Assessment Of Caffeine Content In Some Energy Drink Sold In Ekwulobia

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Abstract

Caffeine is a naturally occurring chemical stimulant found in leaves, seeds and fruits of numerous plant species of groups of nitrogenous organic compound of the alkaloid group called trimethylxanthine. Energy drinks are non-alcoholic beverage that contain high level of substances capable of exciting any bodily functions and tends to stimulate the brain and the central nervous system. The aim and objective of the research is to determine the caffeine content and concentration of caffeine of five (5) different beverages (energy drink) sold in Ekwulobia in Aguata local Government Area. The caffeine content in the drink by name predator, fearless, bullet, climax and power horse were determined. The result showed the level of caffeine in the respective energy drink brand as 0.721mg/L for predator (PRE 101), 0.545mg/L for fearless (FEA 102), 0.275 mg/L for bullet (BUL 103), 0.305 mg/L for climax (CLI 104) and 1.135 mg/L power horse (POW 105). The result showed that the caffeine content in the energy drink samples were significantly lower than the authorized level of (32mg/100L) recommended by World Health Organization which means that the energy drink analyzed are safe for consumption.

Keywords: caffeine, beverage, energy drink, coffee and trimethyl-xanthine

INTRODUCTION

Caffeine's popularity as a natural stimulant is unparalleled. An estimated 80% of the world's population enjoys a caffeinated product daily. Caffeine, the common name for 1,3,7-trimethylxanthine, was derived from the German word *kaffee* and the French word *cafe´*, each meaning coffee (Heckman *et al*.,2010). Caffeine is a

naturally occurring chemical stimulant found in the leaves, seeds and fruits of a numerous plant species of a group of nitrogenous organic compound of the alkaloid group called *trimethylxanthine*. The Royal society of chemistry (2011),described caffeine as a naturally occurring alkaloid found in varying quantities in the beans, leaves, and fruits of more than 60 plants; where it serves as an herbicide, insect repellant, and even attractant for pollination.Some common sources of caffeine are the kola nut (*Cola acuminate*), cacao bean (*Theobromacacao*), yerba mate (*Ilex paraguariensis*), and guarana berries (*Paullinia cupana*); however, roasted coffee beans (*Coffea Arabica and Coffea robusta*), and tea leaves (*Camelia siniensis*) are the world's primary sources of dietary caffeine (Higgins, 2010). In its pure form, caffeine occurs as a white crystalline powder or as silky needles, that is odorless and tastes very bitter. Pure caffeine (*trimethylxanthine*) melts at 238 °C (460 °F).Pure caffeine with molecular mass of 194.19 g/mole, sublimes at 178°C (352°F) at atmospheric pressure and is weakly basic with a pH range of 6.5 to 10.4 requiring strong acid to protonate it (Royal society 0f chemistry, 2017). Caffeine is generally less soluble in organic solvents than in hot water. It is slightly soluble in petroleum ether and Benzene but moderately soluble in alcohols and acetone solvents (Venus and Nulamuga, 2020). Caffeine is moderately soluble in water at ambient temperature (2g/100ml), but very soluble in boiling water (66g/100ml) (Royal society of chemistry, 2017).The compound caffeine has a chemical formula $C_8H_{10}N_4O_2$

Global caffeine consumption is estimated to be around 120,000 tonnes per year, which corresponded to one cup of coffee per day for every human on the planet (Cappelletti *et al.*, 2015).Regulatory agencies worldwide, including those in the United States, Europe, Canada, New Zealand, India, and Australia, have evaluated caffeine safety, and several agencies have issued guidance regarding daily intake amounts (SACN, 2015)(Misra, 2016). The most widely cited of these values is from the year 2003 Health Canada review reports, in which the agency authors conducted a comprehensive (but not systematic) literature search and concluded in a peer-reviewed publication that an intake dose of up to 400 mg caffeine/day was not associated with adverse effects in healthy adults. The US Department of Agriculture (USDA) and European Food Safety Authority (EFSA) define a safe caffeine intake as up to 300 – 400 mg (about 4 cups brewed coffee) per day for a healthy adult with no medical issues (Richling, 2003). Caffeine is generally recognized as safe by the US Food and Drug

Administration (FDA) at a use level not to exceed 200 ppm (0.02%) (Nowak and Jasionowski, 2015)

The level of caffeine can vary depending on what is consumed. That is, the effects of caffeine on human being depend on its concentrations. Consuming high dosage of this caffeine causes various physiological and psychological effects which include stimulation of the central nervous system (CNS), gastric acid secretion and diuresis (Badr, 2013). Caffeine acts as a diuretic and can cause dehydration. Intake of caffeine in excessive amount can induce psychological and physiological dependence (Reid *et al*., 2017). Caffeine intake may also produce in people such negative effects as irritability, nervousness or anxiety, jitteriness, headaches, and insomnia. Due to its stimulant effects on the CNS, caffeine consumption can produce headache, sleep disturbance, restlessness, tachycardia, and irritability in human beings.

