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2022-01

Tuominen , M , Karp , H J & Itkonen , S T 2022 , ' Phosphorus-Containing Food Additives in the Food Supply-An Audit of Products on Supermarket Shelves ' , Journal of Renal Nutrition , vol. 32 , no. 1 , pp. 30-38 . https://doi.org/10.1053/j.jrn.2021.07.010

http://hdl.handle.net/10138/341929
https://doi.org/10.1053/j.jrn.2021.07.010

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Phosphorus-Containing Food Additives in the Food Supply—An Audit of Products on Supermarket Shelves

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Minttu Tuominen, MSc, Heini J. Karp, PhD, RD,† and Suvi T. Itkonen, PhD**

Objectives: Phosphorus (P)-containing food additives pose a risk for chronic kidney disease (CKD) patients. We aimed to investigate the prevalence of P-containing additives in the Finnish food supply across different food categories to evaluate their burden in CKD, reflecting the situation in Europe.

Methods: The dataset of 6,176 products was obtained in June-August 2019 from the *foodie.fi* website, which contains all foodstuffs sold in the grocery stores of the S Group (46% of the Finnish market share in 2019). The food category, full product name, type of P additive (inorganic, organic, and natural P-containing), and reporting methods (name or E number) of P additives were recorded. Duplicates and products lacking ingredient information were excluded.

Results: The prevalence of P additives was 36% in the final sample (n = 5,149). Among food categories, the prevalence varied from 4% in *dairy-based snacks* to 67% in *meat products*. Altogether 17 different P additives were observed. Inorganic P additives were the most common P additive type, present in 20% of foodstuffs. Natural P-containing additives were observed in 19% and organic P additives in 2% of foodstuffs. The most commonly used P additives were lecithin (E 322), pyrophosphate (E 450), and triphosphate (E 451). E number was used as a reporting method in 49% of foodstuffs, and full name in 44% of foodstuffs. Reporting by E number was particularly common in the products containing inorganic P.

Conclusions: The use of P additives is common in the Finnish food supply, indicating the situation in Europe. The high prevalence of inorganic, that is, the most absorbable and potentially most harmful P additives in particular food groups, and their usual reporting only by E numbers can create challenges in CKD dietary counseling.

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Introduction

THE PREVALENCE OF chronic kidney disease (CKD) is growing worldwide.[1] A phosphorus (P)-restricted diet is a key factor in the management of hyperphosphatemia and in slowing the progression of the disease.[2] Growing evidence suggests that high intake of dietary P could also be harmful for bone and cardiovascular health in the general population.[3,4] Among the general population in Western countries, P intake is substantially higher than recommendations.[5–7] The true intake of P might be even higher as P additives are rarely taken into account in the food composition databases.[8] P additives are widely used for different technological purposes in, for example, meat products, processed cheeses, or cola drinks.[9] Furthermore, the amount of P additives can differ between similar products.[8,10,11] However, there are no eligible analytical methods to assess P additive contents in foodstuffs.[12] For that reason, the true amount of P in many products containing P additives remains unclear, but it has been estimated that P additives contribute significantly to the total intake of dietary P.[13]

An increase in the consumption of ready-made meals and convenience foods in combination with a wide utilization of P additives is supposed to play a role in the increased P intake.[13] In Finland, the prevalence of P additives in foodstuffs on the market was previously investigated 20 years ago, and at that time, inorganic P additives were present in 10% of the examined products.[14] Since then, both the food consumption habits and the legislative use of P additives have changed.[15,16] The latest studies in the United States (US) and Australia providing data from 2010 to 2013, respectively, showed that almost half of the foodstuffs reviewed contained P additives.[17,18]

Reporting P contents of foodstuffs on package labeling is not mandatory.[19,20] Even if it was obligatory, studies have shown that food composition databases underestimate the

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Support: This work was supported by The Finnish Food Research Foundation.

