Phosphorus and Potassium Content of Enhanced Meat and Poultry Products: Implications for Patients Who Receive Dialysis

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Background and objectives: Uncooked meat and poultry products are commonly enhanced by food processors using phosphate salts. The addition of potassium and phosphorus to these foods has been recognized but not quantified.

Design, setting, participants, & measurements: We measured the phosphorus, potassium, and protein content of 36 uncooked meat and poultry products: Phosphorus using the Association of Analytical Communities (AOAC) official method 984.27, potassium using AOAC official method 985.01, and protein using AOAC official method 990.03.

Results: Products that reported the use of additives had an average phosphate-protein ratio 28% higher than additive free products; the content ranged up to almost 100% higher. Potassium content in foods with additives varied widely; additive free products all contained <387 mg/100 g, whereas five of the 25 products with additives contained at least 692 mg/100 g (maximum 930 mg/100 g). Most but not all foods with phosphate and potassium additives reported the additives (unquantified) on the labeling; eight of 25 enhanced products did not list the additives. The results cannot be applied to other products. The composition of the food additives used by food processors may change over time.

Conclusions: Uncooked meat and poultry products that are enhanced may contain additives that increase phosphorus and potassium content by as much as almost two- and three-fold, respectively; this modification may not be discernible from inspection of the food label.

Clin J Am Soc Nephrol 4: 1370–1373, 2009. doi: 10.2215/CJN.02830409

The control of dietary phosphorus intake is the lynchpin in the successful control of hyperphosphatemia in dialysis patients (1). Other than limiting dairy products, efforts to reduce dietary phosphorus have been stymied by a belief that there is a close link between dietary protein and dietary phosphorus that can result in protein malnutrition if phosphorus control were to become too strict (2–4). The increasing recognition that phosphorus-containing food additives make up a significant portion of dietary phosphorus is changing this belief; clinicians are becoming more aware that efforts to limit dietary phosphorus can contribute substantially to serum phosphorus control without impairing protein intake (5–10).

One particular source of dietary phosphorus that is achieving growing recognition in the literature and national press is that resulting from the so-called "enhancement" of fresh meat and poultry products (11–13). This enhancement consists of the injection of a solution of water with sodium and potassium salts, particularly phosphates, as well as antioxidants and flavorings into the meat by a machine during processing (11). Marinated and cured meats are also considered enhanced when a similar process is used.

Despite the obvious problem for dialysis patients' ingesting such products, there is no requirement that their phosphorus or potassium content be included on the nutrition label (14,15), although this has been advocated (14,15). Furthermore, to our knowledge, there have been no published studies or other sources of data on potassium and phosphorus burdens imposed by fresh meat and poultry products that have been "enhanced." We therefore examined the potassium and phosphorus content in a variety of enhanced and regular meat and poultry products that are available in local retail stores.

Materials and Methods

Uncooked meat and poultry items were purchased at several local supermarkets. Products were arbitrarily chosen. A variety of products were sought, and an attempt was made to purchase both enhanced and regular versions of the same product. A portion of each item was then repackaged in sealable plastic bags and coded. All food labeling was saved. Bones were removed when present before repackaging. The coded samples were then transported to the laboratory for analysis (New Jersey Feed Laboratory, Trenton, NJ). Laboratory technicians were blinded to all food labeling information. All samples were ground before analysis. Potassium was measured using the Association of Analytical Communities (AOAC) official method 985.01. Phosphorus was measured using AOAC official method 984.27; both the potassium and phosphorus assays are inductively coupled plasma atomic spectroscopy procedures. Protein was measured using the AOAC official

Received April 28, 2009. Accepted June 3, 2009.

Published online ahead of print. Publication date available at www.cjasn.org.

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ISSN: 1555-9041/408–1370

method 990.03, the Dumas nitrogen combustion method, with the Elementar Americas Rapid-N apparatus (Elementar Americas, Mt. Laurel, NJ). A Perkin-Elmer model Optima 2000 DV equipped with a model AS 90 plus Autosampler was used (Perkin-Elmer, Waltham, MA). Sample weights were obtained with a Sartorius model U 4800P balance (Sartorius Corp., Edgewood, NY). All instruments were calibrated according to manufacturers' specifications. Samples from the laboratory were routinely analyzed for accuracy by the American Association of Feed Control Officials and the American Oil Chemists Society.

