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PHOSPHORUS CONTAINING FOOD ADDITIVES AND THE ACCURACY OF NUTRIENT DATABASES: IMPLICATIONS FOR RENAL PATIENTS

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Abstract

Objective—Phosphorus containing additives are increasingly added to food products. We sought to determine the potential impact of these additives. We focused on chicken products as an example.

Methods—We purchased a variety of chicken products, prepared them according to package directions, and performed laboratory analyses to determine their actual phosphorus content. We used ESHA Food Processor SQL Software to determine the expected phosphorus content of each product.

Results—Of 38 chicken products, 35 (92%) had phosphorus containing additives listed among their ingredients. For every category of chicken products containing additives, the actual phosphorus content was greater than the content expected from nutrient database. For example, actual phosphorus content exceeded expected phosphorus content by an average of 84 mg/100g for breaded breast strips. There was also a great deal of variation within each category. For example, the difference between actual and expected phosphorus content ranged from 59 to 165 mg/100g for breast patties. Two 100 g servings of additive containing products contain an average of 440 mg of phosphorus, or about half the total daily recommended intake for dialysis patients.

Conclusion—Phosphorus containing additives significantly increase the amount of phosphorus in chicken products. Available nutrient databases do not reflect this higher phosphorus content, and the variation between similar products makes it impossible for patients and dietitians to accurately estimate phosphorus content. We recommend that dialysis patients limit their intake of additive containing products and that the phosphorus content of food products be included on nutrition facts labels.

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Keywords

phosphorus containing additives; dialysis; nutrient databases; nutrition facts labels

INTRODUCTION

Hyperphosphatemia is a major contributor to poor outcomes among dialysis patients and results in increases in both all-cause and cardiovascular mortality rates.[1,2] Excess phosphorus combines with calcium and deposits in arteries and other soft tissues and leads to the development of atherosclerotic heart disease.[3] Elevated serum phosphorus also stimulates parathyroid hormone and contributes to secondary hyperparathyroidism and renal bone disease.[1,4,5]

The amount of phosphorus in the American diet has increased considerably, primarily from phosphorus containing additives in convenience and fast foods.[6] It is estimated that, depending on individual food choices, such additives add as much 1000 mg/day of phosphorus to the diet.[7] Moreover, phosphorus in additives is almost entirely absorbed while only 60% of naturally occurring phosphorus is absorbed.[8] Education regarding high phosphorus foods is a key component of hyperphosphatemia management,[9,10] but the use of phosphorus containing additives may make it difficult for patients and dietitians to accurately estimate the phosphorus content of foods.

We therefore sought to determine the actual phosphorus content of a number of chicken products and to compare the actual content with that estimated from a reference source that dietitians might consult in advising patients. We focused on chicken products because chicken is a good source of high quality protein for dialysis patients.

METHODS

We surveyed grocery stores in greater Cleveland to determine the types of stores in the area (e.g. grocery chains, discount stores, warehouse stores), the categories of chicken products available (e.g. raw chicken, breaded patties, breaded nuggets), and the specific brands available. We then purchased 38 chicken samples across a variety of store types, products, and brands. We cooked raw chicken products at 350 degrees Fahrenheit until they reached an internal temperature of 165 degrees Fahrenheit and prepared precooked chicken products according to package directions. The samples were allowed to cool and then shipped in cool pack boxes to Medallion Laboratories (Minneapolis, Minnesota). Medallion Laboratories ashed the samples at high temperature, digested them in acid, and used inductively coupled plasma to determine their actual phosphorus content. One sample was analyzed for each product.

We used ESHA Food Processor SQL Software (version 9.8, ESHA Research. Salem OR), to determine the expected phosphorus content of each chicken product. ESHA data is obtained from the United States Department of Agriculture National Nutrient Database for Standard Reference,[11] manufacturers' analyses, and other reference sources.

The actual and expected phosphorus content were calculated per 100 grams of product. Serving size was determined from nutrition facts labels on each product. The presence of phosphorus containing additives was determined from the ingredient lists of products. In presenting the results, we grouped chicken products based on amount of processing, size, and content (i.e. breast vs. mixed chicken).

RESULTS

Of the 38 chicken products, 35 (92%) had phosphorus containing additives listed among their ingredients (Table 1). Among the 8 boneless breast products, 5 (63%) had phosphorus containing additives. Among the 30 breaded breast strips, breast nuggets, mixed nuggets, breast patties, and mixed patties, 100% had phosphorus containing additives. Additives present included sodium phosphate (present in 71% of products), sodium aluminum phosphate (32%), sodium acid pyrophosphate (26%), monocalcium phosphate (26%), and sodium tripolyphosphate (16%). Ten products contained two additives and another ten products contained three additives.