Conflicts of interest: The authors declare that there are no conflicts of interest.

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1051-2276

https://doi.org/10.1053/j.jrn.2021.07.010

true P content in many foodstuffs by as much as 30%.[13] In addition, there are differences in the absorption of P from different food sources; inorganic P additives can be especially harmful due to their high bioavailability.[21–23] According to European Union (EU) legislation, the P additives can be reported either by E numbers or names on package labels.[19] Moreover, of the modified starches (MS), 5 of 11 contain P compounds and they can be reported either by full name or by the group name *modified starches*.[16,19] This causes a challenge in the management of CKD because patients cannot recognize the P burden of the product without knowing the name or E number of P-containing additives. Thus, there is a need for simple solutions for patient education and nutritional counseling such as information on the product categories widely containing P additives that should be avoided.

Here, we aimed to investigate the prevalence of P additives in the Finnish food supply, reflecting the current situation in Europe. The use of inorganic, organic, and natural P-containing additives in different food categories and the labeling methods for P additives were examined. In addition, the prevalence of MS in foodstuffs was investigated.

Materials and Methods

Data Source

The data were obtained during June and August 2019 from *foodie.fi* website, which is maintained by the S Group. The website provides information on the selection of goods currently sold in the S Group grocery stores (market share in 2019 of 46.2%).[24] For this study, the selection of hypermarket Prisma Kaari in the district of Kannelmäki in Helsinki was used. *Foodie.fi* contains extensive product information classified into different food categories, including complete product name, packaging size, list of ingredients, manufacturer, and country of origin.

Food categories chosen for the study were based on a preliminary review on the website, and the categories with a low or minimal presence of P additives were excluded. In addition, categories where P additives are not permitted, such as fresh meat products and fresh fruits and vegetables, were excluded, together with some other minimally processed food categories. Moreover, fruit-flavored carbonated soft drinks were excluded because they do not contain P additives. The product information obtained from the website included the following: category of the product, full product name, size of the package, and information on P additives.

Collection and Analysis of Phosphorus-Containing Food Additive Data

Information on the food products were recorded in predefined *foodie.fi* food categories on Microsoft Excel spreadsheets. Here, we use the term "phosphorus additives" for all additives that contain P in some form, not only for those whose names contain the word *phosphorus* or *phosphate*. In the current study, the P additives of interest were the ones permitted in the EU (Supplemental Table 1).[16] MS was examined separately as they can be presented by the group name "MS" without giving information about possible P additives.[19] Furthermore, food packagings show no information about whether the colorant riboflavin (E 101) is riboflavin-5′-phosphate sodium form; thus, it was not included as an additive of interest. The presence or absence of each P additive of interest in each product was recorded. If the product contained no P additives, the information was recorded as "no P additives." The products lacking the necessary information were recorded as "no information."

The recording of P additive reporting methods on package labeling was adapted from the paper of McCutcheon et al.[18] The products were classified into 4 categories of reporting methods: "reported with E numbers," when additives were listed exclusively with E numbers; "reported with words," when additives were listed with written names; "reported with a combination of E numbers and words," when the same additive was listed with an E number and written name; and "part of the additives reported with E numbers and part with words," in case the product contained more than one P additive and the additives were reported with different methods. In addition, lecithin was examined separately, as it is reported differently than the other P additives because it usually contains allergens (namely soy).[19]

After all relevant food categories were recorded, the data were checked for duplicates, as some of the *foodie.fi* categories overlapped. Then, existing *foodie.fi* categories were reclassified and combined according to the purpose of use, altogether into 16 new categories (Table 1). At this point, the products were also classified into 3 different types of P additives (inorganic, organic, and natural P-containing food additives) based on the chemical nature and origin of the food additive (Supplemental Table 1). Frozen meats, matured cheeses, and unflavored noodles were excluded due to a minimal number of P additives. A matching category for plant-based protein sources was not found, and for that reason they were excluded (n = 73). Weight loss products, protein powders, and other protein products that are considered dietary supplements were also excluded.

