Determination of Caffeine and pH Levels of Selected Carbonated Soft Drinks and Ready to Drink Juices in Eldoret, Kenya.

Magut Hillary, Dr. T. Anthoney Swamy* and Terer Erick Kipngetich
Dept of Chemistry, University of Eastern Africa, Baraton, P. O Box 2500-30100, Eldoret, Kenya

ABSTRACT: Different brands of soft drinks and selected ready to drink juices were randomly sampled from different stores in Eldoret town. Two methods of extraction were employed; hydrochloric acid acidified water and distilled water. UV analysis results of acidified water samples, the caffeine levels were found to be in the range of 1.43 mg/L and 40.51 mg/L, the lowest being Stoney and the highest being Coca-Cola respectively. With distilled water alone, the concentration ranged from 1.51 to 39.65 mg/L, these being Stoney and Coca-Cola respectively. Ready to drink juices showed the highest levels of caffeine content in both distilled and acidified water extraction with the lowest reading of 59.43 mg/L obtained from Pineapple Marche brand while the highest concentration was from orange Marche brand with 75.71 mg/L caffeine in acidified water extraction.

Key words: Caffeine, Soft drinks, pH, UV- Spectroscopy.

***Corresponding Author: drtanthony2011@yahoo.com**

INTRODUCTION

Caffeine has quick effects on the central nervous system. It also increases heart beat rate, dilate blood vessels and elevate levels of free fatty acids and glucose in the plasma. 1 g of caffeine leads to insomnia, nervousness, nausea, ear ringing, flashing of light derillum and tremulousness (Lawrence, 1986). Caffeine has diuretic properties when administered in sufficient doses to subjects who do not have a tolerance for it (Kalra et al, 2011).

Caffeine also stimulates the stomach to pour out large amounts of acid. This in turn leads to burning in the pits of the stomach and aggravates peptic ulcers of the stomach and duodenum. It also raises blood sugar level as a result of quickening of respiration. It also reduces blood flow to the brain by causing the brains blood vessels to constrict. It also may induce benign (non-cancerous) breast diseases and may worsen pre-menstrual symptoms in women who overuse it. Caffeine crosses the placenta and enters the fetal circulation and its use at a pharmacological level has been associated with low birth weight (Wanyika et al, 2010). Excessive consumption during lactation may cause irritability and wakefulness in a breast- fed baby (Eva, 1988).

Caffeine has a mild analeptic (respiratory stimulating activity) effect. Other action includes cardiac stimulation which may produce tachycardia dilation of coronary and peripheral blood vessels, constriction of blood vessels and skeletal muscles. It increases the risk of spontaneous abortion in women (Eva, 1988). An excessive intake of caffeine in some persons appears to augment the sensitivity of the heart to emotional and other factors and so increase the incidence of extra systoles and other arrhythmias. Since caffeine affect the central nervous system conversely, omission of a habitual morning dosage often results in nervousness irritability, drowsiness, poor work performance and headache curable only by taking more caffeine (Stanley et al. 1979).

Caffeine is bioactive and in moderation, it has beneficial effects on the body; it increases alertness, serves as a bronchial dilator, stimulates metabolism and contributes to an increase in dopamine levels in the blood, which improves mood. However, at high levels it can cause restlessness, insomnia and anxiety. It can also exert some mild withdrawal effects such a transient but persistent headache and inability to concentrate and can be addictive. Caffeine is a bioactive and if taken in moderation has beneficial effects to the body. Caffeine is the most widely consumed stimulant drug in the world (Wachira et al., 2010). Caffeine is added to soft drinks as a flavoring agent, it is part of the overall profile of soft drinks, which consumers enjoy for refreshment, taste and hydration. Most of the caffeine in cola drinks is added during the formulation process (Marcia et al., 2002; Nour Violeta et al., 2008; Dionex, 2007).

All over the world, the caffeine contents in soft drinks varies according to the type of the brand, yet its average content in soft drinks is approximately 18 mg per six ounces (i.e. 100 ppm). The US Food and Drug Administration (FDA) limit the maximum caffeine amount in carbonated beverages to 6 mg/oz (200 ppm) (Violeta Nour et al., 2010). Consumption of a gram of caffeine leads to insomnia, nervousness, nausea, ear ringing, flashing of light derillum and tremulousness. In cases of overdosing and in combination with alcohol, narcotics and some other drugs, these compounds produce a toxic effect, sometimes with lethal outcome (Mamina and Pershin, 2002; Ben Yuhas, 2002; Wanyika et al., 2010; James et al., 1990; Tavallali and Sheikhaei, 2009).