For boneless breasts without phosphorus containing additives, the actual phosphorus content was somewhat less than the content expected from the nutrient database (Figure 1). For every other category of chicken products, the actual phosphorus content was greater than the content expected from the nutrient database. For example, actual phosphorus content exceeded expected phosphorus content by an average of 84 mg/100g for breaded breast strips. There was also a great deal of variation within each category. For example, the difference between actual and expected phosphorus content ranged from 59 to 165 mg/100g for breast patties.

The difference between actual and expected phosphorus content was significantly higher for products containing phosphorus additives compared to products without additives (−38 vs. +68, p= <.0001**).** Two 100 g servings of additive containing products would provide an average of 440 mg of phosphorus (range 256 – 634 mg), or about half the total daily recommended intake for dialysis patients.

DISCUSSION

We found that phosphorus containing additives are present in the vast majority of chicken products and significantly increase the phosphorus content of such products. Available reference sources do not reflect this higher phosphorus content, and the variation between similar products makes it impossible for patients and dietitians to accurately estimate phosphorus content.

Our findings have important implications for patients, providers, policy makers, and food manufacturers. Dialysis patients and their providers struggle not only with dietary restrictions but also with nutritional barriers such as poor appetite and needing help with cooking.[12] Convenience and fast foods tend to be palatable and require little or no preparation but often contain phosphorus additives. Instructing dialysis patients to limit their intake of additive containing products would seem to be a reasonable recommendation. However, following such a recommendation will be challenging for several reasons. First, as our analysis of chicken products demonstrates, the availability of additive-free products in grocery stores may be limited. Second, ingredient lists are generally not present on fast food items, making it difficult to identify the presence of phosphorus containing additives. Third, simply knowing that a product contains a phosphorus additive doesn't allow an accurate estimate of its phosphorus content. Fourth, additive-free products, such as raw chicken breast, may require more effort to prepare. This may not be possible for dialysis patients with physical or social limitations.[12]

Phosphorus containing additives may also have an impact on patients with earlier stages of chronic kidney disease and on the general population. Hyperphosphatemia may contribute to cardiovascular and bone disease among the 10 million Americans with moderate kidney disease.[13–15] In the general population, dietary intakes of phosphorus have been increasing while intakes of calcium have been decreasing.[6] There is evidence to suggest that these intake patterns interfere with the normal process of calcium regulation and affect peak bone mass and rate of bone loss even among individuals with normal renal function. [6,16–20]

We recommend that manufacturers analyze their products for phosphorus content and make these data available for incorporation into nutrient databases. Food manufacturers should also create lower phosphorus versions of popular products. We also recommend that policymakers mandate that phosphorus content of foods be included on the nutrition facts label. These actions by manufacturers and policymakers will help patients limit their phosphorus intake, will help providers to better instruct patients, and will help researchers to accurately assess dietary intake.

Several limitations must be considered in interpreting our results. We focused only on chicken products obtained in a single geographic region and analyzed one sample per product. However, many of the products we analyzed are national brands and phosphorus containing additives are known to be present in numerous other products. Nonetheless, we recommend that other investigators perform similar analyses with a variety of products in other geographic regions.

In conclusion, phosphorus containing additives significantly increase the amount of phosphorus in chicken products. Available nutrient databases do not reflect this higher phosphorus content, and the variation between similar products makes it impossible for patients and providers to accurately estimate phosphorus content. Despite the development and widespread use of new vitamin D analogues and phosphorus binders, one-third to one-half of dialysis patients continue to have elevated phosphorus levels[14,21–24]. We speculate that the use of phosphorus containing additives limits the effectiveness of these new therapies. We recommend that dialysis patients limit their intake of additive containing products, that manufacturers develop lower phosphorus versions of their products, and that policymakers require phosphorus content of food products to be included on nutrition facts labels.