Data were analyzed using Microsoft Excel 2016. The numbers and percentages of P additive-containing products in the total data and separately in each food category were calculated. Medians and maximum numbers of P additives in the products containing P additives in each category were also analyzed. The prevalence of each P additive type was presented for the total data (n = 5,149); however, the analysis of P additive types among food categories was based on the products containing P additives (n = 1,868), and thus, P additive-free products were excluded at this point. Statistical tests between the food categories or

Table 1. Descriptions of Food Categories Included in the Analysis

Category	Description
Processed and cream cheeses	Processed cheeses and cream cheeses
Fish products	Canned and pickled fish, frozen fish products, fish-roe pastes, and fish products in cold storage, including fish fingers and fish patties
Meat products	Cold cuts and cooked meats, barbeque sausages, salami-type meats, bacon and ham products, and liver products such as liver pâtés and sausages
Ice creams	Ice cream packages, blocks, bars, and wafers. Sorbets and ice pops
Plant-based alternatives for dairy products	Plant-based drinks, yoghurts, and cheeses
Coffee and chocolate drinks	Coffee capsules, instant coffees, and cocoa powders
Cola and energy drinks	Cola-flavored soft drinks and energy drinks
Fat spreads	Vegetable-oil spreads, butter-vegetable-oil spreads, and margarines
Snacks	Potato chips, popcorns, flavored and salted nuts, chocolate, licorice, and fruit-flavored sweets
Dairy-based snacks	Yoghurts and other fermented dairy products, quark products, and berry soups
Confectionery and other cereal products	Cookies and savory biscuits, cereals, frozen and room temperature pastries, coffee breads, and flour mixes
Desserts	Puddings, custards, chocolate and caramel toppings, and nut and chocolate spreads
Sauces and condiments	Condiments, stock products such as cubes and concentrates, salad dressings, barbeque sauces, mayonnaises, and low-fat creams for cooking
Ready meals and convenience foods (room temperature)	Prepared foods and instant meals including canned sauces and meals, dry meal mixes, flavored instant noodles, texmex products, pickled cucumbers, and beetroots
Ready meals and convenience foods (cold storage)	Ready-made meals and foods including salads, casseroles, stews, pizzas, soups, pastas, pies, porridges, and sandwiches. Convenience foods including nuggets and balls, fresh pastas (e.g., tortellini and ravioli), and potato dishes
Frozen meals and convenience foods	Frozen ready-made meals including oriental meals, nuggets and balls, pan-fried vegetable and meat meals, pizzas, and potato products

additive types were not conducted due to the characteristics of the data.

Results

Prevalence of Phosphorus-Containing Additives

Altogether 6,176 food products on the *foodie.fi* website were reviewed in order to examine the presence of P additives. After the selected categories were reviewed, 1,027 products (17%) were excluded according to the criteria presented in Figure 1, and 5,149 products (83%) were included in the further analysis. Among the foodstuffs reviewed, 17 different P additives of the 27 ones allowed in the EU,[16] including E 101, were observed (Supplemental Table 2). Of the 5,149 foodstuffs included in the analysis, 36% contained one or more P additives (Fig. 2). The prevalence of P additives varied between the categories from 4% in *dairy-based snacks* to 67% in *meat products*. P additives were particularly common also in the following categories: *ice creams* (62%), *confectionery and other cereal products* (62%), *fat spreads* (57%), *snacks* (46%), *cola and energy drinks* (44%), and *processed and cream cheeses* (40%). The median of P additives among the products containing P additives in all categories was 1, except in *processed and cream cheeses*, where the median was 2, and in *ready-made meals and convenience foods (cold storage)*, where the median was 1.5 (Table 2). The maximum number of P additives in the categories varied between 1 and 6, but only 16 products (0.3%) in the total data contained more than 3 P additives, corresponding to

