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Caffeine Content of Cocoa and Coffee Beverages in Lagos, Nigeria

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Abstract: This study determined the caffeine content of various brands of cocoa and coffee-based beverages in Lagos, Nigeria. Ten brands of these products were purchased from various shops in the Lagos metropolis. Caffeine was carefully extracted from each product and analyzed by ultraviolet/visible spectrophotometric methods. The results show that the caffeine content of the cocoa-based products ranged from 1.8 to 3.1 mg/g of product while classic and decaffeinated coffee contained 8.4 and 2.3 mg/g of product respectively. These amounts are considered low and safe for healthy adults when compared with established safety levels of the US Food and Drugs Administration. It was recommended that people who need caffeine restriction due to health conditions should choose products with lower caffeine contents. Also, since caffeine is an additive substance, manufacturers of caffeine-containing products should be required by regulation to indicate its presence and amounts on package labels for the information of the consuming public.

Key Words: Caffeine; beverage; Lagos, cocoa, extraction.

INTRODUCTION

A beverage is a drink specially prepared for human consumption either at meal or leisure times. There are a variety of beverages which can be broadly classified into alcoholic and non-alcoholic. Alcoholic beverages contain alcohol in varying concentrations while non-alcoholic beverages comprise soft drinks, fruit juices and hot beverages. Soft drinks and some fruit juices may contain caffeine arising from the raw materials used for its preparation or from deliberate addition. Hot beverages often contain caffeine and are termed 'hot' because they are usually served hot by addition of hot water or milk. This group consists of cocoa, tea and coffee-based products which are commercially available in the Nigerian market.

Caffeine is a xanthine alkaloid found abundantly in natural sources such as the seeds of coffee tree (Coffee arabica), leaves of tea bush (Thea sinensis), nuts of kola tree (Cola acuminata) and seeds of cocoa tree (Theobroma cacao). Caffeine is therefore present in beverages like coffee, tea, chocolate and soft drinks prepared using raw materials from these sources. Coffee has been found to be the biggest

source of caffeine in adults (Matissek, 1997). Even decaffeinated coffee is not totally free of caffeine because decaffeination is a process which is not 100% efficient. Caffeine-containing beverages are widely consumed worldwide.

Caffeine is a psychoactive stimulant known to increase alertness, elevate mood and give temporary energy boost thereby easing fatigue. It also increases the effectiveness of certain drugs, hence its use in some over-the-counter drugs for the treatment of conditions such as migraine and cluster headaches. In the form of coffee, it is said to have some cardio-protective effect in individuals who are not hypertensive. Caffeine is the most widely consumed psychoactive substance in the world and is largely unregulated (Lovett, 2005).

While some people take hot beverages with milk, sugar and other additives for nutritional purposes, many others use caffeine-containing beverages for stimulant effect which reflects the propensity of people to use stimulant drugs with the attendant addiction liability. Coffee is consumed regularly by millions of people in order to induce wakefulness when arising from sleep or to prevent falling asleep at specific times and to relieve the boredom of daily routines.

The chemical name of caffeine is 1, 3, 7-trimethylxanthine. It is well absorbed from the gastro-intestinal tract and readily crosses the blood-brain barrier and the placenta. It is known to act primarily by blocking adenosine receptors in the brain. This action antagonizes the suppressive effect of adenosine on neural activity resulting in stimulation (Nehlig, Daval, and Debry, 1992; Fisone, Borgkvist, Usiello, 2004). The effect is however temporary because it is by competitive inhibition which diminishes with decrease in caffeine concentration.

Caffeine also has other effects which may be unrelated to adenosine and some are attributable to its three primary metabolites: paraxanthine, theobromine and theophylline. These effects include increase in blood pressure, diuresis, increase in blood sugar, increase in gastric acid and pepsin secretion, increased plasma levels of fatty acids, cortisol and epinephrine, raised intraocular pressure and loss of calcium leading to bone loss (Klang, Wang and Meoni, 2002; Higginbotham et al., 1989). Some drugs such as fluvoxamine, levofloxacin and oral contraceptives inhibit the liver enzyme, cytochrome P-450 involved in the metabolism of caffeine thereby raising its blood levels and potentiating its numerous effects.

