<tr>
<td>Gold Peak Iced Tea, Sweet</td>
<td>10</td>
</tr>
<tr>
<td>Vit Water Revive Fruit Punch</td>
<td>392</td>
</tr>
<tr>
<td>Vit Water, Focus Kiwi Strawberry</td>
<td>1</td>
</tr>
<tr>
<td>Aquafina Flavor Splash, Berry</td>
<td>84</td>
</tr>
<tr>
<td>Gatorade Orange (powder)</td>
<td>32</td>
</tr>
<tr>
<td>Powerade, Orange</td>
<td>28</td>
</tr>
</tbody>
</table>

*Moser, Am J Kidney Dis 65:969, ‘15*
Beer and wine often have a significant, but variable, amount of diammonium phosphate (DAP) used to provide nitrogen to support growth of yeast for fermentation.

Beer \((N=18)\) 31 – 96 mg/12oz

Wine \((N=16)\) 14 – 38 mg/4oz

Lindley E, J Renal Nutr 24:353, 2014
Drugs: Another Source of Phosphate

23 of 200 (11.5%) in top 200 Rx at DCI (branded formulations)

74 of 741 (10%) drugs Rx’ed to 1989 CKD pts in Caserta, Italy

Sherman RA. Kidney Int 87:1097, ‘15

Sultana J. Nutr MetabCardiovascDis (in press)
Common Phosphate Containing Drugs

Amlodipine (Norvasc)
Clonidine (Catapres)
Lisinopril (Prinivil, Zestril)
Paroxetine (Zoloft)
Sitagliptin (Januvia)
Repaglinide (Prandin)
Bisoprolol (Zebeta)
Rosuvastatin (Crestor)

P in branded *usually* means P in generic

No P in branded *usually* means no P in generic
Phosphate in Drugs: Significant but Unpredictable

Dose Relationship: Unpredictable
Lisinopril (Merck) 10mg=21mg P
   20mg=22mg P
Amlodipine (Greenstone) 5mg=14mg P
   10mg=28mg P

Manufacturer Differences
Amlodipine (10mg) 8 - 40mg P
Lisinopril (20mg) 7 - 31mg P
Paroxetine (20mg) 5 - 56mg P

Scope of the Problem
# Mfg of amlodipine=137
**Phosphate : Protein Ratio and Mortality**

<table>
<thead>
<tr>
<th>Phos:Protein ratio</th>
<th>&lt;12 mg/gm</th>
<th>12 to &lt;14 mg/gm</th>
<th>14 to &lt;16 mg/gm</th>
<th>&gt;16 mg/gm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death hazard ratio</td>
<td>0.88</td>
<td>1.0</td>
<td>1.50</td>
<td>2.09</td>
</tr>
</tbody>
</table>

5 yr mortality in 224 HD pts

Results adjusted for diet (calorie, protein, K), case mix, serum phosphate

Study based on 152 question Block FFQ

Noori N. *CJASN* 5: 683, 2010