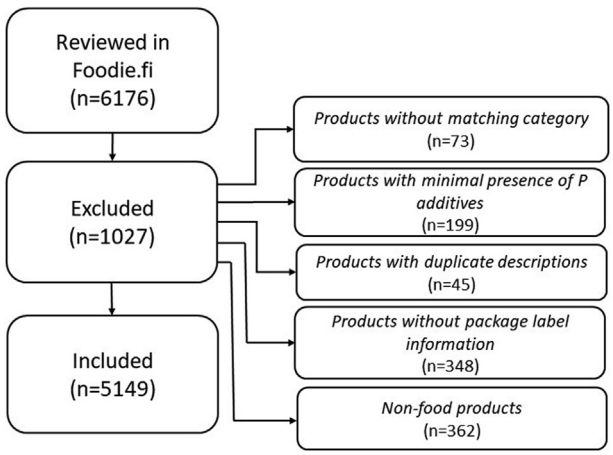

Figure 1. Flow chart of reviewed products.

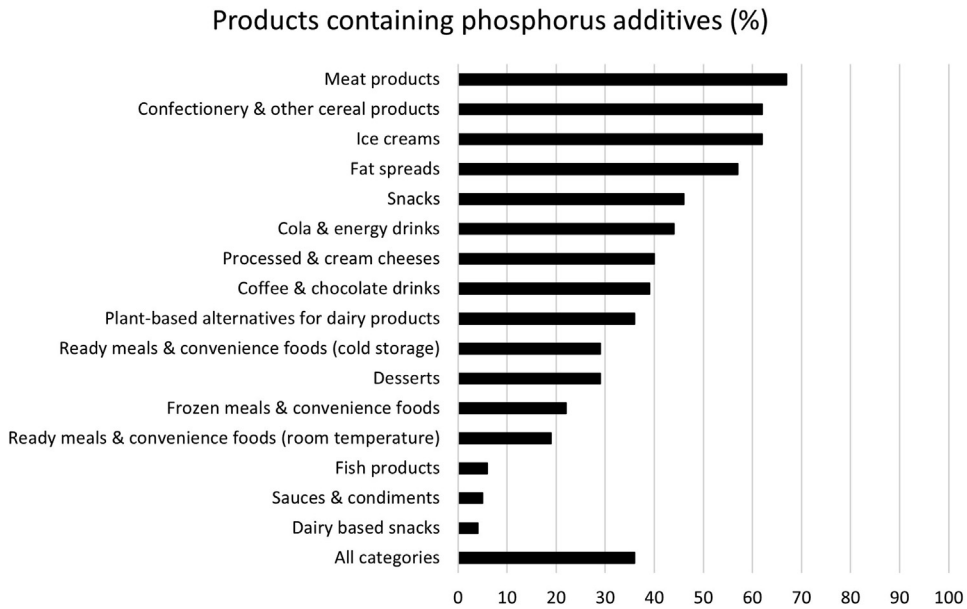

Figure 2. Prevalence (%) of all phosphorus-containing additives in the reviewed foodstuffs by food category (n = 5,149).

a prevalence of 0.8% among the products that contained P additives.

The most used P additives were lecithin (E 322), pyrophosphate (E 450), and triphosphate (E 451) present in 18%, 14%, and 6% of all reviewed products, respectively. MS was used in 23% of the products (Fig. 3), and the use was particularly common in *desserts* (present in 50% of the products in the category), *dairy-based snacks* (43%), and *sauces and condiments* (41%). E 101 was present in 37 foodstuffs in 9 categories; however, the presence of P could not be confirmed as it is not indicated on food packagings. The exact numbers of each P additive, additive-free products, and MS in food categories are shown in Supplemental Table 2.

Prevalence of Inorganic, Organic, and Natural Phosphorus-Containing Additives

Among all foodstuffs, including products without P additives, the prevalence of inorganic, organic, and natural P-containing additives were 20%, 2%, and 19%, respectively. The P additive types in the food categories were examined in the subgroups of products that contained P additives (Table 3).

