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# Improving Estimates of Phosphorus Additive Content: Manufacturers Needed

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DIETARY PHOSPHORUS RESTRICTION is a common feature of medical nutrition therapy for patients with chronic kidney disease or end-stage renal disease.[1] Mean phosphorus intake in the general American population is estimated at 1655 mg/day for men and 1190 mg/day in women as reported by 2009-2010 National Health and Nutrition Survey data.[2]

Although specific limits may be individualized, a maximum of 800-1000 mg of dietary phosphorus per day is commonly used in clinical practice.[1] Restricting dietary phosphorus can be quite challenging, particularly for patients on dialysis who have increased protein requirements. Naturally occurring sources of phosphorus include dairy products, fish, poultry, meat, and whole grains. Patients are often encouraged to consume these types of foods as part of a healthy diet, and thus, giving advice to reduce phosphorus from natural sources becomes challenging.

Adding to the difficulty of restricting dietary phosphorus is the increasing contribution of phosphorus from food additives.[3] In a recent study examining phosphorus content of the most popular food items purchased in Northeast Ohio, Leon et al. found that 44% of products contained phosphorus additives. Furthermore, a diet composed of products with phosphorus additives contained 67 ± 14 mg phosphorus/100 g more than a comparable diet composed of products without phosphorus additives. Moreover, although only 40%-60% of naturally occurring phosphorus is typically absorbed, up to 80%-100% of phosphorus additives may be absorbed.[3]

Currently, manufacturers are not required to report phosphorus on nutrition facts panels.[4] Several studies have demonstrated higher phosphorus content in foods containing phosphorus additives and inaccuracies in nutritional databases' reporting of the phosphorus content of these processed food and beverage products.[3,5,6] In Table 1, we present data from a recent study[6] examining phosphorus content in beverages containing phosphorus-based additives and compare measured values (Medallion Laboratories, Minneapolis, MN) with those reported by the Nutrient Data System for Research (NDSR) software version 2014. We also searched the USDA Standard Nutrient Reference Database,[7] manufacturer websites,[8-10] and 2 popular calorie tracking websites[11,12] to further investigate the extent of publically available data on phosphorus content for these beverages.

Exact matches were found for 28 (61%) of the 46 beverages in NDSR. Phosphorus content was underestimated by NDSR for 78% of the beverages analyzed.[6] The USDA Standard Nutrient Reference Database only had product-specific information for 11%[5] of the beverages. Neither MyFitnessPal nor CalorieKing™ had any product-specific information on any of the products.[11,12] Manufacturer-reported data were available for 14 (30%) of the beverages and were very similar to measured values.[8-10]

Finally, for products lacking manufacturer reported data, we determined phosphorus content based on reported values of cation(s) (e.g., calcium) on the nutrition facts label, if provided (Table 1). Results for calculations that could be done were very close to what was measured and occasionally outperformed values from NDSR. Note that in some cases, only ranges were able to be calculated as manufacturers may write calcium phosphate on the label, which could include monocalcium, dicalcium, or tricalcium phosphate.

Example calculation: Product X contains **tricalcium phosphate** and no other ingredients that contain a significant amount of **phosphorus** or **calcium**. Product nutrition label lists **10% Daily Value (DV) calcium** in 1 serving.

Determine mass ratio for tricalcium phosphate.

Calcium = Ca = 40.08 amu; Phosphorus = P = 30.97 amu; Tricalcium phosphate = $Ca_3O_8P_2$ (310.17 g/mol).

Calculate mass ratio of calcium in tricalcium phosphate = 40.08 g/mol × 3/310.17 g/mol = 38.76%.

Calculate mass ratio of phosphorus in tricalcium phosphate = 30.97 g/mol × 2/310.17 g/mol = 19.97%.