Use of caffeine may contribute to development of certain diseases or aggravate existing conditions; therefore caffeine may not be for everyone. Due to its numerous effects, certain categories of

people may need to abstain from, or restrict their intake of, caffeine. These include pregnant women and people suffering from hypertension or other cardiovascular diseases, diabetes, open angle glaucoma, insomnia, etc. For these people, the benefits derived from taking caffeine may not be worth the health risks. Manufacturers of most of the beverages in the market do not specify the quantity of caffeine on their product label. There is therefore a need for analysis of different products for caffeine content so that people can make informed choices.

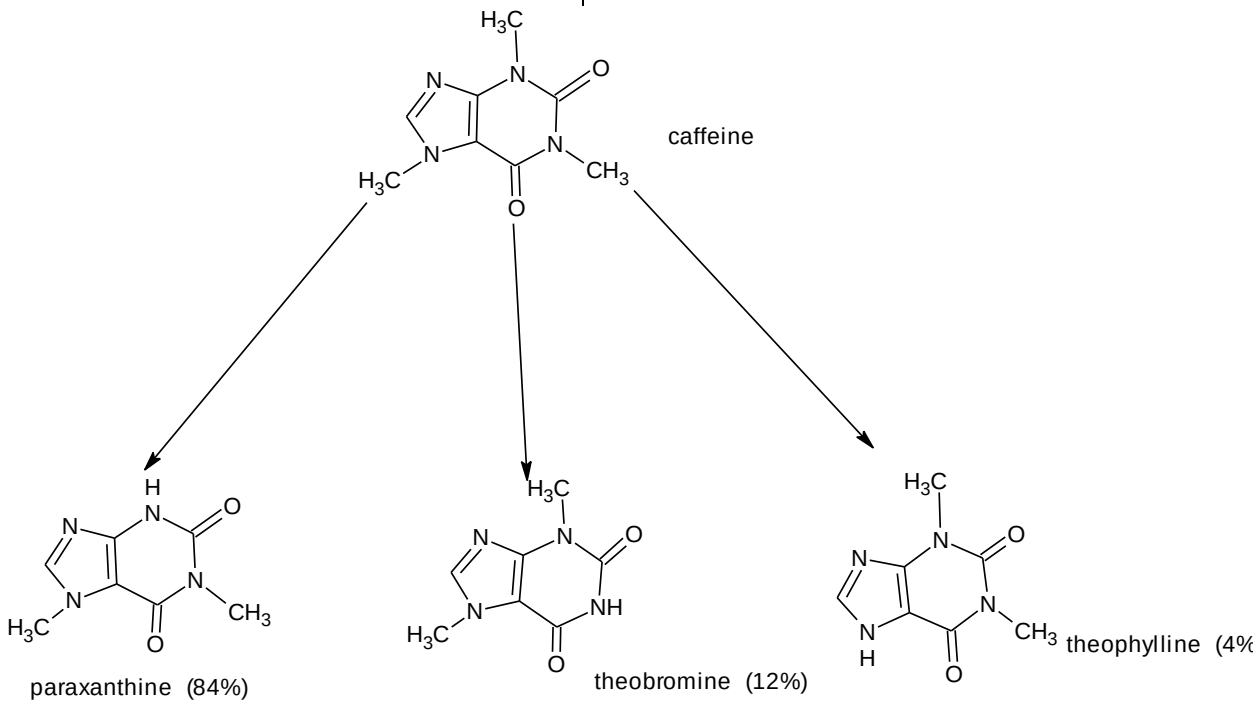

Figure 1: Caffeine and its Main Metabolic Products

MATERIALS AND METHODS

Collection of Samples

The following brands of beverages were purchased from retail shops across the Lagos metropolis and used in the study: Blue Boat Choco, Bournvita, Cowbell Chocolate, Jago Chocolate, Milo, Nescafe Classic, Nescafe Gold Blend (Decaffeinated), Ovaltine, Peak Choco and Richoco. All were within their shelf life and bore NAFDAC numbers on their packages.

Preparation of Standard Solutions

Standard caffeine powder (50mg) was weighed and dissolved in 20ml distilled water. This was made up to 100ml with distilled water. 10ml of this solution was taken and made up to 100ml with distilled water to produce a 50µg/ml stock

solution. The stock solution was then serially diluted to produce concentrations of 2, 4, 8, 12 and 16 µg/ml. The absorbance of each solution was measured using a UV/Vis spectrophotometer at absorption maximum of 272nm. The absorbance values were then plotted against concentrations to generate a calibration curve.

