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The Prevalence of Phosphorus Containing Food Additives in Top Selling Foods in Grocery Stores

Janeen B. León, MS, RD, LD[1] **[Junior Researcher]**, **Catherine M. Sullivan, MS, RD, LD**[2] **[Manager Clinical Research]**, and **Ashwini R. Sehgal, MD**[2,3,4] **[Duncan Neuhauser Professor of Community Health Improvement; Professor of Epidemiology and Biostatistics, Bioethics, and Medicine; and Director, Center for Reducing Health Disparities]**

[1]MetroHealth Medical Center and Department of Medicine, Case Western Reserve University, Cleveland, OH

[2]Center for Reducing Health Disparities, Case Western Reserve University, Cleveland, OH

[3]Division of Nephrology, Department of Medicine, MetroHealth Medical Center, Cleveland, OH

[4]Departments of Medicine, Epidemiology and Biostatistics, and Bioethics, Case Western Reserve University, Cleveland, OH

Abstract

Objective—To determine the prevalence of phosphorus-containing food additives in best selling processed grocery products and to compare the phosphorus content of a subset of top selling foods with and without phosphorus additives.

Design—The labels of 2394 best selling branded grocery products in northeast Ohio were reviewed for phosphorus additives. The top 5 best selling products containing phosphorus additives from each food category were matched with similar products without phosphorus additives and analyzed for phosphorus content. Four days of sample meals consisting of foods with and without phosphorus additives were created and daily phosphorus and pricing differentials were computed.

Setting—Northeast Ohio

Main outcome measures—Presence of phosphorus-containing food additives, phosphorus content

Results—44% of the best selling grocery items contained phosphorus additives. The additives were particularly common in prepared frozen foods (72%), dry food mixes (70%), packaged meat (65%), bread & baked goods (57%), soup (54%), and yogurt (51%) categories. Phosphorus additive containing foods averaged 67 mg phosphorus/100 gm more than matched non-additive containing foods (p=.03). Sample meals comprised mostly of phosphorus additive-containing foods had 736 mg more phosphorus per day compared to meals consisting of only additive-free foods. Phosphorus additive-free meals cost an average of $2.00 more per day.

Conclusion—Phosphorus additives are common in best selling processed groceries and contribute significantly to their phosphorus content. Moreover, phosphorus additive foods are less costly than phosphorus additive-free foods. As a result, persons with chronic kidney disease may

Corresponding Author: Janeen B. León, MetroHealth Medical Center, R229A, 2500 MetroHealth Drive, Cleveland, OH 44109, 216-778-8491 (ph); 216-778-3945 (f); Janeen.Leon@case.edu.

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purchase these popular low-cost groceries and unknowingly increase their intake of highly bioavailable phosphorus.

Keywords

Phosphorus; Food additives; Food supply; Chronic kidney disease

Introduction

An increasing body of epidemiological evidence implicates serum phosphorus and fibroblast growth factor-23 (FGF-23) as independent predictive risk factors for mortality, cardiovascular morbidity and disordered bone metabolism in persons with or without chronic kidney disease (CKD).(1–10) While mechanisms are still not fully understood, dietary phosphorus loads have been shown to increase serum phosphorus in persons with CKD and to increase FGF-23 in healthy persons and those with CKD, independent of its effects on parathyroid hormone.(11–13) As a result, persons with CKD are advised by healthcare providers to limit dietary phosphorus to 800–1000 mg/day and to avoid foods containing phosphorus additives due to their high bioavailability. (14–16)

Persons desiring to limit highly absorbable phosphorus additives must read small font food label ingredient lists to determine the presence of phosphorus additives in foods. While we have demonstrated this as an effective nutrition intervention to reduce serum phosphorus in hemodialysis patients, it may be overly restrictive as the phosphorus content of brand-specific food items is generally unknown. Food labeling regulations do not mandate reporting of phosphorus content on nutrition facts labels. (17)

Phosphorus additives have long been added to convenience and processed foods for their myriad of features including leavening, color and moisture retention, anti-caking, and flavor enhancement (18) and are classified as generally recognized as safe (GRAS) food ingredients (19). No current public data source quantifies the volume of phosphorus-containing food additives used within the United States food supply, however consumers increasingly purchase convenience, fast and processed foods due to time constraints, limited cooking skills, and learned taste preferences.(20–22) It is therefore presumed that the consumption of hidden phosphorus from additives in the United States has increased over time.

