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Vitamin C is the best substitute for phosphoric acid in cola drinks

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Abstract
Vitamin C, also known as ascorbic acid or L-ascorbic acid, is an "*essential*" nutrient. This means that humans are unable to synthesize it internally so it must be supplied from outside (food or dietary supplement). Harrison's Principles of Internal Medicine, believed to be the world leading book on internal medicine, and Linus Pauling Institute, believed to be the world leading scientific research entity on vitamin C have eloquently explained the favorable roles of vitamin C in health.
From the U.S. regulations point of view, vitamin C is considered a generally recognized as safe (GRAS) substance. The RDA for vitamin C is 90 mg/day for an adult male and 75 mg/day for an adult female. Tolerable Upper Intake Level for vitamin C is 2,000 mg/day for adults (male and female).
By definition, the premium application of vitamin C is when this health-promoting essential nutrient replaces an ingredient with known health risks. The case of cola drinks is the best example.
Considering the following health benefits of vitamin C:
- *A potent antioxidant (inhibits oxidation, counteracts damaging effects of reactive oxygen species);*
- *Supporting synthesis of collagen/connective tissue (healthy gum, skin and bone, wound healing);*
- *Supporting synthesis of certain neurotransmitters (conversion of dopamine to norepinephrine);*
- *Supporting synthesis of peptide hormones;*
- *Limiting in-vivo formation of carcinogen nitrosamines;*
- *Helping reduce risk of unhealthy cardiovascular system;*
- *Helping boost immune system;*
- *Helping improve absorption of nonheme iron;*
- *Helping reduce risk of Parkinson disease*

And considering the following health risks of phosphoric acid in cola drinks:
- *Risk to bone health;*
- *Risk to kidney health;*
- *Risk to teeth health*

it is logical to conclude that the premium application of vitamin C is when it replaces phosphoric acid in cola drinks (US patent application 2020/0077678).

Keywords: vitamin c, ascorbic acid, phosphoric acid, cola, cola drink

Introduction
Vitamin C, also known as ascorbic acid or L-ascorbic acid, is an "*essential*" nutrient. This means that humans are unable to synthesize it internally so it must be supplied from outside (food or supplement).

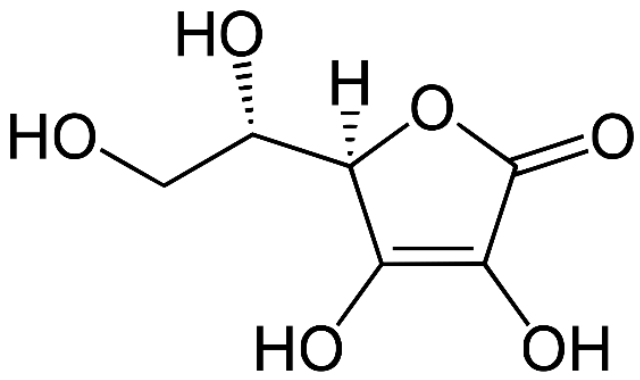

Fig 1: Vitamin C Chemical Formula ($C_6H_8O_6$)

The most extensive source of information about vitamin C is the National Institutes of Health - Office of Dietary Supplements [1]. General sources such as Wikipedia [2] and Healthline [3] also present considerable information.

- **Discovery of Vitamin C**

Vitamin C was discovered in 1912, isolated in 1928 and synthesized in 1933, making it the first vitamin to be synthesized. Shortly thereafter, Tadeus Reichstein succeeded in synthesizing the vitamin in bulk. This made possible the inexpensive mass-production of vitamin C. In 1934 Hoffman-La Roche trademarked synthetic vitamin C under the brand name Redoxon® and began to market it as a dietary supplement (the brand is now owned by German pharmaceutical company Bayer).