Inorganic P additives were the most common type of additives, being present in all food categories, and in 7 food categories inorganic P additives were present in more than 80% of the products (Table 3). All categories contained products with inorganic P additives, but in the categories of *processed and cream cheese*, *processed meats,* and *cola and energy drinks*, all products contained them, whereas the prevalence in *snacks*, *ice creams*, and *fat spreads* was very low, 4-5%. Of the inorganic P additives, E 343 and E 541 were not observed in the data.

Natural P-containing additives were observed in 14 food categories (Table 3). They were particularly common in the categories of *ice creams*, *fat spreads*, *desserts*, and *snacks*, as natural P-containing additives were used in more than 95% of the products. This was mainly due to lecithin, which was present in 912 products. *Processed and cream cheeses* and *cola and energy drinks* did not contain any natural P-containing additives, and only 1 product in the category of *meat products* contained them. Of the flavor enhancers, E 635, E 631, and E 627 were the most commonly used, whereas E 629 was observed only in 1 product, and E 626, E 628, E 630, and E 632-634 were not observed at all.

The prevalence of organic P additives was very low among most of the food categories, except in *dairy-based snacks* (44%) and *sauces and condiments* (25%). Seven categories contained organic P additives less than in 10% of the products and 7 did not contain at all. Of organic P additives, E 1410 and E 1413 were not observed.

Reporting Methods

In 49% of the products, P additives were reported using E numbers, whereas full names of P additives were used in 44% (Table 2). In 3%, P additives were reported by a combination of name and E number, and in 5% the reporting methods among different P additives varied. E number was the most common reporting method in *processed and cream cheeses* (100%) and in *meat products* (98%), while reporting by full name was the most common in *plant-based alternatives for dairy products* (93%). Of all the categories, the combination of E number and full name was the most common in *cola and energy drinks*, where it was used in 35% of the products. A separate examination of lecithin showed that it was reported by full name in 82% and by E

Table 2. Descriptive Statistics of the Prevalence of Phosphorus Additives in Foodstuffs and Their Reporting Methods in Each Food Category

	Descriptive Statistics				Reporting Methods*			
Category	Total Number of Items	Number of Items With P Additives (%)	Maximum P Additives per Item	Median of P Additives per Item†	E Number Reported (%)	Name Reported (%)	Both E Number and Name Reported (%)	Reported as Combination‡ (%)
Processed and cream cheeses	87	35 (40)	4	2	100	0	0	0
Fish products	220	13 (6)	2	1	62	38	0	0
Meat products	472	317 (67)	4	1	98	2	0	0
Ice creams	330	204 (62)	2	1	24	67	7	2
Plant-based alternatives for dairy products	168	60 (36)	3	1	7	93	0	0
Coffee and chocolate drinks	94	37 (39)	2	1	35	54	0	11
Cola and energy drinks	90	40 (44)	1	1	58	8	35	0
Fat spreads	93	53 (57)	1	1	17	83	0	0
Snacks	613	279 (46)	3	1	14	85	1	0
Dairy-based snacks	402	16 (4)	1	1	56	44	0	0
Confectionery and other cereal products	691	425 (62)	3	1	28	55	3	14
Desserts	84	24 (29)	2	1	17	75	4	4
Sauces and condiments	391	20 (5)	1	1	60	25	15	0
Ready meals and convenience foods (room temperature)	507	98 (19)	6	1	78	14	0	8
Ready meals and convenience foods (cold storage)	646	189 (29)	5	1.5	87	8	1	4
Frozen meals and convenience foods	261	58 (22)	5	1	76	24	0	0
Total	5,149	1,868 (36)			49	44	3	5

P, phosphorus.

*Lecithins are not included in reporting methods.