Given broad reliance on processed foods, difficulty in reading label ingredient lists and the limited availability of brand-specific phosphorus content information, we sought to determine the prevalence of phosphorus-containing food additives in best-selling grocery products and to compare the difference in phosphorus content and costs in a subset of top selling food products with and without phosphorus additives.

Methods

We obtained a dataset of grocery sales in northeast Ohio for the twelve months ending February 2010 produced by The Nielsen Company. The dataset provided regional sales data for 1.8 billion units of grocery items ($4.7 billion in sales) grouped into 125 categories. All categories were ranked by unit sales from highest to lowest. We selected the top twenty categories by unit sales, then excluded fresh produce, milk, pet food, candy, and paper products because they were minimally processed and known to not contain additives, were not food or not part of typical meals. We focused on the top 200 grocery items by unit sales for each of the remaining 15 categories, creating a dataset of 3000 items to review.

Two trained research assistants independently located each grocery item at area grocery retail stores. For each item, the Universal Product Code (UPC) on the food label was matched to the UPC in the dataset, the ingredient list searched, and the presence or absence of phosphorus-containing food additives recorded. A research coordinator compared the results to ensure uniform data collection and accuracy. When discrepancies existed, the food label was reviewed a third time to resolve the discrepancy. If an item could not be located at grocery retail stores, the manufacturer was contacted for ingredient information. It was necessary to exclude store branded items because the dataset aggregated multiple store brands into a single line item and store brands varied in presence of additives from store brand to store brand.

To explore the quantity of phosphorus contributed by phosphorus additives, the top five grocery items ranked by unit sales in each category that contained phosphorus additives were matched with similar grocery items without food additives. The matched items were chosen from the list of top selling foods identified above when possible. To illustrate, we matched Kraft Macaroni & Cheese Dinner™ with Kraft Organic Cheddar Macaroni & Cheese Dinner™. When the top 5 items included identical items in multiple package sizes (i.e. 8- and 12-ounce packaging), we chose only the top selling product and skipped to the next unique product by sales volume. If an item was discontinued or could not be located at an area grocery retail outlet, we selected the next product in the database as outlined above. The canned vegetable category was excluded from phosphorus analysis because none of the products contained phosphorus additives. The carbonated beverage category was excluded from matching because we were unable to locate similar phosphorus additive-free cola products for comparison.

Each of the top five matched items were purchased at local grocery retail outlets and, if applicable, prepared according to package instructions. When more than one cooking method was suggested, the first cooking method was used. Extra ingredients were added according to package specifications. Distilled water was used when water was required for boiling or reconstitution of dry or condensed products. When type of ingredient was not specified on the package, we used 2% milk for milk, 85% lean for ground beef, unsalted butter for butter, canola oil for oil, and soft margarine for margarine.

All food samples were weighed on a scientific grade scale and packaged in sealed containers. Samples were shipped to Medallion Laboratories, Inc., Minneapolis, MN for analysis of total phosphorus content. Medallion Laboratories ashed the samples at high temperature, digested them in acid, and used inductively coupled plasma to determine phosphorus content. One sample was analyzed for each product. Results were reported as mg phosphorus per 100 gm of product. Serving size was determined from nutrition facts labels on each product. We computed the amount of phosphorus per serving by multiplying laboratory results by measured sample weights.

Sample meals were developed using analyzed matched foods to approximate the mean calorie, protein, carbohydrate and total fat intake of adults in the 2007–2008 NHANES *What We Eat in America* study (Table 1).(23) Fruits, vegetables, milk and margarine were included in menus to more closely approximate “typical” meals. Meal costs were calculated using prices from sales receipts for the items analyzed and local grocery prices for any additional items.

Data was analyzed using JMP 9 by SAS. Data is reported as mean±SE with significance set at $p<0.05$.

Results

The labels of 2394 (80%) commonly purchased branded grocery products in northeast Ohio were reviewed for phosphorus additives. 606 (20%) of the food items were excluded due to inability to locate the products, items were store branded, or were discontinued. The grocery items reviewed comprised 25% of groceries (by unit volume) sold in northeast Ohio during the 52-week period included in the dataset.

