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Quantitative Analysis of Caffeine in Some Selected Brands of Energy Drinks Available in Kano State Nigeria

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ABSTRACT
This research work was aimed to determine the pH and level of caffeine in some selected brands of energy drinks available in Kano state, Nigeria. Different brands of these products were purchased from different shops in Kano metropolis. Caffeine was carefully extracted from each product and analysed by ultraviolet/visible spectrophotometric methods. The results showed that the caffeine content of the energy drinks ranged from 34.65 to 40.88mg/100mL. Like-wise the mean pH of carbonated energy drinks were highly acidic ranging from 2.99±0.017 to 3.98±0.012, The reason behind the low pH values in carbonated drinks could be as a result of the presence of carbon (iv) oxide gas and other acids such as phosphoric acid, malic acid, ascorbic acid, citric acid and tartaric acid used as preservatives by the manufacturers of these product.

Keywords: Energy drinks, Caffeine, pH, Kano- Nigeria

INTRODUCTION

A beverage is a drink specially prepared for human consumption either at meal or leisure times (Ogah and Obebe, 2012). There are varieties of beverages which can be broadly classified in to alcoholic and non-alcoholic beverages. Alcoholic beverages contain alcohol in varying proportion while the non alcoholic beverage comprises soft drinks, energy drinks, fruit juices and hot beverages. Soft drinks, energy drinks, fruit juices may contain caffeine arising from the raw materials used for its preparation or from its deliberate addition. Hot beverages often contain caffeine and are term hot because they are usually serve hot by addition of hot water or milk. This group consist of cocoa, tea and coffee based product which are commercially available in the Nigerian market (Ogah and Obebe, 2012).

Energy drinks are acidic in nature having lower pH values. The lower pH value is due to the presence of CO_2 gas or other acids such as phosphoric acid, malic acid, ascorbic acid, citric acid and tartaric acid used as preservative by the manufacturer of these energy drinks (Bassiouny and Yang, 2005; Ashurst, 2005). These acids inhibit the growth of microorganisms such as bacteria, mould and fungi which may contaminate beverages. Studies showed that drinking acidic beverages over a long period can cause erosion of tooth enamel and predisposition of the consumer to dental disease (Marshall et al., 2003; Bassiouny and Yang, 2005).

Caffeine is a common ingredient of energy drinks. It is deliberately added as a flavoring agent and to make the drinks addictive. It is a bitter white crystalline 'xanthine' alkaloid that acts as a mild psychoactive stimulant drug. It is found in varying quantities in the seeds, leaves or fruits of many plants species (Andrews *et al.,* 2007; Wanyika *et al.,* 2010; Violeta *et al.,* 2010). The most common sources of caffeine are coffee, cocoa beans, cola nuts and tea leaves. Caffeine stimulates CNS reducing physical fatigue and restoring mental alertness when unusual weakness or drowsiness occurs Mozammel *et al*.,(2015)

Caffeine causes various physiological effects, such as relaxation of bronchial muscle, stimulation of central nervous system, gastric acid secretion and dieresis. On the other hand chemical analysis of caffeine in coffee and tea leaves are also used as an additional tool for evaluating tea and coffee (Dobrinas *et al.,* 2012).

MATERIALS AND METHOD

All glass and plastic ware containers were washed with detergent and rinsed with tap water, then soaked overnight in 6M HNO_3 solution and rinsed several times with deionized water to eliminate absorbance due to detergent (Cabrera, 1994). Analar grade reagents and deionized water were used throughout the analysis.

Sampling

The samples of different types of soft drinks and energy drinks were obtained from different super Markets in Kano metropolis.

Sample Preparation

The energy drinks were used as supplied by the manufacturers.

Preparation of caffeine standard solution:

A 100ppm stock standard of caffeine was prepared by dissolving 25mg of caffeine in 250cm^3 purified carbon tetrachloride (CCl_4) in a 250cm^3 volumetric flask. Working standards were prepared by pipetting 2, 4, 6,8,10 cm^3 aliquots of the stock standard solution in to separate 100cm^3 volumetric flasks and diluted to volume with carbon tetrachloride (CCl_4) to produce concentration of 2,4,6,8, and 10mg/100mL standard solution. The absorbance of each solution was measured at the wavelength of maximum absorption of 270nm using quartz curvette. The absorbance values were then plotted against concentrations to generate a standard calibration curve and the concentration of caffeine in the samples was obtained from it by interpolation.

pH determination:

pH of Energy drinks were determined using Sartorius Jenway pH meter (3510 model), The pH of all the soft and energy drinks were determined directly by dipping the pH meter electrode in triplicate in to the portion of a liquid sample.