†Of products with phosphorus additives. Interquartile ranges could not be calculated due to low variation of phosphorus additives in foodstuff.

‡Different E numbers reported as combination.

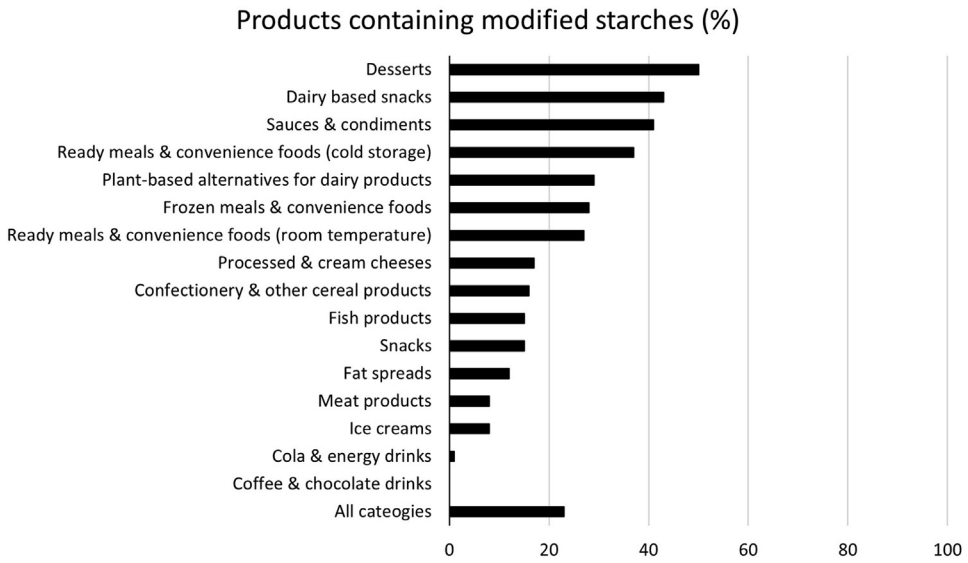

Figure 3. Prevalence (%) of modified starch in the reviewed foodstuffs by food category (n = 5,149).

number in 13% of the products. The remaining 5% of lecithin was reported as a combination of full name and E number.

Discussion

This study provided information on the prevalence of P additive use in the Finnish food supply for the first time in the 21st century. More than one-third of the reviewed 5,149 processed foodstuffs in the leading grocery store selection contained P additives, indicating the situation in Europe. All food categories contained products with P additives, but the prevalence varied highly, from 4% in *dairy-based snacks* to 67% in *meat products*. Inorganic P was the most common P additive type. It was typically used in the categories of *meat products*, *processed and cream cheeses*, and *cola and energy drinks*. These findings will, without a doubt, have important implications in the nutritional counseling of CKD patients to better adhere to a P-restricted diet.

In each food category, there were foodstuffs containing inorganic P additives, which are supposed to be the most absorbable and most harmful form of P.[21-23] In addition to the above-mentioned categories, they were widely used in all 3 categories of *ready-made meals and convenience foods*, whereas in *ice creams*, *fat spreads*, and *snacks* the use of inorganic P was rare. The high prevalence of inorganic