- **Industrial Production of Vitamin C**

Vitamin C is produced from glucose by two main routes: 1) The Reichstein process, developed in the 1930s, which uses a single pre-fermentation followed by a purely chemical

route. 2) The modern two-step fermentation process, originally developed in China in the 1960s, uses additional fermentation to replace part of the later chemical stages. Both processes yield approximately 60% vitamin C from the glucose feed. Neither the Reichstein process, nor the two-stage fermentation process, involves the use of genetically modified organisms (GMOs).

In biological systems, ascorbic acid can be found only at low pH, but in solutions above pH 5 is predominantly found in the ionized form, ascorbate. All of these molecules have vitamin C activity and thus are used synonymously with vitamin C. Therefore, the term *vitamin C* encompasses several vitaminers that have vitamin C activity. Ascorbate salts such as sodium ascorbate, potassium ascorbate, calcium ascorbate, magnesium ascorbate and zinc ascorbate are used in some dietary supplements. These compounds release ascorbate upon digestion. Ascorbate and ascorbic acid are both naturally present in the body since the forms interconvert according to pH. Ascorbyl palmitate is an ester formed from ascorbic acid and palmitic acid creating a fat-soluble form of vitamin C. In addition to its use as a source of vitamin C, it is also used as an antioxidant food additive.

- **Sources of Vitamin C**

Fruits and vegetables are the best sources of vitamin C. Citrus fruits, tomatoes and tomato juice, and potatoes are major contributors of vitamin C to the American diet. Other good food sources include red and green peppers, kiwifruit, broccoli, strawberries, Brussels sprouts, and cantaloupe. The richest source of natural vitamin C is acerola cherry. The vitamin C content of food may be reduced by prolonged storage and by cooking because ascorbic acid is water soluble and is destroyed by heat. Supplements typically contain vitamin C in the form of ascorbic acid, which has equivalent bioavailability to that of naturally occurring ascorbic acid in foods, such as orange juice and broccoli. Vitamin C supplements include sodium ascorbate, potassium ascorbate, calcium ascorbate, and magnesium ascorbate and combination products. Vitamin C is among the most widely taken dietary supplement and is available in a variety of forms, including tablets, drink mix packets, capsules, and as crystalline powder. Tablet and capsule content ranges from 25 mg to 1500 mg per serving. The most commonly used supplement compounds are ascorbic acid, sodium ascorbate and calcium ascorbate.

Regulatory Aspects of Vitamin C

- **GRAS Status**

From U.S. regulations point of view, vitamin C is considered a generally recognized as safe (GRAS) substance. This includes ascorbic acid (21 CFR 182.8013 and 182.3013), sodium L-ascorbate (21 CFR 182.3731), calcium L-ascorbate (21 CFR 182.3189) and ascorbyl palmitate (palmitoyl L-ascorbate (21 CFR 182.3149).

- **Recommended Intakes**

In US, intake recommendations for vitamin C and other nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Food and Nutrition Board (FNB) at the Institute of Medicine (IOM) of the National Academies (formerly National Academy of Sciences). DRI is the general term for a set of reference values used for planning and assessing nutrient intakes of healthy people. These values, which vary by age and gender include:

- Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97%–98%) healthy individuals; often used to plan nutritionally adequate diets for individuals.
- Tolerable Upper Intake Level (UL): Maximum daily intake unlikely to cause adverse health effects.

The RDA for vitamin C is 90 mg/day for an adult male and 75 mg/day for an adult female. The UL for vitamin C is 2,000 mg/day for adults (male and female). This amount is 22 times of RDA for an adult male and 26 times of RDA for an adult female. Interestingly, in 2014, the Canadian Food Inspection Agency evaluated the effect of fortification of foods with ascorbate in the guidance document, *Foods to Which Vitamins, Mineral Nutrients and Amino Acids May or must be added*. Voluntary and mandatory fortification was described for various classes of foods. Among foods classified for mandatory fortification with vitamin C were fruit-flavored drinks, bases, concentrates and mixes that are used for making fruit flavored drinks, foods for a very low-energy diet, meal replacement products, ready breakfast, instant breakfast, and evaporated milk.