Caffeine extraction procedure:

An aliquot (5cm^3) of the drink sample was drawn with 10cm^3 pipette and placed into a 125cm^3 separatory funnel followed by addition of (10cm^3) distilled water, 1cm^3 of 20% aqueous disodium carbonate (iv) (Na_2CO_3) solution and 20cm^3 analytical grade CCl_4 .The caffeine was extracted by inverting the funnel at least three times, venting the funnel after each inversion, The non aqueous CCl_4 layers was transferred to a clean 50cm^3 volumetric flask. Another 20cm^3 portion of CCl_4 was added to the aqueous solution in the separating volume was made up to 50cm^3 the volumetric flask with the solvent. This procedure was repeated for all the drink, coffee and tea samples. The absorbance of each resulting solution was measured on UV/Visible spectrophotometer at 270nm using 10mm curvette.

Quantitative Caffeine Determination:

Quantitative analysis of caffeine was performed by using 6405 Jenway UV/Visible spectrophotometer. The maximum Wavelength was determined by scanning the standard solution from 200-600nm and the obtained results gave the highest absorption value at 270nm.Standard linear calibration curve was run to obtain the linear range of sample analysis, correlation factor of accepted value 0.9989 and the standard calibration curve was linear over the range of (2-10) ppm caffeine with equation($y = 0.0749x + 0.0082$).

The quantitative amount of caffeine in the samples analysed (mg/100mL) was then determined using the standard curve.

RESULT AND DISCUSSION

The caffeine contents of energy drinks are presented in Figure 1 from which it can be seen that the caffeine content of energy drinks ranged from 34.65 ± 0.45mg/100mL to 40.88 ± 0.56mg/100mL. The minimum caffeine content was observed in energy drink 1 (EDB 1) which was 34.65±0.45mg/100mL while energy drink 9 (RED 9) showed the highest caffeine content of 40.88±0.56mg/100mL. The mean caffeine level in analysed energy drink samples was found to be 34.78±0.31mg/100mL .Similar results were obtained by other researchers which include(Violeta et al.,2010),whose reported caffeine content of energy drink samples ranged from 16.82 to39.48mg/100mL. Also (Tautua *et al.*,2014) reported the caffeine content of energy drinks ranging from 47.56ppm to 58.31ppm. These values could also be considered low and safe when compared with the recommended daily intake set by International food information council (300mg/day), but most of energy drinks analysed cross the limit set by NAFDAC (32mg/100mL). All over the world, the caffeine contents of drink samples varies according to the type of brand analysed, (Violeta et al,2010). Clearly, the caffeine mean level in the analyzed samples marketed in Kano super markets is well below the values reported by other researchers.

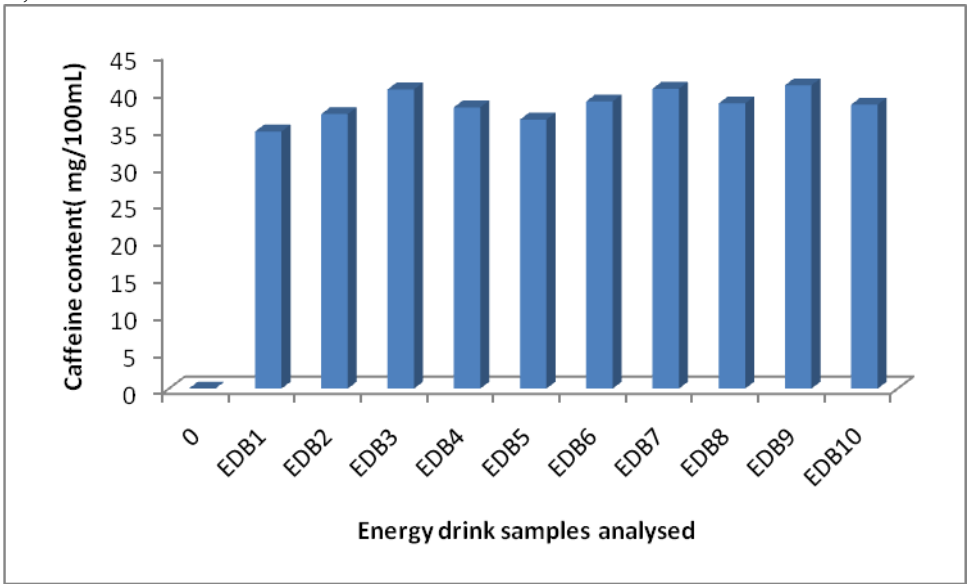

Fig.1: Caffeine content of the Energy drink samples analysed.