The Food and Drug Administration (FDA) has included caffeine in the list of substances that are generally recognized as safe and has set the maximum concentration of caffeine in cola beverages at 32.4 mg of caffeine per 6-oz bottle or 65 mg of caffeine per 12 oz (12). According to (Mei M. et al.,2012), caffeine is considered to be a risk factor for cardiovascular diseases and may affect behavior effects of depression and caffeine is one of the most comprehensively studied ingredients in the food supply, with centuries of safe consumption in foods and beverages.

The aims of the present investigation is to determine the levels of caffeine in carbonated soft drinks and selected brand of ready to drink juices. Also to compare two different caffeine extraction methods; acidified water and distilled water extraction.

MATERIALS AND METHODS

Preparation of Standards:

Caffeine stock solution (1000 ppm) was prepared by dissolving 100.00 mg of pure caffeine in 100 ml of distilled water. 0, 10, 20, 40, 60 and 80 ppm caffeine working solutions were prepared by serial dilution of the stock in 25 ml volumetric flasks with addition of 1.0 ml hydrochloric acid before topping to the mark with distilled water. Water extraction was performed in a similar manner but leaving out hydrochloric acid. The absorbance of the standards and the samples were taken at a wavelength 271.2 nm.

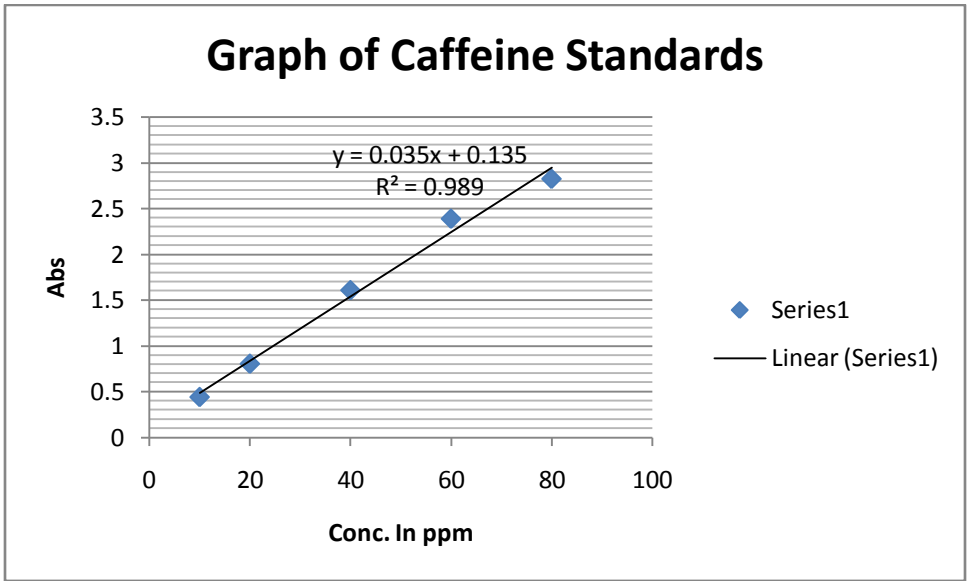

Figure 1. Graph of Caffeine standards

Sample Preparations:

Once the sample bottles were opened, the drinks were degassed by gently warming, sonication, homogenized and filtered through a Whatman filter paper. The samples were then cooled to room temperature. One ml of the filtrate was measured into a 100 ml volumetric flask, followed by addition of 1.0 ml hydrochloric acid before topping to the mark with distilled water. The pH of the samples was measured using pH600 meter. Analysis was done at 271.2 nm.

RESULTS AND DISCUSSION

Carbonated Soft drinks Sample Name	[Distilled Water Extract] mg/L	[Acidified Water Extract] mg/L	pH
Fanta orange	13.22	14.93	3.0
Stoney	1.51	1.43	2.7
Fanta Black Currant	25.79	24.36	3.1
Krest	5.79	9.51	2.8
Coca-Cola	39.65	40.51	2.7
Fanta Pineaple	6.09	6.65	3.3
Mean Concentration	**14.49**	**16.23**	
Standard Deviation	**13.39**	**15.92**	

Table1: Concentration of the different brands in both water extraction and acid extraction.

Ready to Drink Juices	[Distilled Water Extract] mg/L	[Acidified Water Extract] mg/L	pH
Pineapple Marche	59.43	67.14	3.0
Lemon Marche	60.57	64.29	3.1
Orange Marche	75.71	75.71	3.1
Strawberry Marche	59.71	58.36	3.2
Mean Concentration	**63.86**	**66.38**	
Standard Deviation	**6.86**	**6.26**	

Table2: Ready to drink soft drinks

From table 1, caffeine is best extracted in acidified water. The analysis of carbonated soft drinks showed high levels of caffeine in the Coca-Cola drink in both distilled and acidified water with an average concentration of 40.01 mg/L with Stoney being the lowest caffeinated carbonated soft drink in both extraction methods with an average concentration of 1.47 mg/L. According to table 2 above, ready to drink samples had the highest caffeine levels of all the analyzed samples. Orange Marche showed the highest caffeine concentration level with an average of 75.71 mg/L whereas the lowest caffeine level was obtained from Strawberry Marche with an average concentration of 59.04 mg/L. The results from both soft drinks and ready to drink samples were all below the maximum of 200 mg/L allowed by Food and Drug administration.

