

RESEARCH ARTICLE

(Open Access)**Evaluation of Phosphorus in Cola Drinks in Albanian Market**

ANISA PEÇULI*, NERTIL XHAFERAJ, ANILA KOPALI, AIDA SHKURTI, FATJON HOXHA

Agricultural University of Tirana, Faculty of Biotechnology and Food, Department of Agro-Food Technology Kodër Kamëz, SH1, Tirana 1000, Albania

*Corresponding author Email: apeculi@ubt.edu.al**Abstract**

Phosphates are inorganic compounds, based on the element phosphorus (P), and combined with oxygen to form phosphates (PO₄), the form in which phosphorus is present in nature. Phosphate occurs naturally in the form of organic esters in many kinds of food, like meat, potatoes, bread, and milk. In the body, they are broken down to simple phosphate ions (PO₄), the basic building block of the many different biological molecules which include phosphorus. Inorganic phosphat is commonly used as an additive in industrial food production for a range of purposes including maintaining natural colors and flavors, acidity buffering, leavening, stabilization of texture, shelf-life quality.

High levels of phosphorus in the blood, has been associated with adverse health effects like organ damage, most notably of the kidneys, lower calcium levels which lead to brittle bone diseases, vascular calcification and cardiovascular diseases. Because of the potential damage to health from excessive phosphate consumption, a labeling requirement is advised for foods with added phosphate. The aim of our study was the evaluation of phosphate concentration in cola drinks in Albanian market and compliances with the current legal limits regarding this additive set by the European regulations. Phosphate concentration of selected drinks were evaluated using an UV spectrophotometric procedure. The results obtained indicated that phosphate concentration in cola drinks ranged from 887 mg/L to 1,800 mg/L. European regulations allow up to 700 mg/L of phosphate in cola drinks, a quantity that provide already 50% to 75% of the recommended daily intake of phosphate for adults.

Keywords: inorganic phosphor, UV/Visible Spectrophotometer, Soft drinks, EU Regulations

Introduction

Phosphorus (as phosphate) is a natural constituent of human, animals and plants and is present in all biological materials. Phosphorus is widely present in food, largely as the phosphate ion. Phosphorus is an essential mineral and plays an important role in the metabolism of carbohydrate, fat, protein and in bone remodeling. Even though they are naturally present in nearly all foods, protein-rich foods are especially high in phosphorus; these include dairy products (100–900 mg/100 g), meats (200 mg/100 g), fish (200 mg/100 g) and grain products (100–300 mg/100 g)[1]. High levels of phosphorus in the blood, has been associated with adverse health effects like organ damage, most notably of the kidneys, lower calcium levels which lead to brittle bone diseases, vascular calcification and cardiovascular diseases[2]. In the light of the potential harmful effects associated

with excessive phosphate consumption the average intake from foods in adults is estimated to be between 1,000 and 2,000 mg/day [3]. The total phosphorus daily intake is depended also by contribution of added food phosphates. Phosphoric acid and phosphates (E 338-452) are food additives authorized[4] for a range of purposes[5] including maintaining natural colors and flavors, acidity buffering, leavening, stabilization of texture, shelf-life quality. The contribution of added food phosphates to total phosphorus intake is in low levels, usually 20-30% of dietary intake of phosphorus from natural foods, but latest evidence from studies showing a possible association between elevated serum phosphate concentration and an increased risk of cardiovascular disease (CVD)[6,7], call for a labelling requirement to be introduced for foods with added phosphates[8]

Food source is the main factor for phosphorus bioavailability. In plants, phosphorus is largely

present in the form of phytate, a form which is not bioavailable in humans because they lack the enzyme phytase, which is necessary to release phosphorus. Phosphorus in meat is typically found as intracellular organic compounds which can be easily hydrolyzed to release inorganic phosphate [9]. The phosphate as food additive is in form of inorganic salts. PTH (parathyroid hormone), and 1,25-dihydroxyvitamin D are the two hormones which in daily cycle regulate the body fluid phosphate concentration.