Overall, phosphorus-containing food additives were present in 44% of the products reviewed. There was wide variation in the presence of phosphorus food additives between categories ranging from 72% of prepared frozen foods to 0% of canned vegetables (Figure 1). Food additives were particularly common in prepared frozen foods (72%), dry food mixes (70%), packaged meat (65%), bread & baked goods (57%), soup (54%) and yogurt (51%) categories.

We successfully matched 56 (86%) of the 5 top-selling grocery items containing phosphorus additives in 13 categories with similar products without phosphorus additives. Foods with phosphorus additives contained an average of 67±14 mg phosphorus/100 gm more than the matched non-additive containing foods (178±27 mg/100gm and 111±15 mg/100 gm respectively; p=0.03). There was notable variation between grocery categories in the amount of extra phosphorus present in additive-containing foods, ranging from 0 mg/100 gm for frozen vegetables to 347 mg/100 gm for cheeses. In addition to cheese, cereal, packaged meats, dry food mixes, snacks, condiments and yogurt categories showed substantial differences in phosphorus content between matched additive and non-additive containing foods (Table 2).

In sample meals, phosphorus additive foods contributed an average excess phosphorus burden of 736±91mg per day (Table 3). Phosphorus additive-free meals cost an average of $2.00±.42 more per day.

Discussion

We and other researchers have reported that persons may unknowingly consume excess highly bioavailable phosphorus via food additives as part of the standard American diet.(16, 17, 24–30) In this study we showed that nearly half of the best-selling grocery foods items in our region contain phosphorus additives. One-half to three-quarters of all prepared frozen foods, dry food mixes, packaged meats, breads and baked goods, soups and yogurts reviewed contained these additives (Figure 1).

Overall, the additives contributed a significant amount of phosphorus compared to additive-free foods, averaging 67 mg/100 g of additional phosphorus, but there was significant variation in extra phosphorus both within and between categories (Table 2). For instance, bread, canned vegetables and soups had minimal difference in phosphorus content between additive containing and additive-free products. This knowledge can help persons avoid phosphorus from additives and allow clinicians to focus their patient education efforts on food categories most likely to contain appreciable amounts of phosphorus additives. Understanding the magnitude of content difference is important when teaching patients how to self-dose phosphorus binders based on dietary phosphorus intake (phosphorus unit system).(31)

The cumulative effect of consuming phosphorus additives is unknown. We found that a diet comprised of multiple common processed foods with phosphorus additives contributed 736 mg/day more phosphorus (41% increase) than a diet consisting of only non-additive foods. Since these additives are highly bioavailable in the gastrointestinal tract, the impact of this

excess phosphorus may be substantial. While a person with fully functioning kidneys may be able to maintain serum phosphorus within the normal range despite such a phosphorus load, persons with advanced kidney disease require dialysis and sufficient dosing of phosphorus binding medications to remove excess phosphorus (32). As a result, dialysis patients may have a particularly difficult time maintaining normal serum phosphorus levels if they consume multiple phosphorus-additive containing grocery foods. Our findings suggest reduction of additive phosphorus is an important part of phosphorus management in these patients.

Additive-containing meals were $2.00 cheaper per day than non-additive containing meals. This finding supports the potential for socioeconomic-based health disparities for developing kidney, bone and cardiovascular disease or increased morbidity and mortality as described by Gutierrez in both dialysis and non-dialysis CKD populations (33, 34). While $2.00/day may sound insignificant, average household supplemental food assistance benefits (SNAP) average only $287/month, or $4.30 per person per day.(35) Families eligible for SNAP are unlikely to afford $240 per month additional food costs to avoid phosphorus additives. ($8/day × 30 days/month).

This is the first study to survey the prevalence of phosphorus additives in commonly sold branded grocery food items and the findings have several implications for patients, healthcare providers, policy makers, manufacturers and researchers. Patients and healthcare providers should become knowledgeable about the ubiquitous use of highly bioavailable phosphorus additives in the food supply in order to enhance dietary avoidance. Reading food ingredient labels with magnifiers for ingredients containing the letters “phos” is one tested, simple educational intervention that can be employed.(17) It may be most time efficient to focus attention to ingredient labels in specific food categories with high prevalence of phosphorus additives and significantly greater phosphorus content such as dry food mixes, packaged meats, soups, yogurt, cheese and yogurt. Development of regularly updated lists of brand-specific additive-free foods may guide patients in purchasing groceries.