In pregnancy, results are conflicting in relation to the association of increased caffeine intake and fetal growth restriction and low birth weight. The main concerns are possible causes of spontaneous abortion and impaired fetal growth. Caffeine affects children in a similar way as adults, and may disturb their sleep patterns and thus impair their normal development. Investigations on young adults and adolescents have reported an association between energy drinks and some behavioral risks such as smoking, violence, and drug and alcohol usage (Mozammel *et al*., 2015). The daily consumption of caffeinated drinks can increase blood sugar levels and cause problems for people with diabetes. Caffeine stimulates the release of a stress hormone called epinephrine, which causes liver and muscle tissue to release its stored glucose into the bloodstream, temporarily raising blood glucose levels.

Toxicity from excess consumption of caffeine has been found to lead to osteoporosis, nausea, dehydration, irregular headache, nervousness, increased respiration, insomnia, hallucinations, poor academic performance, aggressive behavior, cardiac dysarhythmias, hypokalaemia, paralysis, cerebral oedema, rhabdomyolysis, sudden cardiac death, and psychosis (Cappelletti *et al*., 2015). Some other reports also stated that the excessive intake of caffeine is associated with several other diseases such as myocardial infarction, anxiety, coronary heart disease, fibrocystic breast disease, and variety of cancers including kidney, pancreas, and urinary tract cancers (Mozammei *et al*., 2015).

Caffeine has been widely studied in a variety of areas regarding human health and performance (Nowak and Jasionowski ,

2015). The positive effects that have been described in people who use caffeine include improved motor performance, decreased fatigue, enhanced sensory activity, and increased alertness. These positive effects may partly explain the compulsion of many adults to consume coffee or other caffeine-containing beverages as part of the morning ritual of awakening. Similarly, Mozammel *et al*. (2015) report also confirms that caffeine stimulates CNS reducing physical fatigue and restoring mental alertness when unusual weakness or drowsiness occurs. Several studies confirm that caffeine consumption can increase energy utilization, enhances alertness and focus, increase metabolism, and improve exercise and athletic performance (Badr, 2013).

Caffeine has a stimulating effect on the central nervous system, heart, blood vessels, and kidneys. Caffeine from plant extracts that contain polyphenol has been associated with positive vascular health and improved blood flow as a result of its antioxidant, anti-inflammatory and anti-cancer qualities (Nowak and Jasionowski, 2015). Taurine has also been identified to enhance endurance performance and to aid in the reduction of lactic acid build-up after exercise. Caffeine's potent stimulatory action makes it a valuable antidote to respiratory depression induced by drug overdose (e.g., from morphine or barbiturates). Other health benefits of caffeine as highlighted by Reid *et al*. (2017) include: stimulates the gallbladder and reduce the risk of gallstones; reduces inflammation and helps in preventing certain heart related illnesses; increases analgesics potency; and used for weight loss.

Caffeine supplementation has also been recently considered as an effective means of weight management (Heckman *et al*., 2010). Caffeine is often added to weight loss supplements to help "burn calories." Another area in which caffeine may play a positive role is in the prevention of sunlight-induced skin cancer as suggested by Reid et al.(2017) The main mutagenic effect of UV radiation is DNA damage in which research suggests caffeine has a protective role in both mice and humans (Cappelletti *et al*., 2015). Additionally, research has suggested that caffeine can aid in reducing symptoms associated with Parkinson's disease (PD) such as the deterioration of gross and small motor skills, and tremors (Mozammel et al.,2015).

A beverage is a drink specially prepared for human consumption either at meal or leisure times (Buxton and Hagan, 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. Research by the Scientific Advisory Committee on Nutrition (SACN, 2015) revealed that energy drinks are different from other beverages and soft drink. Energy drinks may also be referred to as "Sugar Sweetened Low pH Caffeinated Drink" (Akpoghe *et al*., 2020). The authors went further to define energy drinksas non–alcoholic beverages that contains high level of substances capable to excite any bodily functions and tend to stimulate the brain and the central nervous system.

Energy drinks are non–alcoholic, carbonated beverages claimed to give extra burst of energy for daily obligation. Products described as 'energy drinks' by food industries are typically glucose-based energy drinks: functional or stimulation energy drinks which claim a particular energy boost compound from caffeine, guarana, taurine, ginseng or other herbs or some combination of these ingredients, which are known to have stimulant properties and are distinct from sports drinks (which are often described as 'sports', 'isotonic' or 'hypotonic' and 'hypertonic') Whilst both claims to be the same there are several significant differences between them, both in terms of ingredients but also their branding and marketing.

METHODOLOGY

Collection of samples

Five commercially sold energy drink brands namely; Predator, Fearless, Bullet, Climax and Power Horse were purchased from the Eke Ekwulobia market in Aguata LGA., of Anambra state and were assigned codes as PRE 101, FEA 102, BUL 103, CLI 104 and POW 105, respectively.