Must be evidenced that the dietary intake, absorption in intestines, exchanges with bone and intracellular compartments and renal excretion, play a vital role in the homeostasis of phosphorus. Skeleton and teeth bound, which contain phosphorus in solid form and counts for nearly 80% of total found in the body, and the other part is found in extracellular fluid and soft tissues. In general, the values ranging from 3.0 to 4.5 mg/dl (expressed as elemental phosphorus), are regarded to be common for serum phosphate concentration, and may change throughout the day succeeding a circadian rhythm, where the lowest values is recorded in the morning and the highest at night [9]. Although, scientists haven't found conclusive relation of regulatory hormones, cellular flux and renal excretion in the concentration of serum phosphorus due to complex interaction, it is known that the amount of dietary phosphorus intake doesn't influence it directly.

Nowadays, the dynamic way of living has increased the consumption of processed and ready-to-eat foods, increasing the concern that the phosphorus intake may be much higher and the use of phosphates as food additive may lead to an elevated phosphate serum concentration. Cola beverages are among the ready to drink products which contain phosphoric acid as food additive, and is one of the most favorable consumed drinks among teenagers and students [10–12]. The aim of our study was the evaluation of phosphate concentration in cola drinks in Albanian market and compliances with the current legal limits regarding this additive set by the European regulations.

Material and Methods

Sample preparation

Cola drinks analyzed were taken in different Albanian market and were local and international brands. The samples were decarbonated prior of analyzing by vigorous stirring in room temperature for several hours in order to release all carbon dioxide present in drinks.

Instruments

Biochrom Libra S22 UV/Vis Spectrophotometer was used for the spectrophotometric measurement. The pH meter SI Analytic lab 845 was used for pH measurement of cola drinks.

Chemical estimation of phosphorus

The content of phosphorus was determined according to the method proposed by Lozano-Calero [13]. The method consists of the formation of a complex of phosphate ion with a molybdate compound in acid solution. The colorless hexavalent molybdenum phosphate complex is reduced to a blue pentavalent form by ascorbic acid in acid medium. The intensity of the blue color is proportional to the amount of phosphate and is measured spectrophotometrically at 830 nm.

Results and Discussion

In Figure 1 is given the calibration curve of phosphorus, which was prepared by using standard solutions of phosphorus in the concentration range of 0–1.8 ppm and absorbance was measured on a UV/Vis spectrometer at wavelength 830 nm, as shown in Table 1. Moreover, the corresponding equation and the correlation coefficient are given.

Figure 2 shows the absorption spectra of phosphorus standard solution and all the samples. As it can be seen by the graph the wavelength of maximum absorption is at 830 nm. At this wavelength the system obeys Lambert–Beer's law in the concentration range of 0.5–5.0 µg/mL of

phosphate[14]. The phosphor content and pH of cola drinks are given in Tab.2.

Table 1 Phosphorous content of standard solution and the absorbance measurements

Phosphor P ₂ O ₅ Content (ppm)	Absorbance at 830nm
0.0	0.000
0.6	0.034
1.0	0.056
1.4	0.081
1.8	0.107