Physiological Aspects of Vitamin C

Vitamin C is a cofactor in at least eight enzymatic reactions in humans and important in many essential functions, including wound healing. In humans, vitamin C deficiency compromises collagen synthesis, contributing to the more severe symptoms of scurvy.

- **Absorption and Excretion**

Oral vitamin C produces tissue and plasma concentrations that the body tightly controls. Approximately 70%–90% of vitamin C is absorbed at moderate intakes of 30–180 mg/day. However, at doses above 1 g/day, absorption falls to less than 50% and absorbed, unmetabolized ascorbic acid is excreted in the urine [4]. Results from pharmacokinetic studies indicate that oral doses of 1.25 g/day ascorbic acid produce mean peak plasma vitamin C concentrations of 135 micromol/L, which are about two times higher than those produced by consuming 200–300 mg/day ascorbic acid from vitamin C-rich foods. Pharmacokinetic modeling predicts that even doses as high as 3 g ascorbic acid taken every 4 hours would produce peak plasma concentrations of only 220 micromol/L [5]. *The human body can store only a certain amount of vitamin C, and so the body stores are depleted if fresh supplies are not consumed*. Vitamin C is a water-soluble vitamin, with dietary excesses not absorbed, and excesses in the blood rapidly excreted in the urine, so it exhibits remarkably low acute toxicity. Excretion, can be as ascorbic acid, via urine. In humans, during times of low dietary intake, vitamin C is reabsorbed by the kidneys rather than excreted. Only when plasma concentrations are 1.4 mg/dL or higher does re-absorption decline and the excess amounts pass freely into the urine.

- **Vitamin C Deficiency**

Acute vitamin C deficiency leads to scurvy [6-7]. The timeline for the development of scurvy varies, depending on vitamin C body stores, but signs can appear within 1 month of little or no vitamin C intake (below 10 mg/day). Initial symptoms can include fatigue (probably the result of

impaired carnitine biosynthesis), malaise, and inflammation of the gums. As vitamin C deficiency progresses, collagen synthesis becomes impaired and connective tissues become weakened, causing petechiae, ecchymoses, purpura, joint pain, poor wound healing, hyperkeratosis, and corkscrew hairs. Additional signs of scurvy include depression as well as swollen, bleeding gums and loosening or loss of teeth due to tissue and capillary fragility. Iron deficiency anemia can also occur due to increased bleeding and decreased nonheme iron absorption secondary to low vitamin C intake. In children, bone disease can be present. Left untreated, scurvy is fatal. Today, vitamin C deficiency and scurvy are rare in developed countries but can still occur in people with limited food variety.

- **Groups at Risk of Vitamin C Inadequacy**

The following groups are more likely than others to be at risk of obtaining insufficient amounts of vitamin C: smokers and passive "smokers", individuals with limited food variety, people with malabsorption and certain chronic diseases and infants fed evaporated or boiled milk.

Vitamin C and Health

Vitamin C is required for the biosynthesis of collagen, L-carnitine, and certain neurotransmitters; vitamin C is also involved in protein metabolism. Collagen is an essential component of connective tissue, which plays a vital role in wound healing. Vitamin C is also an important physiological antioxidant. Ongoing research is examining whether vitamin C, by limiting the damaging effects of free radicals through its antioxidant activity, might help prevent or delay the development of certain cancers, cardiovascular disease, and other diseases in which oxidative stress plays a causal role. Due to its function as an antioxidant and its role in immune function, vitamin C has been promoted as a means to help prevent and/or treat numerous health conditions. The following section focuses on four diseases and disorders in which vitamin C might play a role [1]:

- **Cancer prevention**

Epidemiologic evidence suggests that higher consumption of fruits and vegetables is associated with lower risk of most types of cancer, perhaps, in part, due to their high vitamin C content. Vitamin C can limit the formation of carcinogens, such as nitrosamines, *in vivo*; modulate immune response; and, through its antioxidant function, possibly attenuate oxidative damage that can lead to cancer [8, 9]. Most *case-control* studies have found an inverse association between dietary vitamin C intake and cancers of the lung, breast, colon or rectum, stomach, oral cavity, larynx or pharynx, and esophagus. Plasma concentrations of vitamin C are also lower in people with cancer than controls. However, evidence from *prospective cohort* studies is inconsistent, possibly due to varying intakes of vitamin C among studies. Evidence from most *randomized* clinical trials suggests that vitamin C supplementation, usually in combination with other micronutrients, does not affect cancer risk [1]. At this time, the evidence is inconsistent on whether dietary vitamin C intake affects cancer risk. Results from most clinical trials suggest that modest vitamin C *supplementation* alone or with other nutrients offers no benefit in the prevention of cancer. A substantial limitation in interpreting many of these studies is that investigators did not measure vitamin C concentrations before or after supplementation. Plasma and tissue concentrations of vitamin C are tightly controlled in humans. At daily intakes of 100 mg or higher, cells appear to be saturated and at intakes of at least 200 mg, plasma concentrations increase only marginally. If subjects' vitamin C levels were already close to saturation at study entry, supplementation would be expected to have made little or no difference on measured outcomes.

- **Cancer treatment**

Studies in 1970s suggested that high-dose vitamin C has beneficial effects on quality of life and survival time in patients with terminal cancer. However, some subsequent studies did not support these findings. A 2003 review assessing the effects of vitamin C in patients with advanced cancer concluded that vitamin C confers no significant mortality benefit. Emerging research suggests that the route of vitamin C administration (intravenous vs. oral) could explain the conflicting findings. Some researchers support reassessment of the use of high-dose intravenous vitamin C as a drug to treat cancer. It is uncertain whether supplemental vitamin C and other antioxidants might interact with chemotherapy and/or radiation. Therefore, individuals undergoing these procedures should consult with their oncologist prior to taking vitamin C or other antioxidant supplements, especially in high doses.

- **Cardiovascular disease**

Evidence from many epidemiological studies suggests that high intakes of fruits and vegetables are associated with a reduced risk of cardiovascular disease. This association might be partly attributable to the antioxidant content of these foods because oxidative damage, including oxidative modification of low-density lipoproteins, is a major cause of cardiovascular disease [10-11]. Results from prospective studies examining associations between vitamin C intake and cardiovascular disease risk are conflicting. In a 16-year prospective study involving 85,118 female nurses, total intake of vitamin C from both dietary and supplemental sources was inversely associated with coronary heart disease risk. However, intake of vitamin C from diet alone showed no significant associations, suggesting that vitamin C supplement users might be at lower risk of coronary heart disease. A much smaller study indicated that postmenopausal women with diabetes who took at least 300 mg/day vitamin C supplements had increased cardiovascular disease mortality while in male physicians, use of vitamin C supplements for a mean of 5.5 years was not associated with a significant decrease in total cardiovascular disease mortality or coronary heart disease mortality. A pooled analysis of nine prospective studies that included 293,172 subjects free of coronary heart disease at baseline found that people who took ≥700 mg/day of supplemental vitamin C had a 25% lower risk of coronary heart disease incidence than those who took no supplemental vitamin C. The authors of a 2008 meta-analysis of prospective cohort studies, including 14 studies reporting on vitamin C for a median follow-up of 10 years, concluded that dietary, but not supplemental, intake of vitamin C is inversely associated with coronary heart disease risk. Results from most clinical intervention trials have failed to show a beneficial effect of vitamin C supplementation on the primary or secondary prevention of cardiovascular disease. However, as discussed in the cancer prevention section, clinical trial data for vitamin C are limited by the fact that plasma and tissue

concentrations of vitamin C are tightly controlled in humans. If subjects' vitamin C levels were already close to saturation at study entry, supplementation would be expected to have made little or no difference on measured outcomes.