Preparation of Standard Caffeine

A reading of 2.1916g of caffeine was gotten using an electric weighing balance. 1mg/ml stock standard of caffeine was prepared by dissolving the caffeine in 200ml purified water. Working standard were prepared by pipetting 2.5, 5, 7.5, 10 and 12.5ml aliquots of stock standard solution into separate 50.0ml volumetric flask and diluting to volume and then stock

caffeine reading was obtained by pipetting. (a)47.5 into the 2.5ml to get 50;(b) 45 into the 5ml to get 50; (c) 42.5 into the 7.5ml to get 50; (d) 40 into the 10ml to get 50, (e) 37.5 into the 12.5ml to get 50. Then, the wavelength (absorbance) of each sample solution was measured at absorption maximum of 270nm using 1cm quartz cuvette. The absorbance values were then plotted against concentrations to generate a standard calibration curve.

Extraction of Caffeine

Exactly 200ml distilled water was added to each of the 250ml beaker containing 1g solid or 200ml of samples in liquid form. The mixture was stirred for 30seconds and allowed to cool down. 50ml aliquot of each solution was placed separately in a separating funnel and 25ml of dichloromethane was added to extract the caffeine by inverting the funnel. The dichloromethane layer was decanted to a clean flask and the extraction process was repeated. The principle of this procedure is based on the increased solubility of caffeine in dichloromethane. The caffeine level of the samples was extrapolated from the prepared standard curve as described.

Determination of Caffeine

Aliquots of the extracted samples were placed into glass cuvettes and the quantitative analysis of caffeine and their absorbencies read from the spectrophotometer to obtain the caffeine concentrations.

Result and Discussion

Table 1 : Caffeine concentration for Predator, Fearless, Bullet, Climax and Power Horse.

SAMPLES OF ENERGY DRINK	CAFFEINE CONCENTRATION (mg/L)
PRE-101	0.720
FEA-102	0.545
BUL-103	0.275
CLI-104	0.305
POW-105	1.135

KEY

PRE: Predator

FEA: Fearless

BUL: Bullet

CLI: Climax

POW: Power horse

Discussion

The caffeine contents of energy drinks are presented in Table 1 above, from which it can be seen that the caffeine content of the energy drinks ranges from 0.721 to 1.135mg/L. It is observed that the caffeine content for Predator (PRE 101) to be 0.721mg/L, 0.545mg/Lfor Fearless (FEA 102), 0.275mg/L for Bullet (BUL 103), 0.305mg/Lfor Climax (CLI 104) and 1.135mg/Lfor Power Horse (POW 105). The lowest caffeine content was found in the Bullet brand (0.275mg/L), while Power Horse brand showed the highest caffeine content (1.135mg/L). The findings from the study is similar to results obtained by other researchers which include (Camelia *et a*l., 2018), who reported caffeine content of energy drink samples that ranged from 16.82 to 39.48mg/100mL. (Powles, 2018) showed that caffeine content in energy drink samples of Nigeria ranged from 47.56 to 58.31ppm and the average caffeine quantity in the energy drinks was found to be 52.24ppm. Patrick (2013) found that caffeine concentrations in energy drinks samples of Sudan ranged from 170.6ppm to 324ppm with average concentration of 255.6ppm. Consumption of 300mg of caffeine per day is generally considered as safe (Higgins, 2010). However, the research investigation, shows that the levels of caffeine in all energy drink samples are well below the maximum allowable limits set by World Health Organization.

Conclusion

The results from this research revealed the level of caffeine in energy drink brand namely;Predator (PRE 101), Fearless (FEA 102), Bullet (BUL 103), Climax (CLI 104) and Power Horse (POW 105) as0.721mg/L, 0.545mg/L, 0.275mg/L for, 0.305mg/L for and 1.135mg/L respectively. It is shown from the results that the concentration of caffeine in the energy drink samples were significantly lower than the maximum authorized level of (32mg/100mL) by International Food Information Council, World Health Organization and Nigeria regulatory agency such as National Agency for Food and Drug Administration (NAFDAC). From the results, Bullet (BUL 103) has the lowest caffeine content which is preferable while Power Horse (POW 105) has the highest content of caffeine. This research also opened our eyes about the intake of caffeine and its health effect. Inasmuch as we have gotten knowledge of caffeine content of different brand of energy drink, caution should be applied not to consume

excess of it. There is a saying that little drop of water makes an ocean therefore take energy drink with caution.

Since caffeine is an additive substance and because of health concerns arising from consumption of energy drinks, it seems appropriate that warning labels, indication of the presence and amounts of caffeine should accompany all caffeinated beverages. It therefore calls for more enlightenment by the appropriate government agencies such as NAFDAC to educate the youth about the health implication of the consumption of such drinks. We further recommend that labeling and any marketing of these products should include appropriate health warnings. Furthermore, cans and bottle sizes of energy drinks should also be decreased to reduce the overall consumption of sugar, energy and caffeine.

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