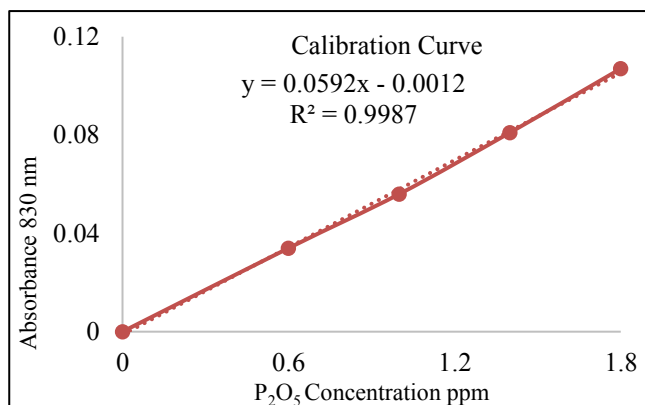


Figure 1 The calibration curve of phosphorous standard solution

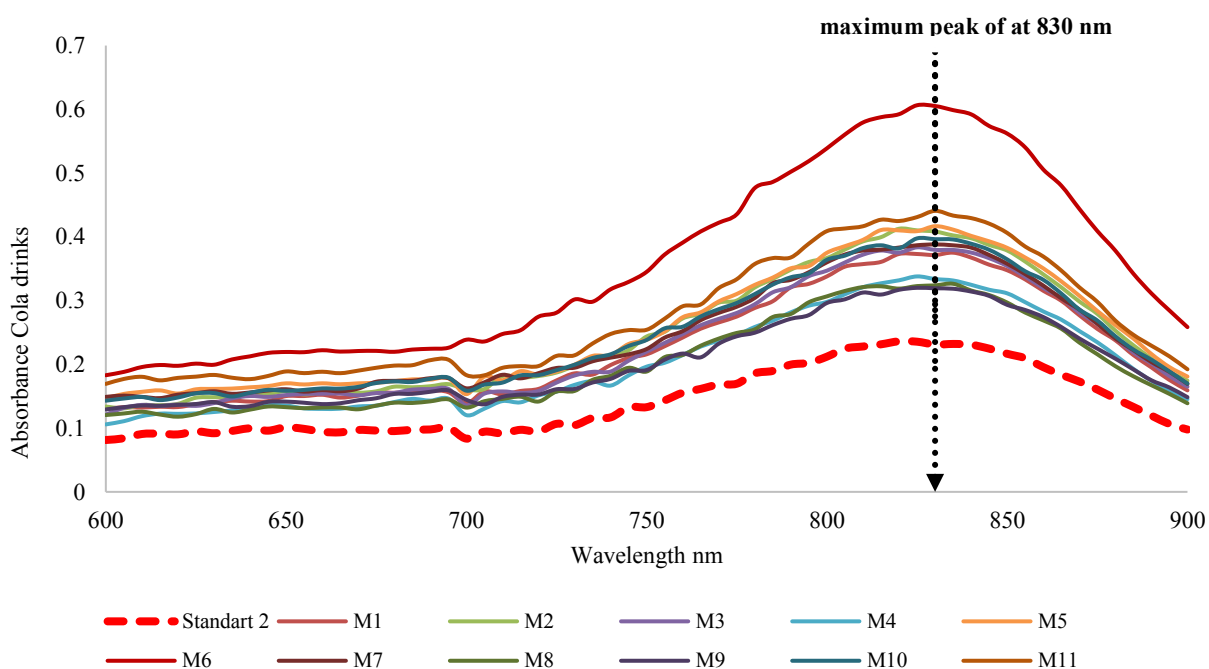


Figure 2 Absorption spectra of phosphorous standard solution and of all the samples.