For purposes of this investigation, we considered a meat or poultry product to be enhanced when this word was used on the package labeling (n = 8) or when this word was omitted but other terms suggesting the presence of food additives were noted on the label (n = 17), such as "cured," "contains solution," and "natural flavorings." We termed other meat and poultry products with no evidence indicating the presence of food additives as a "regular" (or additive-free) item (n = 11).

We report the potassium and phosphorus content as milligrams per 100 grams of product; however, for phosphorus, we also report this content as milligrams of phosphorus per gram of protein content; this is the measure generally used in the text. Because phosphorus content is closely tied to protein content, we believe that this is a more useful means of presenting these data; others agree (5,16).

Results

Enhanced meat and poultry products (EMPP) had on average a phosphorus-protein ratio that was 28.4% higher than that for regular products (Table 1). The average potassium content in EMPP was 8.7% higher than for regular products. This difference in mean values obscures a marked variability in potassium content in EMPP. Whereas the highest potassium content in a regular product was 387 mg/100 g, the five enhanced products with the most potassium contained at least 692 mg/100 g (maximum 930 mg/100 g). Although some differences in phosphorus and potassium content of the enhanced and regular products may be due to the different foods in the two groups, closer examination shows that food additives are likely to be the predominant factor. Figure 1 shows the data for equivalent products. For example, an enhanced pork chop had 81% more phosphorus than a visually identical regular pork chop.

Whether an EMPP listed specific additives on the ingredient label varied; 16 of 25 such products did so. When these additives were specifically named, this information offered useful guidance as to the potassium and phosphorus content of the product. The 15 EMPP with specific labeling and no potassium additives had only 235 mg/100 g potassium, whereas the two products that specifically excluded phosphate salts had a phosphorus-protein ratio of only 8.6 mg/g protein. EMPP with no specifics on the label had a wide range for both potassium (170 to 930 mg/100 g) and phosphorus (6.86 to 17.35 mg/g protein) content. The presence of phosphorus on the ingredient label of an EMPP (n = 14) indicated a higher average level of phosphorus (mean 11.6 mg/g protein), but the range extended from 6 to 15 mg/g protein.

Discussion

The use of phosphorus-containing food additives became widespread in the United States after a 1982 ruling by the Food Safety and Inspection Service of the US Department of Agriculture allowed expanded use of these products. The term "enhanced" is sometimes limited to meat and poultry that is altered primarily for reasons other than flavor and that has other than "natural" ingredients. These enhanced products are required to report the specific additives used, although they are not quantified; however, a chicken breast marinated in seasoning or in a "natural" broth solution might contain added phosphorus but does not fall under the narrow definition of an enhanced meat product. The more broadly defined EMPP generally do not detail the chemical composition of the additives used.

Although much attention has been paid to the added sodium and phosphorus in processed foods, none has been paid to the added potassium. Our data indicate that more attention is warranted. In some EMPP, little potassium seems to have been added (*e.g.*, sirloin steak: product 8 [enhanced] *versus* product 21 [regular]), whereas in others, the amount of added potassium is striking. The enhanced boneless loin strip steak (product 6) had 930 mg of potassium per 100 g, a level three-fold higher than a similar regular product (product 20). Thus, a 200-g portion would contain almost 2 g of potassium, most of a dialysis patient's daily restricted intake. A dialysis patient who eats this product would be at increased risk for the development of hyperkalemia; its origin would very likely be unrecognized.

The discordance between potassium and phosphorus content in these products is not surprising given the approval (by the US Department of Agriculture) of 11 different phosphate salts for use in meat and poultry products: six are sodium salts, and five are potassium salts. These salts differ in their properties and serve different purposes in food processing.