- **Age-related macular degeneration (AMD) and cataracts**

AMD and cataracts are two of the leading causes of vision loss in older individuals. Oxidative stress might contribute to the etiology of both conditions. Thus, researchers have hypothesized that vitamin C and other antioxidants play a role in the development and/or treatment of these diseases. The authors of a 2007 systematic review and meta-analysis of prospective cohort studies and randomized clinical trials concluded that the current evidence does not support a role for vitamin C and other antioxidants, including antioxidant supplements, in the primary prevention of early AMD. Although research has not shown that antioxidants play a role in AMD development, some evidence suggests that they might help slow AMD progression [12]. High dietary intakes of vitamin C and higher plasma ascorbate concentrations have been associated with a lower risk of cataract formation in some studies.

- **The common cold**

In the 1970s, Linus Pauling suggested that vitamin C could successfully treat and/or prevent the common cold. Results of subsequent controlled studies have been inconsistent, resulting in confusion and controversy, although public interest in the subject remains high. Overall, the evidence to date suggests that regular intakes of vitamin C at doses of at least 200 mg/day do not reduce the incidence of the common cold in the general population, but such intakes might be helpful in people exposed to extreme physical exercise or cold environments and those with marginal vitamin C status, such as the elderly and chronic smokers. The use of vitamin C supplements might shorten the duration of the common cold and ameliorate symptom severity in the general population [13, 14] possibly due to the anti-histamine effect of high-dose vitamin C. However, taking vitamin C after the onset of cold symptoms does not appear to be beneficial. According to Harvard Health Letter (January 2017): "the nutrient appears to have modest prevention power." "The data show that vitamin C is only marginally beneficial when it comes to the common cold."

- **Parkinson disease**

In the Swedish National March Cohort, 43,865 men and women aged 18-94 years were followed through record linkages to National Health Registries from 1997 until 2016. Baseline dietary vitamin E, C and beta-carotene intake, as well as non-enzymatic antioxidant capacity (NEAC) were assessed by a validated food frequency questionnaire collected at baseline. All exposure variables were adjusted for energy intake and categorized into tertiles. Multivariable Cox proportional hazard regression models were fitted to estimate hazard ratios (HRs) with 95% confidence intervals (CIs) for Parkinson disease. After a mean follow-up time of 17.6 years, 465 incidence cases of Parkinson disease were detected. In the multivariable adjusted model, dietary vitamin E and C were inversely associated with the risk of Parkinson disease. The conclusion of this study suggests that dietary vitamin E and C intake might be inversely associated with the risk of Parkinson disease [15].

- **Excessive Vitamin C**

Vitamin C has low toxicity and is not believed to cause serious adverse effects at high intakes [7]. The most common complaints are diarrhea, nausea, abdominal cramps, and other gastrointestinal disturbances due to the *osmotic effect* of unabsorbed vitamin C in the gastrointestinal tract. In postmenopausal women with diabetes who participated in the Iowa Women's Health Study, supplemental (but not dietary) vitamin C intake (at least 300 mg/day) was significantly associated with an increased risk of cardiovascular disease mortality. The mechanism for this effect, if real, is not clear and this finding is from a subgroup of patients in an epidemiological study. No such association has been observed in any other epidemiological study, so the significance of this finding is uncertain. High vitamin C intakes also have the potential to increase urinary oxalate and uric acid excretion, which could contribute to the formation of kidney stones, especially in individuals with renal disorders. However, studies evaluating the effects on urinary oxalate excretion of vitamin C intakes ranging from 30 mg to 10 g/day have had conflicting results, so it is not clear whether vitamin C actually plays a role in the development of kidney stones. The best evidence that vitamin C contributes to kidney stone formation is in patients with pre-existing hyperoxaluria. Due to the enhancement of nonheme iron absorption by vitamin C, a theoretical concern is that high vitamin C intakes might cause excess iron absorption. In healthy individuals, this does not appear to be a concern. However, in individuals with hereditary hemochromatosis, chronic consumption of high doses of vitamin C could exacerbate iron overload and result in tissue damage. Under certain conditions, vitamin C can act as a pro-oxidant, potentially contributing to oxidative damage. A few studies *in vitro* have suggested that by acting as a pro-oxidant, supplemental oral vitamin C could cause chromosomal and/or DNA damage and possibly contribute to the development of cancer. However, other studies have not shown increased oxidative damage or increased cancer risk with high intakes of vitamin C. Other reported effects of high intakes of vitamin C include reduced vitamin B12 and copper levels, accelerated metabolism or excretion of ascorbic acid, erosion of dental enamel, and allergic responses. However, at least some of these conclusions were a consequence of assay artifact, and additional studies have not confirmed these observations.