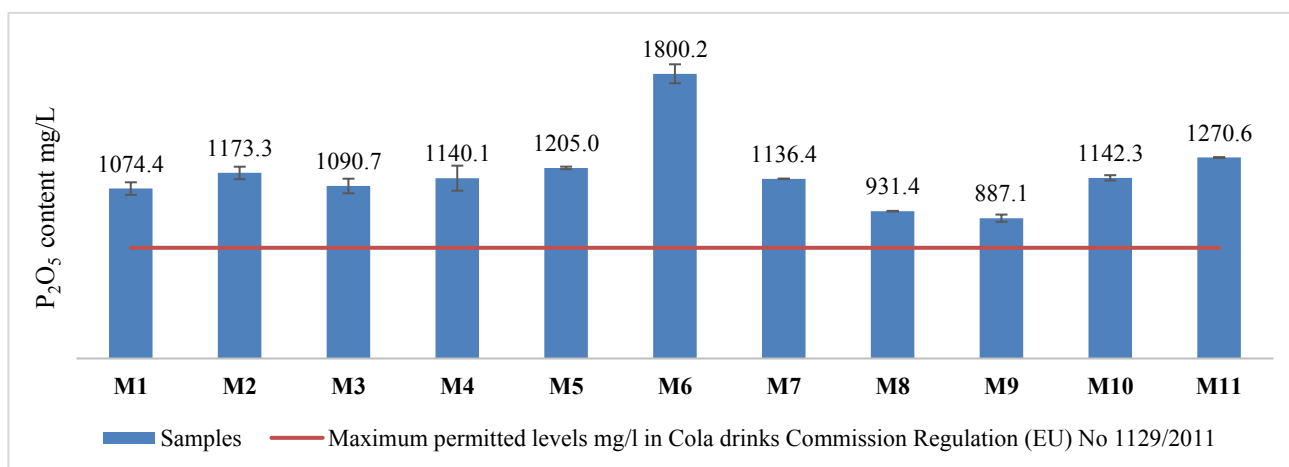


Figure 3 Phosphorus content in Cola drinks in Albanian market in comparison with MPL for this additive in EU

Table 2 Phosphorous content in Cola drinks

Sample	Absorbance830 nm	Phosphor content (P ₂ O ₅) mg/L	pH
M1	0.363	1074.4±39.60	3.14
M2	0.397	1173.3±39.50	2.90
M3	0.369	1090.7±46.10	2.89
M4	0.385	1140.1±79.30	3.17
M5	0.407	1205.0±8.12	3.86
M6	0.609	1800.2±59.90	3.15
M7	0.384	1136.4±0.00	3.10
M8	0.315	931.4±2.08	3.25
M9	0.300	887.1±22.90	2.80
M10	0.386	1142.3±16.68	2.76
M11	0.430	1270.6±2.08	2.90

The higher phosphor content was found in sample M6, respectively 1800 mg/L and the lowest content was found in sample M9 (887mg/L). Phosphoric acid (E 338) is the only inorganic acid commonly used to give a specific taste profile to cola type drinks and has a strong effect on pH. The pH in our samples varied from 2.76 (M10) to 3.86 (M5) and no significant correlation was found between the low pH and high content of phosphor. A pH below 5.5 influence the health of our teeth as the acid begins to dissolve the hard enamel. Our bodies' ability to maintain a one-to-one balance between calcium and phosphorus in our systems it's the main factor for a good health. Soft drink consumption take away our bodies' calcium, leading to soft teeth. Excess amount of phosphoric acid in blood mean an extra work for kidneys, which are less able to excrete it. Soft drinks remove calcium from the body, and deposited in kidney, resulting in chronic kidney disease. An association between elevated serum phosphate levels and increase risk of cardiovascular disease in patients with chronic kidney disease has long been known[15,16].

Figure 3 shows the phosphor content in all samples compared to maximum permitted level (MPL) set by Commission Regulation (EU) No 1129/2011. The maximum permitted level for flavored drinks, a group which include cola drinks, is

700 mg/L expressed as P₂O₅¹, a quantity that provide already 50% to 75% of the recommended daily intake of phosphate for adults. Chart shows very clear that the samples are above the MPL set by EU for this additive in a range of 26.7% to 157% higher.

Conclusions

Data obtained from our study, shown that the content of phosphor in cola drinks in Albanian market is higher than the maximum limit authorized from the international authority of drug regulation. The exceed amount is higher at significant levels, respectively 26.7% to 157 %. Taking into consideration health problems arising from high phosphor daily intake, we suggest to the manufacturer to be transparent in the declaration of phosphor content in the label of the product in way to help consumer to make informed decisions about the purchase of products. The most important suggestion to the manufacturer should be: they always should produce in compliance with national and international regulations and standards of food safety. Determination of phosphor was carried out by means of spectrophotometer UV-VIS as cheapest, fast, and excellent accuracy.

¹ Food Additives Database in EU: https://webgate.ec.europa.eu/foods_system/main/index.cfm?event=substance.view&identifier=128

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