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**Table 1.** Measured Phosphorus Content and Reference Values of Popular Beverages

| Beverage | Measured Phosphorus (mg per 8 fl oz) | NDSR 2014 Reference Values for Phosphorus (mg per 8 fl oz) | USDA Reference Values for Phosphorus (mg per 8 fl oz) | Manufacturer Website Values (mg per 8 fl oz) | Nutrition Panel Point Estimate or Range Estimate (min, max) (mg per 8 fl oz) |
|---|---|---|---|---|---|
| Carbonated drinks | | | | | |
| Coke | 37.5 (0.2) | 25 | 22 | 40.69 | — |
| Cherry Coke | 33.8 (0) | 25 | 22 | — | 7.16 |
| Dr Pepper | 25.9 (0.2) | 25 | 27 | — | — |
| Diet Dr Pepper | 27.1 (0.5) | 21 | 21 | — | — |
| Pepsi | 31.2 (0.7) | 25 | 22 | 35 | — |
| Diet Pepsi | 24.1 (0.3) | 21 | 21 | 30 | — |
| AMP Energy | 30.9 (0.8) | 40 | 39[*] | 34 | — |
| Fruit-flavored drinks | | | | | |
| Crystal Light, Classic Orange[†] | 100.5 (16.0) | 10 | 9 | — | 51.5-154.5 |
| Crystal Light, Raspberry Ice[†] | 2.4 (0.1) | 10 | 4 | — | 0-15.5 |
| Crystal Light, Fruit Punch[†] | 10.9 (0.5) | 10 | 16 | — | 0-15.5 |
| Tang, Orange[†] | 91.1 (5.0) | 39 | 51 | — | 102-208 |
| Kool-Aid, Tropical Punch[†] | 2.7 (0.3) | 0 | 0 | — | 0-15.5 |
| Kool-Aid, Black Cherry[†] | 2.4 (0.1) | 0 | 0 | — | 0-15.5 |
| Kool-Aid, Grape[†] | 4.7 (0.6) | 0 | 0 | — | 0-15.5 |
| Hawaiian Punch, Fruit Juicy Red | 77.4 (0.3) | 7 | 0 | — | 68.9-103.3 |
| Sunny-D, Tangy Original | 68.8 (0) | 4 | 10 | 90[‡] | — |
| Sunny-D, Smooth | 69.0 (0.5) | 4 | 10 | 90[‡] | — |
| Coffee drinks | | | | | |
| Starbucks Doubleshot Energy, Mocha[§] | 131.2 (0.2) | 13 | 156 | — | 110-164.1 |
| Starbucks Doubleshot Energy, Vanilla[§] | 130.2 (1.5) | 13 | 140 | — | 110-164.1 |
| Iced Teas | | | | | |
| Gold Peak Iced Tea, Sweet Tea[§] | 6.7 (0.2) | 2 | 0 | — | — |
| Gold Peak Iced Tea, Lemon[§] | 2.5 (0.2) | 2 | 3[*] | — | — |
| Lipton Brisk Iced Tea, Sweet Tea[§] | 105.2 (0.8) | 2 | 3 | 126 | — |
| Lipton Brisk Iced Tea, Lemon[§] | 56.9 (0.5) | 2 | 64 | 65.2 | — |
| Lipton Brisk Iced Tea, Raspberry[§] | 83.6 (3.8) | 2 | 64 | 93.2 | — |
| Lemonade | | | | | |
| Crystal Light, Raspberry Lemonade[†] | 8.0 (0.7) | 10 | 18 | — | 0-15.5 |
| Country Time, Lemonade[§] | 15.8 (0.0) | 0 | 18 | — | 0-18.4 |
| Country Time, Pink Lemonade[§] | 14.1 (0.2) | 0 | 18 | — | 0-23 |
| Kool-Aid, Pink Lemonade[†] | 7.3 (0.1) | 0 | 18 | — | 0-15.5 |
| Vitamin Water, Power C Dragonfruit | 1.0 (0) | 0 | 0 | — | 0-11.1 |
| Vitamin Water, Revive Fruit Punch | 261.4 (1.7) | 0 | 0[*] | — | 138.6-277.2 |
| Vitamin Water, Focus Kiwi Strawberry | 0.9 (0) | 0 | 0 | — | 0-11.1 |
| Vitamin Water, Essential Orange-Orange | 63.4 (0.7) | 0 | 0 | — | 18.48-55.44 |
| Vitamin Water, Defense Raspberry Apple[§] | 1.5 (0.1) | 0 | 0 | — | 0-11.1 |
| Vitamin Water Zero, Squeezed Lemonade[§] | 86.2 (1.2) | 0 | 0 | — | 20.6-72.9 |
| Vitamin Water Zero, Rise Orange[§] | 97.7 (1.7) | 0 | 0 | — | 12.36-92.54 |