Policymakers should require phosphorus content as part of the standard Nutrition Facts Panel so that patients, clinicians and researchers can better assess dietary phosphorus intake in clinical and research settings. Finally, researchers should undertake studies to determine if reducing dietary phosphorus loads via food additive avoidance reduces cardiovascular risk in CKD and other populations.

There are a few important limitations to our study. First, the number of matched products analyzed within each grocery category was small due to budget limitations and inability to identify additive-free foods that closely mirrored several top selling food items. Second, we analyzed only one sample of each food item. It is not known how much variation in phosphorus content is present within individual food products, Third, this study was limited to grocery sales in northeast Ohio, representing $4.7 billion in retail grocery sales. By comparison, the U.S. Census Bureau 2010 Annual Retail Trade Report documents $521.4 billion in grocery sales.(36) However, the majority of grocery items reviewed were common, widely marketed national brands. Finally, our study included only brand name food items. Store branded foods vary in phosphorus additives content, but are generally less costly then brand name groceries. As a result, use of store branded foods may alter the results of the cost estimates we report.

Practical Application

Phosphorus-containing food items are common among the best selling grocery food items, and are particularly present in frozen meals, dry food mixes, packaged meats, breads and baked goods, soups and yogurts. The additives contributed a significant amount of

phosphorus compared to additive-free foods. Modeled menus with additives contained nearly 750 mg more phosphorus per day and were less costly than phosphorus additive free meals. Because phosphorus additives are highly bioavailable, patients eating these commonly purchased foods may have difficulty maintaining serum phosphorus within the normal range. These findings suggest emphasis on label reading to avoid phosphorus additives is an appropriate strategy to manage serum phosphorus in persons with kidney disease in the absence of phosphorus content on labels.

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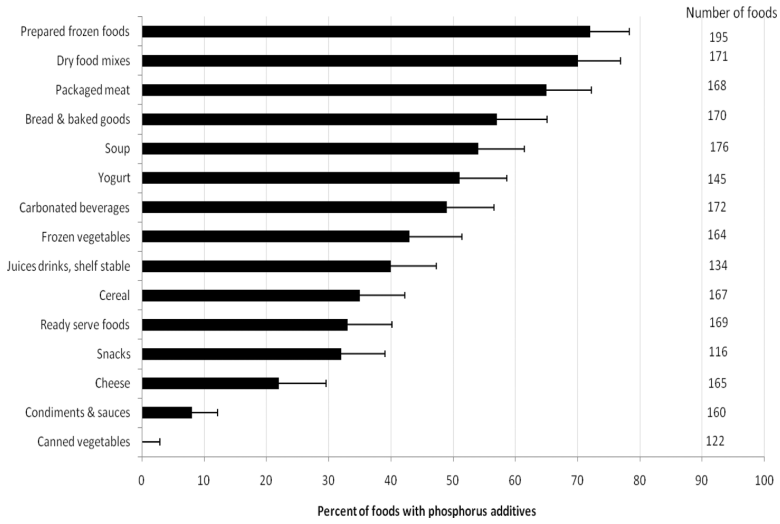

Figure 1.
Prevalence of phosphorus containing food additives by food category (n=2394 total foods).

Table 1

Day 1 menu used to estimate phosphorus content and cost of meals with and without phosphorus additives

Menu with Phosphorus Additives	Menu without Phosphorus Additives
Breakfast	**Breakfast**
Cheerios, 1.5 cups	Nature's Path Organic Whole O's, 1.5 cups
1% milk, 6 oz	1% milk, 6 oz
Schwebels Italiano bread, 1 slice	Nickles Italian bread, 1 slice
Margarine, 1 teaspoon	Margarine, 1 teaspoon
Sunny Delight, 8 oz	Tampico citrus punch, 8 oz
Lunch	**Lunch**
Grilled cheese sandwich	Grilled cheese sandwich
Home Pride butter top wheat bread, 2 slices	Nickles split top wheat bread, 2 slices
Kraft Singles American cheese, 2 slices	Horizon Organic American cheese, 2 slices
Margarine, 1 teaspoon	Margarine, 1 teaspoon
Lay's cheddar and sour cream potato chips, 1 oz	Ruffles cheddar and sour cream potato chips, 1 oz
Celery sticks, 1 cup raw	Celery sticks, 1 cup raw
Apple, 1 raw	Apple, 1 raw
Ocean Spray cranberry juice cocktail, 12 oz	Ocean Spray cranberry juice cocktail, 12 oz
Dinner	**Dinner**
Hillshire Farms polska kielbasa ring, 6 oz	Johnsonville original brats links, 6 oz
Ore Ida golden crinkles fries, 6 oz	Cascadian Farms golden crinkle cut fries, 6 oz
Green beans, .5 cup cooked	Green beans, .5 cup cooked
Yoplait strawberry yogurt, 6 oz	Breyer strawberry yogurt, 6 oz
Coca-cola, 12 oz	A&W root beer, 12 oz