The impact of addition of phosphorus to EMPP is likely to be clinically significant, especially so in view of the probability that phosphorus in food additives is much better absorbed than phosphorus that is contained in unprocessed foods (1,12). Increasing the clinical importance of this added phosphorus further is its disproportionate effect on phosphorus binder requirements. Binders are required to remove only phosphorus that is not eliminated by dialysis; however, dialytic phosphorus removal is relatively fixed for a given plasma phosphorus concentration for standard thrice-weekly hemodialysis (although not with more frequent dialysis regimens) (17). Any additional dietary phosphorus will thus need to be removed by binders. For example, with a dietary phosphorus of 8400 mg/wk (1200 mg/d), binders and dialysis are needed to eliminate 5040 mg/wk (assuming that 60% of phosphorus is potentially absorbed). If dialysis removes 3000 mg, then binders must remove 2040 mg. A rise in dietary phosphorus from 1200 to 1500 mg/d, a 25% increase, would increase phosphorus binding requirements by 62%. The increase in binder requirement would probably be even greater because the calculation ignores any facilitated absorption of phosphorus in the form of additives.

We did not examine the effect of cooking on phosphorus or potassium content. Cooking is likely to alter theses results in an inconsistent way depending on the specific cooking method. Retail cost was also not formally compared for the products; however, producer costs for EMPP are clearly lower, a difference likely to be reflected in retail cost.

Avoiding phosphorus in uncooked meat and poultry prod-

Table 1. Phosphorus, potassium, and protein content in uncooked meat and poultry

Number	Item	Enhanced?	Phosphate (mg/100 g)	Protein (g/100 g)	Phosphorus-Protein Ratio (mg/g)	Potassium (mg/100 g)
1	Bone-In Loin Center Cut Pork Chops	Y	340	19.6	17.35	584
2	Kirkwood Ice Glazed Boneless, Skinless Chicken Breasts with Rib Meat	Y	190	21.7	8.76	315
3	Kirkwood Ice Glazed Chicken Drumsticks	Y	170	18	9.44	238
4	Kirkwood Ice Glazed Chicken Wings	Y	120	17.5	6.86	170
5	Pork Boneless Loin Country Style Pork Ribs	Y	230	20.1	11.44	671
6	USDA Select Beef Boneless Loin Strip Steak	Y	260	19.4	13.40	930
7	USDA Select Beef Boneless Chuck Roast	Y	200	17.9	11.17	561
8	Granger Beef Filet of Sirloin	Y	250	19.6	12.76	331
9	Appleton Center Slice Hardwood Smoked Ham	Y	210	18.1	11.60	255
10	Granger Beef USDA Choice Beef T-Bone Steaks	Y	240	19.3	12.44	261
11	Boar’s Head Naturally Smoked Sliced Bacon	Y	100	10.4	9.62	185
12	John Morrell Hardwood Smoked Bacon	Y	120	9.4	12.77	164
13	Nature’s Promise Uncured Hickory Smoked Bacon	N	110	11.8	9.32	246
14	Oscar Meyer Naturally Hardwood Smoked Bacon	Y	150	11.2	13.39	205
15	Hormel Black Label Bacon Original	Y	120	12.2	9.84	233
16	Stop & Shop Fresh White Gem Chicken All Natural Drumsticks	N	170	19.3	8.81	256
17	Stop & Shop Tender & Flavorful Pork Loin Chops	N	210	21.9	9.59	366
18	Stop & Shop Tender & Flavorful Pork Loin Ribs	N	210	21.8	9.63	387
19	Stop & Shop Fresh White Gem Chicken All Natural Boneless Skinless Breasts with Rib Meat	N	220	25.6	8.59	364
20	Stop & Shop Grilling & Boiling Boneless Strip Steaks	N	170	21.1	8.06	311
21	Stop & Shop Grilling & Boiling Beef Loin Top Sirloin Boneless Steaks	N	180	21.2	8.49	328
22	Stop & Shop Tender & Flavorful Pork Hocks	N	160	20.3	7.88	268
23	Shadybrook Farms All Natural Turkey Breast Cutlets	Y	220	25.5	8.63	337
24	Stop & Shop Chicken Breast Boneless Cutlets	N	220	26.7	8.24	367
25	Perdue Oven Stuffer Fresh All Natural Roaster Drumsticks	N	170	19.4	8.76	273
26	Perdue Fresh All Natural Chicken Wings	N	140	18.2	7.69	217
27	Freirich Flavor Porkette Pork Shoulder Butt	Y	210	17.4	12.07	232
28	Freirich Flavor Corned Beef Brisket	Y	130	17.6	7.39	222
29	Smithfield Hardwood Smoked Ham	Y	240	17.5	13.71	255
30	Hillshire Farm Polska Kielbasa (Made with Pork, Turkey, Beef)	Y	170	11.3	15.04	187
31	Hillshire Farm Beef Polska Kielbasa	Y	150	12.4	12.10	197
32	Nebraska Meat Smoked Turkey Drums	Y	200	22.4	8.93	249
33	Nebraska Meat Smoked Pork Hocks	Y	160	26.8	5.97	238
34	Butterball Premium Young Turkey	Y	260	24.1	10.79	310
35	Kirkwood Turkey Breast Roast	Y	230	22.5	10.22	317
36	Tender Choice Boneless Thin-Cut Pork Chops	Y	240	20.7	11.59	714