Table 3. Prevalence of P Additives by P Additive Type in Food Categories

Category	n*	Products With Inorganic P Additives, n (%)	Products With Organic P Additives, n (%)	Products With Natural P-Containing Additives, n (%)
Processed and cream cheeses	35	35 (100)	0 (0)	0 (0)
Fish products	13	9 (69)	1 (8)	4 (31)
Meat products	317	317 (100)	27 (9)	1 (0)
Ice creams	204	11 (5)	1 (0)	199 (98)
Plant-based alternatives for dairy products	60	53 (88)	2 (3)	12 (20)
Coffee and chocolate drinks	37	14 (38)	0 (0)	27 (73)
Cola and energy drinks	40	40 (100)	0 (0)	0 (0)
Fat spreads	53	2 (4)	0 (0)	51 (96)
Snacks	279	15 (5)	1 (0)	265 (95)
Dairy-based snacks	16	4 (25)	7 (44)	5 (31)
Confectionery and other cereal products	425	217 (51)	31 (7)	303 (71)
Desserts	24	2 (8)	0 (0)	23 (96)
Sauces and condiments	20	2 (10)	5 (25)	13 (65)
Ready meals and convenience foods (room temperature)	98	79 (81)	4 (4)	52 (53)
Ready meals and convenience foods (cold storage)	189	167 (88)	12 (6)	39 (21)
Frozen meals and convenience foods	58	57 (98)	3 (5)	3 (5)
Total	1,868	1,024 (55)	94 (5)	997 (53)

P, phosphorus.
*Products without P additives are not included.

P additives, especially pyrophosphate and triphosphate, in *meat products* is due to their functions as stabilizing agents and decreasing the demand for sodium chloride.[9] They were typically used alone or as a combination widely in different processed meats such as cold cuts and barbeque sausages. The *processed and cream cheeses* category contained only inorganic P additives, which are used as emulsifying salts in processed cheeses.[9] Phosphoric acid was the prevailing P additive in the category of *cola and energy drinks*, where it is used to provide the characteristic acidic flavor of cola drinks.[9]

The use of natural P-containing additives was also common but in different categories than the inorganic additives: in *ice creams*, *fat spreads*, and *desserts*, where lecithin is typically used as an emulsifier.[9] Lecithin was used in almost one-fifth of all foodstuffs, being also commonly observed in products containing chocolate. In contrast, the use of organic P additive types was not typical; however, this may not describe the true use of organic P as they can be reported in the ingredient list under their group name.[19] MS was used in almost one-fourth of foodstuffs, being more widespread than any of the P additive types. Of the 12 MS with E numbers, 5 contain P.[25] Hence, it is likely that a relatively high number of products with MS contain P. MS was typically used in the categories that mainly did not contain any P additives, except for *desserts*, where MS was present in almost half of the products and P additives in almost one-third of them. *Dairy-based snacks* and *sauces and condiments* had the lowest prevalence of P additives, but they had the second and third highest prevalence of MS, which is used for the smooth texture.[25] Information on the use of different P additive types stratified by food categories is important because of their assumed different bioavailability, especially almost complete absorption of inorganic P additives.[26] Studies that model in vitro digestible P contents in foodstuffs have reported significant differences in the relative amounts of absorbable P between products containing inorganic P additives and natural P.[22,23] However, it is questionable how efficiently P from MS is absorbed in the human body and whether the amount of P in them is sufficient to cause a hidden threat for kidney patients.[25]

High or elevated-normal serum phosphate (S-Pi) concentrations have been associated with adverse cardiovascular outcomes and mortality not only among CKD patients but also among the general population.[27-29] National Health and Nutrition Examination Survey 2003-2006 showed that even after adjustment for kidney function and body mass index, consumption of dairy products and cereals containing inorganic P additives was associated with a significantly higher S-Pi, despite being consumed less frequently than foods without P additives.[30] Interestingly, no such association was observed regarding meat products that contained inorganic P additives. From that point of view, Moore et al.[30] results are unexpected because in the present study as well as in the previous US market survey meat products were among the categories with the highest prevalence of P additives.[17] However, in our study *processed and cream cheeses* had the highest median of P additives; nearly all processed cheeses contained 2 additives, which may also reflect to their association with S-Pi in the above-mentioned study. Nevertheless, a single measurement of S-Pi may not be the best indicator due to its diurnal variation, which stresses the importance of further investigation on this topic.[31]

The prevalence of P additives among all products in our study was slightly lower than in earlier studies carried out in the US and Australia (44% in both countries).[17,18] The median (1) of P additives in the products in our study was also lower than in the US and Australia. It is notable that the 3 most common P additives here were the same as in Australia. The results among food categories were partly in line with those of previous studies: confectionary and bakery items widely contained P additives in all 3 countries, and meat products played an important role in the US and in Finland; however, in Australia the meat products were not separated as one food category. P additives in prepared (frozen) meals and foods were less common in Finland than in the US and Australia, where these food items were among the most important sources of P additives. In Finland, interestingly, P additives were widely used in ice creams; however, in Australia and the US ice creams were not included in any of the examined food categories. Nevertheless, the data in these studies were obtained on a different basis and the food groups are not fully comparable.