Table 2

Phosphorus content of foods with and without phosphorus additives. Results are shown as means and standard errors.

		Phosphorus mg/100 gm		
Category	**Number of Matched Pairs**	**Additives**	**No Additives**	**Difference**
Prepared frozen foods	2	86 (4)	72 (0)	14 (3)
Dry food mixes	3	184 (29)	121 (3)	63 (31)
Packaged meat	5	308 (73)	190 (47)	118 (32)
Bread & baked goods	4	121 (18)	103 (10)	18 (15)
Soup	5	23 (3)	20 (3)	3 (5)
Yogurt	5	126 (23)	77 (2)	49 (25)
Frozen vegetables	4	71 (2)	71 (6)	0 (5)
Juice drinks, shelf stable	5	4 (2)	0 (0)	4 (2)
Cereal	4	313 (62)	176 (47)	137 (63)
Ready serve foods	5	80 (29)	56 (19)	24 (12)
Snacks	5	202 (22)	145 (27)	57 (13)
Cheese	4	753 (87)	407 (8)	347 (79)
Condiments & sauces	5	99 (22)	46 (9)	53 (16)
ALL CATEGORIES	**56**	**178 (27)**	**111 (15)**	**67 (14)**

Table 3

Phosphorus content and cost of meals with and without phosphorus additives. Results are shown as means and standard errors.

		Phosphorus, mg			Cost, $		
Meal	**Number of Meals**	**With additives**	**No additives**	**Difference**	**With additives**	**No additives**	**Difference**
Breakfast	4	540 (36)	343 (30)	197 (16)	1.92 (.33)	2.56 (.52)	−0.64 (.20)
Lunch	4	513 (52)	293 (20)	221 (43)	2.59 (.19)	2.88 (.18)	−0.28 (.03)
Dinner	4	735 (89)	417 (44)	318 (54)	3.25 (.20)	4.32 (.20)	−1.07 (.28)
ENTIRE DAY		**788 (138)**	**1053 (57)**	**736 (91)**	**7.76(.18)**	**9.76 (.46)**	**−2.00 (.42)**

Table 4

Day 2 menu used to estimate phosphorus content and cost of meals with and without phosphorus additives

Menu with Phosphorus Additives	Menu without Phosphorus Additives
Breakfast	**Breakfast**
Sugardale bacon, 4 slices	Oscar Mayer smoked uncured bacon, 4 slices
Egg, 1	Egg, 1
Ore Ida hash browns country style, .5 cup cooked	Alexia hash browns, .5 cup cooked
Home Pride butter top wheat bread, 1 slice	Nickles split top wheat bread, 1 slice
Margarine, 1 teaspoon	Margarine, 1 teaspoon
Sunny Delight, 8 fl oz	Tampico citrus punch, 8 fl oz
Lunch	**Lunch**
Ball Park bun size franks, 1	Coleman natural uncured beef hot dog, 1
Kraft macaroni and cheese original, 1 cup	Kraft organic macaroni and cheese dinner, 1 cup
Home Pride butter top wheat bread, 1 slice	Nickles split top wheat bread, 1 slice
Baby carrots, 1 cup raw	Baby carrots, 1 cup raw
Pear, .5 cup canned	Pear, .5 cup canned
Gatorade orange, 20 fl oz	Propel citrus punch, 20 fl oz
Dinner	**Dinner**
Chicken Alfredo	Chicken Alfredo
Swanson premium chunk chicken breast, 4 oz	Valley Fresh chunk chicken, 4 oz
Ragu classic alfredo, .5 cup	Classico alfredo, .5 cup
Pasta, 1 cup	Pasta, 1 cup
Schewbels Italiano bread, 1 slice	Nickels Italian bread, 1 slice
Birdseye steamfresh broccoli cuts, 1 cup	Birdseye steamfresh broccoli cuts, 1 cup
Margarine, 1 teaspoon	Margarine, 1 teaspoon
Pepsi, 12 fl oz	A&W Rootbeer, 12 fl oz