- **Interactions with Medications**

Vitamin C supplements have the potential to interact with several types of medications, e.g., chemotherapy and radiation and statins. Individuals taking these medications on a regular basis should discuss their vitamin C intakes with their healthcare providers.

Vitamin C in the World's Leading Book on Internal Medicine

Harrison's Principles of Internal Medicine is believed to be the world leading book on internal medicine. Suter and Russell in the chapter *"Vitamin and Trace Mineral Deficiency and Excess"* have written [16]:

"Actions of vitamin C include antioxidant activity, promotion of nonheme iron absorption, carnitine biosynthesis, conversion of dopamine to norepinephrine,

and synthesis of many peptide hormones. Vitamin C is also important for connective tissue metabolism and cross-linking (protein hydroxylation), and it is a component of many drug-metabolizing enzyme systems, particularly the mixed-function oxidase system.

Vitamin C is almost completely absorbed if <100 mg is administered in a single dose; however, only ≤50% is absorbed at doses >1 g. Enhanced degradation and fecal and urinary excretion of vitamin C occur at higher intake levels.

Smoking, hemodialysis, pregnancy, lactation, and stress (e.g., infection, trauma) appear to increase vitamin C requirements.

Vitamin C deficiency causes scurvy. In children, vitamin C deficiency may cause impaired bone growth. Administration of vitamin C (200 mg/d) improves the symptoms of scurvy within several days. High-dose vitamin C supplementation (e.g., 0.2 up to several grams per day) may slightly decrease the symptoms and duration of upper respiratory tract infections. Diets high in vitamin C have been claimed to lower the incidence of certain cancers, particularly esophageal and gastric cancer."

Vitamin C in the World Leading Scientific Research Institute

The Linus Pauling Institute (Oregon State University) is the world leading scientific research entity on vitamin C. Below are "Summary" and "Recommendation" on Vitamin C by the Linus Pauling Institute [17]:

Summary

- *"Vitamin C, also known as ascorbic acid, is a water-soluble vitamin. Unlike most mammals and other animals, humans do not have the ability to make ascorbic acid and must obtain vitamin C from the diet.*
- *Inside our bodies, vitamin C functions as an essential cofactor in numerous enzymatic reactions, e.g., in the biosynthesis of collagen, carnitine, and catecholamines, and as a potent antioxidant.*
- *Prospective cohort studies indicate that higher intakes of vitamin C from either diet or supplements are associated with a reduced risk of cardiovascular disease (CVD), including coronary heart disease and stroke.*
- *Observational prospective cohort studies report no or modest inverse associations between vitamin C intake and the risk of developing a given type of cancer. Randomized controlled trials have shown no effect of vitamin C supplementation on cancer outcomes.*
- *Prospective cohort studies indicate that higher blood levels of vitamin C are associated with lower risk of death from all-causes, cancer, and CVD.*
- *Pharmacological doses of vitamin C administered intravenously are generally safe and well tolerated in cancer patients. The potential for intravenous ascorbic acid as an adjunct to cancer therapies is currently under investigation in phase II clinical trials.*
- *Overall, there is evidence that regular use of vitamin C supplements shortens the duration of the common cold, but the effect in cold treatment may be limited.*
- *Vitamin C supplements are available in many forms, but there is little scientific evidence that any one form is better absorbed or more effective than another.*
- *There is no scientific evidence that large amounts of vitamin C (up to 10 grams/day in adults) exert any adverse or toxic effects. An upper level of 2 grams/day is recommended in order to prevent some adults from experiencing diarrhea and gastrointestinal disturbances.*
- *Supplemental vitamin C increases urinary oxalate levels, but whether an increase in urinary oxalate elevates the risk for kidney stones is not yet known. Those predisposed for kidney stone formation may consider avoiding high-dose (≥1,000 mg/day) vitamin C supplementation."*