The variation in the use of P additives among the reviewed products was large in the categories of *ready meals and convenience foods*, as they contained a relatively wide scale of products, such as ready-made salads, sandwiches, and pizzas. The total number of P additives in these products seemed to be determined by the presence of P additive-containing meat or processed cheese as an ingredient. If all ingredients of the ready-made meal (source of protein, carbohydrate, sauce, seasoning) contain P additives, the number of different P additives in the product can be high. The use of various P additives in one product can indicate a high P additive burden, with the quantity of P additives nevertheless remaining unknown.

In our study, the methods of reporting P additives with E number or with full name were almost as common, both covering more than 40% of the reporting methods, whereas in Australia reporting with E numbers was the most popular.[18] E number was particularly common in the products containing inorganic P, such as *processed and cream cheeses*, *meat products*, and all 3 categories of ready-made meals and convenience foods, which complicates the recognition of these highly bioavailable, and thus, potentially detrimental P additives. Reporting by full name was most common in *plant-based alternatives for dairy products* due to the reporting style of inorganic P used as antioxidant in

plant-based drinks. A separate examination of lecithin showed that it was mainly reported by a combination of E number and full name, which probably is due to the legislative requirement to report common allergens.[19]

This study has some limitations. The foodstuffs were not chosen according to the best-selling brands, and thus are not fully representative of consumer choices. As data consisted of the selection of one specific hypermarket, it does not represent all the stores in Finland. However, this is a low-cost method using a publicly available database containing numerous foodstuffs and food categories from a store selection of the company covering almost half of the market share in Finland.[24] The data comprised a variety of not only domestic but also foreign food brands, indicating the international importance of the study. In addition, to our knowledge, for the first time, the use of P-containing additives was reviewed in an European country.

To conclude, the use of P additives in foodstuffs is widespread in Finland, indicating the situation in Europe. Inorganic P additives were the most commonly used P additive type, and the use of MS was even more common. As inorganic P additives are especially harmful to kidney patients due to their high bioavailability, and the presence of P in MS cannot be verified based on ingredient lists, the estimation of the P burden from the diet is challenging. Most of the P additives here were reported by E numbers, thus, without knowing the E number it would be impossible to recognize the additive. This complicates the adherence to P-restricted diets and the control of hyperphosphatemia. It is important to distinguish between the categories where inorganic P additives are rarely used and the categories where they are common; here, inorganic P additives were typically found in meat products, processed cheeses, and cola drinks. More visible information on P additives and labeling of exact, analyzed P (additive) amounts on food packaging are urgently needed to enable CKD management worldwide.

Practical Application

More than one-third of the foodstuffs in the leading grocery store selection in Finland contained P additives, indicating the situation in Europe. Inorganic, that is, the most absorbable and potentially most harmful P additives were typically found in meat products, processed cheeses, and cola drinks. Most of the inorganic P additives were reported by E numbers, which emphasize the awareness of phosphate additives in dietary counseling of CKD patients.

CRediT Authorship Contribution Statement

Minttu Tuominen: Methodology, generation, collection, assembly, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, approval of the final version of the manuscript. **Heini J. Karp:** Methodology, Data curation, Writing – review & editing, approval of the final version of the manuscript. **Suvi T. Itkonen:** Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing, approval of the final version of the manuscript.

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1053/j.jrn.2021.07.010.

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