The pH of carbonated soft drinks ranged from 2.7 to 3.3 while the pH of ready to drink Marche brand soft drinks ranged from 3.0 to 3.2. Carbonated soft drinks have a relatively low pH which makes soft drinks not suitable for people with stomach ulcers. Low pH has effects on the enamel which can affect teeth development in infants. According to Hughes et al., 2000, Larsen et al., 1999, Lissera et al., 1998, and Seow et al., 2005, in vitro studies have shown that soft drinks with low pH can cause dental erosion in permanent and deciduous teeth. Decrease in pH has also been associated with increase in dental erosion. Low pH is as a result of addition of acidulants such as phosphoric acid and citric acid .The acid is used in soft drink product as a key factor in the taste profile of a drink as it balances the sweetness and helps to inhibit microbial growth (Cornelius et al., 2007).

CONCLUSION

From the results of the research, caffeine is best extracted by using acidified water. In all the selected samples, the caffeine levels were below the maximum allowed by FDA of 200 mg/L. However, the soft drinks contained appreciable levels of caffeine hence should be avoided by children at an early age to avoid caffeine dependence. The pH of the soft drinks was low. This is attributed to the addition of acidulants which makes soft drinks harmful to infants and people suffering from ulcers. Despite the fact that caffeine is a permitted food additive, excessive use should be minimized.

*** The authors declare NO competing financial interest.**

REFERENCES

1. Ben Yuhas. (2002). Determination of Caffeine Content in Beverages with HPLC. Chem., 384.

2. Cornelius T. B., Eyitope O. O, Adeyemi O. O and Temitope A. E.(2007). Erosive Potential of Soft Drinks in Nigeria, World Journal of Medical Sciences 2 (**2**): 115-119.

3. Dionex (2007). Determination of Additives in Carbonated Beverages.Application Note 193, Dionex Corporation.

4. Eva M.H. (1988). Nutrition. West publishing company, 4(**7**): 351. http://coffeefaq.com/site/node/15.

5. Hughes, J.A., N.X. West, Parker D.M., M.H. van den Braak and Addy M., (2000). Effects of pH and concentration of citric, malic and lactic acids on enamel, in vitro. Journal of Dentistry, (**28**): 147-52.

6. Kalra K, Kumar S and Maithani J. (2011). Estimation of Caffeine in different beverages by Ultraviolet Spectroscopy, International Journal of Pharmacy and Life Sciences, 2 (**11**): 1214-1215.

7. Kaplan E, Holmes J.H, and Sapeika N. (1974). Caffeine content of tea and coffee. S. Afr. Med. J., (**48**): 510-511.

8. Larsen, M.J. and Nyvad B., (1999). Enamel erosion by some soft drinks and orange juices relative to their pH, buffering effect and contents of calcium phosphate. Caries Research, (**33**): 81-87.

9. Lawrence E.L. (1986). What you need to know about food and cooking for health. Viking Company, 5 (**235**): 254-258.

10. Lissera, R.G., E.R. Luna Maldonado and Battellino L.J., (1998). In vitro erosive capacity of some fruit juices and soft or low alcoholic strength beverages on human teeth, Acta odontológica latinoamericana, (**11**): 55-71.

11. Mei M. A., M E., Mohammed I. T., Badawi A. Z. and Abdalla A. E. (2012). Determination of Caffeine in Some Sudanese Beverages by High Performance Liquid Chromatography. Pakistan Journal of Nutrition 11 (**4**): 336-342.

12. Nour V., Trandafir I. and Ionica M. E. (2008). Quantitative determination of Caffeine in carbonated beverages by an HPLC method. J. Agro alimentary Processes Technol., (**14**): 123-127.

13. Seow, W.K. and K.M. Thong, (2005). Erosive effects of common beverages on extracted premolar teeth. Australian Dental Journal, (**50**): 173-8.

14. Stanley D., Passmore R., and Brock J.F (1979). Human nutrition and dietetics. Longman publishers, 2 (**11**): 200.

15. Wachira F. N. & Kamunya S.(2010). Tea Research Foundation of Kenya Vol.15 No. 2.

16. Wanyika, H.N., E.G. Gatebe, L.M. Gitu, E.K. Ngumba and C.W. Maritim, (2010). Determination of Caffeine content of tea and instant coffee brands found in the Kenyan market Afr. J. Food Sci., (**4**): 353-358.