Table 5

Day 3 menu used to estimate phosphorus content and cost of meals with and without phosphorus additives

Menu with Phosphorus Additives	Menu without Phosphorus Additives
Breakfast	**Breakfast**
Sugardale bacon, 4 slices	Oscar Mayer smoked uncured bacon, 4 slices
Cocoa Puffs cereal, 1.25 cups	Cocoa Pebbles cereal, 1.25 cups
1% milk, 6 fl oz	1% milk, 6 fl oz
Home Pride butter top wheat bread, 1 slice	Nickles split top wheat bread, 1 slice
Margarine, 1 teaspoon	Margarine, 1 teaspoon
Sunny Delight, 8 fl oz	Tampico citrus punch, 8 fl oz
Lunch	**Lunch**
Chef Boyardee spaghetti and meatballs, 2 cups	Chef Boyardee shells and meatballs, 2 cups
Schwebels Italiano bread, 1 slice	Nickles Italian bread, 1 slice
Margarine, 1 teaspoon	Margarine, 1 teaspoon
Canned peaches, .5 cup	Canned peaches, .5 cup
Pepsi, 12 fl oz	A&W Rootbeer, 12 fl oz
Dinner	**Dinner**
Mrs. T's potato and cheese pierogie, 113g	Contes potato, cheese and onion pierogie, 113 g
Schwebels Italiano bread, 1 slice	Nickels Italian bread, 1 slice
Birdseye Steamfresh mixed vegetables, .5 cup	Birdseye Steamfresh mixed vegetables, .5 cup
Margarine, 1 teaspoon	Margarine, 1 teaspoon
Yoplait strawberry yogurt, 6 ounces	Breyer strawberry yogurt, 6 ounces
Gatorade orange, 20 fl oz	Propel citrus punch, 20 fl oz

Table 6

Day 4 menu used to estimate phosphorus content and cost of meals with and without phosphorus additives

Menu with Phosphorus Additives	Menu without Phosphorus Additives
Breakfast	**Breakfast**
Sugardale bacon, 4 slices	Oscar Mayer smoked uncured bacon, 4 slices
Cinnamon Toast Crunch cereal, 1.5 cups	Cinnamon Chex cereal, 1.5 cups
1% milk, 6 fl oz	1% milk, 6 fl oz
Home Pride butter top wheat bread, 1 slice	Nickles split top wheat bread, 1 slice
Margarine, 1 teaspoon	Margarine, 1 teaspoon
Sunny Delight, 8 fl oz	Tampico citrus punch, 8 fl oz
Lunch	**Lunch**
Campbells tomato soup, 1 cup prepared	Valuetine tomato soup, 1 cup prepared
Velveeta shells and cheese, 1 cup	Kraft organic white cheddar organic shells, 1 cup
Baby carrots, 1 cup	Baby carrots, 1 cup
Coca-Cola, 12 fl oz	A&W Rootbeer, 12 fl oz
Dinner	**Dinner**
Broccoli, rice, cheese and chicken casserole	Broccoli, rice, cheese and chicken casserole
Swanson premium chunk chicken breast, 3.3 oz	Valley Fresh premium chunk chicken breast, 3.3 oz
Campbells cream of mushroom, 1.8 oz	Campbells cream of mushroom, 1.8 oz
Campbells cream of chicken soup, 1.8 oz	Health Valley Organic cream of chicken soup, 1.8 oz
Birdseye Steamfresh broccoli cuts, 2 oz.	Birdseye Steamfresh broccoli cuts, 2 oz.
Instant rice, .33 cup	Instant rice, .33 cup
Velveeta loaf, 2.7 ounces	Horizan Organic American single, 4 slices
Onion, .2 small	Onion, .2 small
Butter, 8 teaspoons	Butter, 8 teaspoons
1% milk, 8 teaspoons	1% milk, 8 teaspoons
Apple, 2 inch diameter	Apple, 2 inch diameter
Gatorade orange, 20 oz	Propel citrus punch, 20 oz