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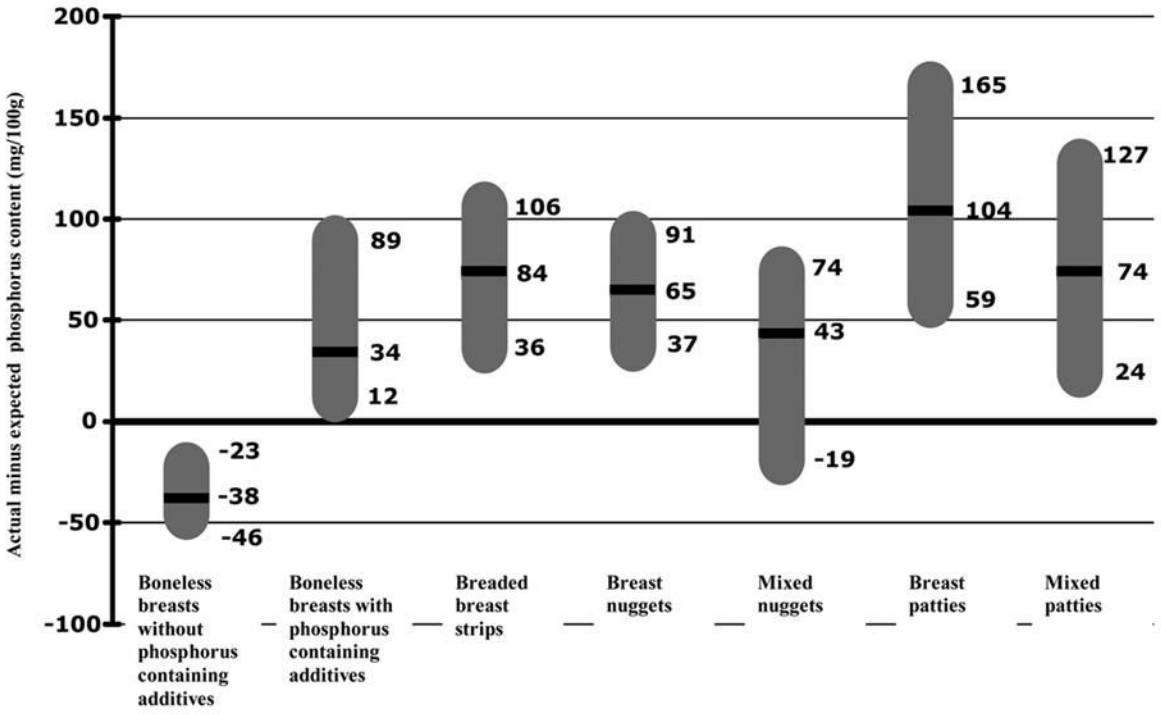

Figure 1.

Actual minus expected content of 38 chicken products. For each category of chicken products, the black line represents the mean value while the top and bottom of the gray bar represent the maximum and minimum values.

Table 1

Actual and expected phosphorus content of a variety of chicken products (n=38).

Category	Product	Phosphorus containing additives*	Serving size (g)	Actual Phosphorus (mg/100g)	Expected phosphorus (mg/100g)	Difference (mg/100g)
Boneless breast	Giant Eagle fresh chicken breast	None	112	205	228	−23
	Dave's fresh chicken breast	None	Not specified	184	228	−44
	Kirkland quick frozen chicken breast	None	112	182	228	−46
	Kirkwood quick frozen chicken breast	1	182	255	228	27
	Townsend quick frozen chicken breast	1	113	250	228	22
	Tyson quick frozen chicken breast	1	112	317	228	89
	Giant Eagle quick frozen chicken breast	1	196	240	228	12
	Great Value quick frozen chicken breast	1	196	246	228	18
Breaded breast strips	Tyson crispy chicken strips	1	92	235	147	88
	Barber chicken breast finger filets	1,3	112	235	147	88
	Tyson chicken breast tenderloins	1,3	68	253	147	106
	Kirkwood chicken breast strip fritters	1	92	236	147	89
	Kirkwood chicken breast tenderloins	1,2,4	68	242	147	95
	Banquet chicken breast strips	2,4,5	85	183	147	36
Breast nuggets	Banquet chicken breast tenders	2,4,5	85	186	147	39
	Kirkwood chicken breast tenders	1,3	85	229	147	82
	Weaver breast tenders	1,3	85	208	147	61
	Tyson breast tenders	1,3	85	238	147	91
	Banquet chicken breast nugget	2,4,5	85	184	147	37
	Tyson breast nuggets	1,3	90	213	147	66
	Fast Fixin breast nuggets	1,2,4	85	226	147	79
Mixed nuggets	Banquet chicken nuggets	2,4,5	85	219	147	72
	Blossom Creek chicken nuggets	3	114	128	147	−19
	Weaver chicken nuggets	1	75	174	147	27
	Redi serve chicken nibblers	1	77	200	147	53
	Giant Eagle chicken nuggets	1,3	91	197	147	50
	Tyson chicken nuggets	1,3	92	221	147	74
Breast patties	Tyson breast patties	1,3	73	185	126	59
	Weaver breast patties	1	74	229	126	103
	Banquet chicken breast patties	2,4,5	76	291	126	165
	Giant Eagle breast patties	1,3	74	202	126	76

Category	Product	Phosphorus containing additives*	Serving size (g)	Actual Phosphorus (mg/100g)	Expected phosphorus (mg/100g)	Difference (mg/100g)
Mixed patties	Kirkwood chicken breast filets	1,2,4	106	236	126	110
	Tyson chicken breast filets	1	129	238	126	112
	Weaver chicken patties	1	74	253	126	127
	Banquet chicken patties	2,4,5	76	189	126	63
	Blossom chicken patties	3	79	150	126	24
	Tyson southern style patties	1,2,4	73	221	126	95
	Redi Serve chicken patties	1	71	188	126	62

* 1 = sodium phosphate, 2 = sodium acid pyrophosphate, 3 = sodium aluminum phosphate, 4 = monocalcium phosphate, 5 = sodium tripolyphosphate