Recommendation

"Based on the combined evidence from metabolic, pharmacokinetic, and observational studies and from randomized controlled trials, it has been argued that sufficient scientific evidence exists to support an optimum, daily vitamin C intake of at least 200 mg/day, which is substantially higher than the current RDA. Studies conducted at the National Institutes of Health showed that plasma and circulating cells in healthy, young subjects attained near-maximal concentrations of vitamin C at a dose of 400 mg/day. Because of the very high benefit-to-risk ratio of vitamin C supplementation, and to ensure tissue and body saturation of vitamin C in almost all healthy people, the Linus Pauling Institute recommends a vitamin C intake of at least 400 mg daily for adult men and women. Consuming at least five servings (2½ cups) of fruit and vegetables daily provides about 200 mg of vitamin C. Most multivitamin/mineral supplements provide 60 mg of vitamin C. To make sure you meet the Institute's recommendation, supplemental vitamin C in two separate 250-mg doses taken in the morning and evening is recommended."

The Premium Application of Vitamin C

By definition, the premium application of vitamin C is when this health-promoting essential nutrient replaces an ingredient with known health risks. The case of cola drinks is the best example.

Cola is a sweetened carbonated soft drink flavored with *cola flavor*. The cola flavor is the signature flavor among carbonated soft drinks and is enormously popular worldwide. Cola flavor (including an acidic flavoring agent such as phosphoric acid) and sweeteners are the required ingredients for the production of colas. Other ingredients, such as color, caffeine and preservatives, are added (as needed) as complementary or auxiliary ingredients.

Phosphoric acid (also known as orthophosphoric acid) is a solid, non-toxic inorganic acid. The most common form of phosphoric acid is colorless, odorless 85% syrupy aqueous solution. Food-grade 85% phosphoric acid has a pH level below 1, meaning it should be distributed by licensed professionals and manufacturing staff who interact with this chemical should wear proper safety attire and equipment. The American Beverage Association defines phosphoric acid as follows: "This flavoring agent in soft drinks is a preservative that provides tartness."

Numerous health risks due to the use of phosphoric acid in colas have been reported in the scientific literature [18]. Careful review of the scientific literature shows that there are three major health risks associated with phosphoric acid in colas: risk to bone health [19-27], risk to kidney health [28-31] and risk to teeth health [32-34]. Consumers deserve to be

informed about the presence of phosphoric acid in their cola drinks. It is reasonable to demand use of appropriate cautionary language about phosphoric acid on the labels of cola drinks.

Conclusion

Considering the following health benefits of vitamin C:

- *A potent antioxidant (inhibits oxidation, counteracts damaging effects of reactive oxygen species);*
- *Supporting synthesis of collagen/connective tissue (healthy gum, skin and bone, wound healing);*
- *Supporting synthesis of certain neurotransmitters (conversion of dopamine to norepinephrine);*
- *Supporting synthesis of peptide hormones;*
- *Limiting in-vivo formation of carcinogen nitrosamines;*
- *Helping reduce risk of unhealthy cardiovascular system;*
- *Helping boost immune system;*
- *Helping improve absorption of nonheme iron;*
- *Helping reduce risk of Parkinson disease*

And considering the following health risks of phosphoric acid in cola drinks:

- *Risk to bone health;*
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It is logical to conclude that the premium application of vitamin C is when it replaces phosphoric acid in cola drinks (US patent application 2020/0077678).

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