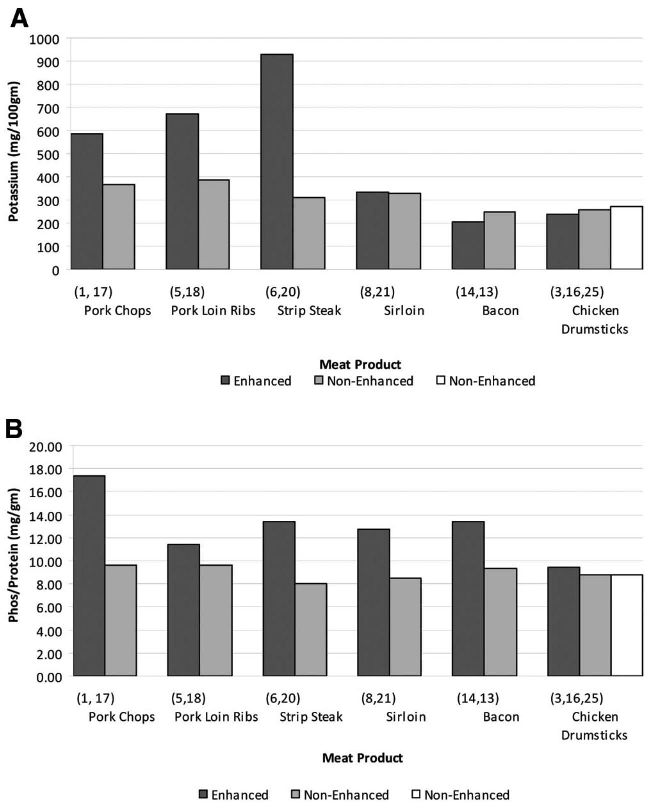

Figure 1. (A and B) Phosphorus-protein ratios (B) and potassium content (A) for enhanced and regular, matched food products. The numbers in parentheses on the abscissa refer to those in Table 1. Two different nonenhanced chicken drumstick products were analyzed.

ucts requires close attention to food labels. Although avoiding food that indicates added phosphorus salts will reduce dietary phosphorus burden (6), additional restrictions are needed because not all EMPP list the salts used in processing. It is also necessary to avoid enhanced foods that may refer only to "added solution" or broth to minimize the risk for excessive unrecognized dietary phosphorus. Similar restrictions are needed to avoid potassium excess. The burden imposed on those who seek to limit dietary phosphorus and potassium could be ameliorated by more complete food labeling by manufacturers.

Acknowledgments

This study was supported by unrestricted educational grants from Dialysis Clinics, Inc., and Genzyme, Inc.

Disclosures

None.

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See related editorial, "Phosphorus Additives in Food and their Effect in Dialysis Patients," on pages 1290–1292.