(*Continued*)

**Table 1.** Measured Phosphorus Content and Reference Values of Popular Beverages (*Continued*)

| Beverage | Measured Phosphorus (mg per 8 fl oz) | NDSR 2014 Reference Values for Phosphorus (mg per 8 fl oz) | USDA Reference Values for Phosphorus (mg per 8 fl oz) | Manufacturer Website Values (mg per 8 fl oz) | Nutrition Panel Point Estimate or Range Estimate (min, max) (mg per 8 fl oz) |
|---|---|---|---|---|---|
| Mio Fit, Arctic Grape †§ | 12.4 (2.1) | 82 | 0 | — | 7.29-27.7 |
| Mio Fit, Berry Blast†§ | 14.4 (1.6) | 82 | 0 | — | 7.29-27.7 |
| SoBe Lifewater, Blood Orange Mango§ | 43.9 (0.5) | 0 | 0 | 45.6 | — |
| Aquafina Flavor Splash, Mixed Berry§ | 56.3 (0.7) | 62 | 0 | 62.4 | — |
| Propel Zero, Berry | 54.9 (0.3) | 59 | 59* | 59.2 | — |
| Sports drinks | | | | | |
| Gatorade, Frost Glacier Freeze (powder)† | 20.9 (3.2) | 0 | 28 | 24.7 | — |
| Gatorade, Orange (powder)† | 21.0 (4.4) | 0 | 28* | 24.7 | — |
| Powerade Zero, Fruit Punch§ | 18.0 (0.2) | 24 | 0 | — | 19.01 |
| Powerade Zero, Orange§ | 18.6 (0.1) | 24 | 0 | — | 19.01 |
| Powerade, Fruit Punch | 18.7 (0.2) | 24 | 2 | — | 19.01 |
| Powerade, Orange | 18.9 (0.1) | 24 | 2 | — | 19.01 |

NDSR, Nutrient Data System for Research.
Means and standard deviations presented for each beverage, using 2 samples for each beverage except for Crystal Light, Classic Orange (5 samples).
*Exact match available in NDSR; for all other products closest substitute was selected.
†Prepared from powder or concentrated liquid according to package instructions.
‡Maximum phosphorus content per manufacturer's website.
§Exact match unavailable in NDSR; closest substitute was selected.

Calculate mass of tricalcium phosphate that contains 100 mg of calcium.

100 mg calcium/38.76% = 258.00 mg of tricalcium phosphate.

Calculate mass of phosphorus in 258.00 mg of tricalcium phosphate

258.00 mg tricalcium phosphate × 19.97% = 51.5 mg phosphorus in one serving

In conclusion, consumer- and research-grade nutritional databases lack product-specific information and may not accurately capture the phosphorus content of foods and beverages containing phosphorus additives. We found that manufacturer websites that reported phosphorus values tended to be accurate and also propose an alternative method to calculate phosphorus content for products that contain phosphorus only from additives. Although our alternative method was able to approximate phosphorus content for some of the products analyzed, it has limited utility for clinical practice. Performing the calculations is time consuming, can only be performed in products without other sources of phosphorus, and even in those cases, may only provide a range if the manufacturer does not specify the numeric prefix for the ionic compound.

Increasing awareness among food manufacturers about the importance of dietary phosphorus restriction in patients with kidney disease may help encourage self-reporting of phosphorus content and consequently improve the quality of dietary phosphorus content information available to both researchers and consumers.

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