The pH of energy drink analysed ranged from 2.99±0.017 to 3.98±0.012, from Figure 2 it can be seen that energy drink 2 (EDB 2) had the lowest pH value of 2.99±0.017, followed by energy drink 9 (EDB 9) 3.20±0.010, both energy drink 7(EDB 7) and energy drink 6 (EDB 6) have pH values of 3.33, the highest pH value was observed in energy drink 9(EDB 9) 3.98±0.012. The mean pH values of energy drink samples was found to be 3.178±0.017. The result obtained in this research was in agreement with the finding of Sarmad *et al*.,(2012),who reported the pH of PBE, PHE, WTE, BBE and KED as 3.38±0.03,3.42±0.09,3.18±0.12,3.40±0.07 and 3.66±0.01 respectively. Also the result is lower than the result obtained by Tautua *et al.*,(2014),who determined the pH of energy drinks i.e. PHE, LBE and RBE as 5.85±2.03,5.79±1.04, and 6.44±0.76 respectively. The result also is in agreement with the result obtained by Mozammel *et al*.,(2015),who determined the pH of five different brands of energy drinks as fallows; Brand 1, Brand 2, Brand 3, Brand 4, and Brand 5, as 2.98,3.01,2.85,3.11, 3.09 respectively. The reason behind the low pH value of carbonated energy drinks could be as a result of presence of Carbon (IV) oxide and other acid such as ascorbic acid, malic acid used as preservative by the manufacturers of these product(Tautua *et al.*,2014).

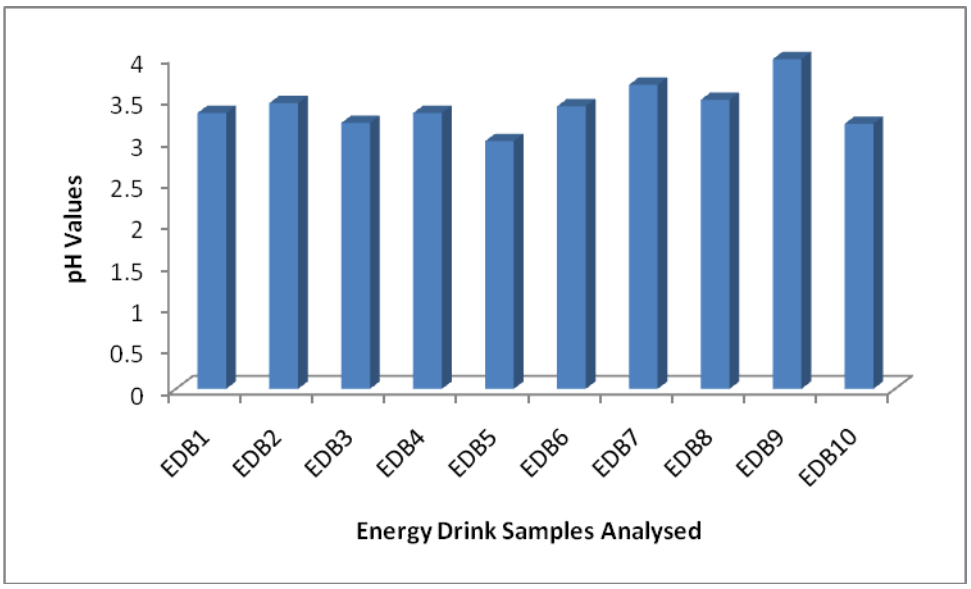

Fig. 2: pH of Energy Drink Samples Analysed.

Key: EDB = Energy Drink Brand

CONCLUSION

It has shown from the results of this study that energy drinks based beverages widely consumed by the public in Kano metropolis, especially the adults, contain high amount of caffeine. However, the amount of caffeine found in most of the products analysed were well above the regulatory level of NAFDAC(32mg/100mL), but are generally considered safe for healthy consumers considering the recommended daily intakes set by the International food information council 300mg/day.

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