Extraction of Caffeine from Beverages

Two grams of sample was weighed and powdered. 200ml of distilled water was added to the sample and shaken for 15 minutes using a magnetic stirrer. Sufficient water was added to produce 250ml and the solution was filtered. To 10ml of the filtrate, 10ml of 1N sodium hydroxide (NaOH) was added and extracted immediately with five quantities each of 30ml of chloroform in a separating funnel. Each extract was washed with 10ml of water. The chloroform extracts were combined and filtered through a plug of absorbent cotton wool previously moistened with chloroform. The solution was then evaporated to dryness and the residue was dissolved completely in 30ml of water, warming gently on a water bath. The solution was cooled, made up to 100ml and filtered. The absorbance of the resulting solution was then measured using a UV/Vis spectrophotometer at 272 nm.

RESULTS

The results obtained from the analysis of the samples are presented in Table 1 and Figures 2 and 3 below.

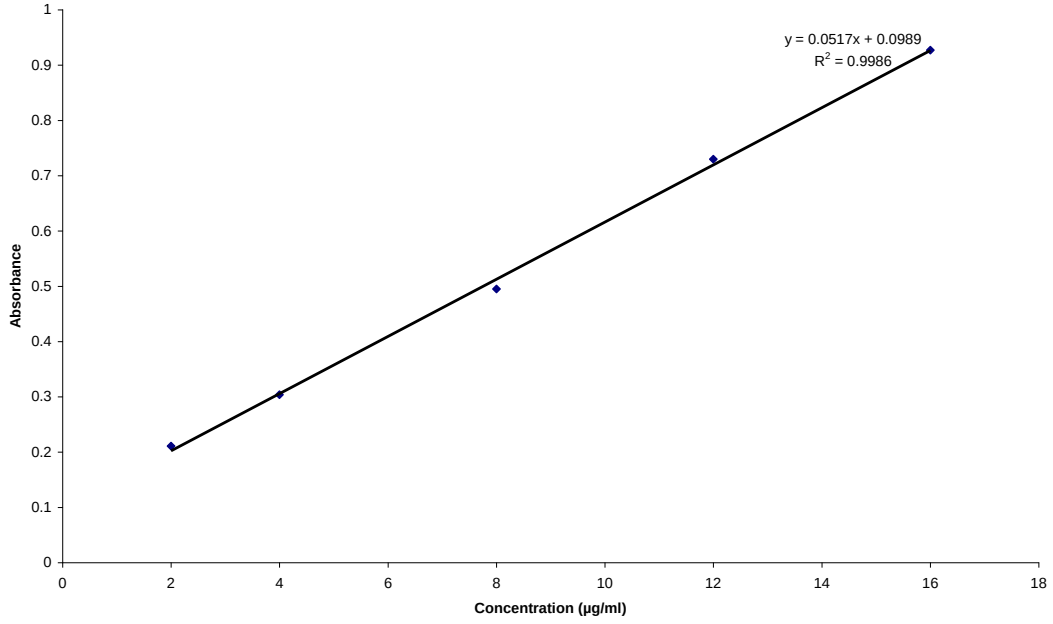

Figure 2: Calibration Curve for Standard Caffeine

Table 1: Concentrations and Amounts of Caffeine in the Various Samples

Sample Name	Sample Code	Absorbance	Concentration (µg/ml)	Amount of Caffeine (mg/per g of Sample)
Blue Boat Choco	BC	0.229	2.503	**3.125**
Bounvita	BV	0.174	1.442	**1.803**
Cowbell Chocolate	CC	0.224	2.404	**3.005**
Jago Chocolate	JC	0.214	2.212	**2.765**
Milo	ML	0.202	1.981	**2.476**
Nescafe Classic	NC	0.448	6.712	**8.390**
Nescafe Gold Blend (Decaffeinated)	ND	0.195	1.846	**2.308**
Ovaltine	OV	0.211	2.154	**2.693**
Peak Choco	PC	0.222	2.365	**2.956**
Richoco	**RC**	**0.208**	**2.096**	**2.620**

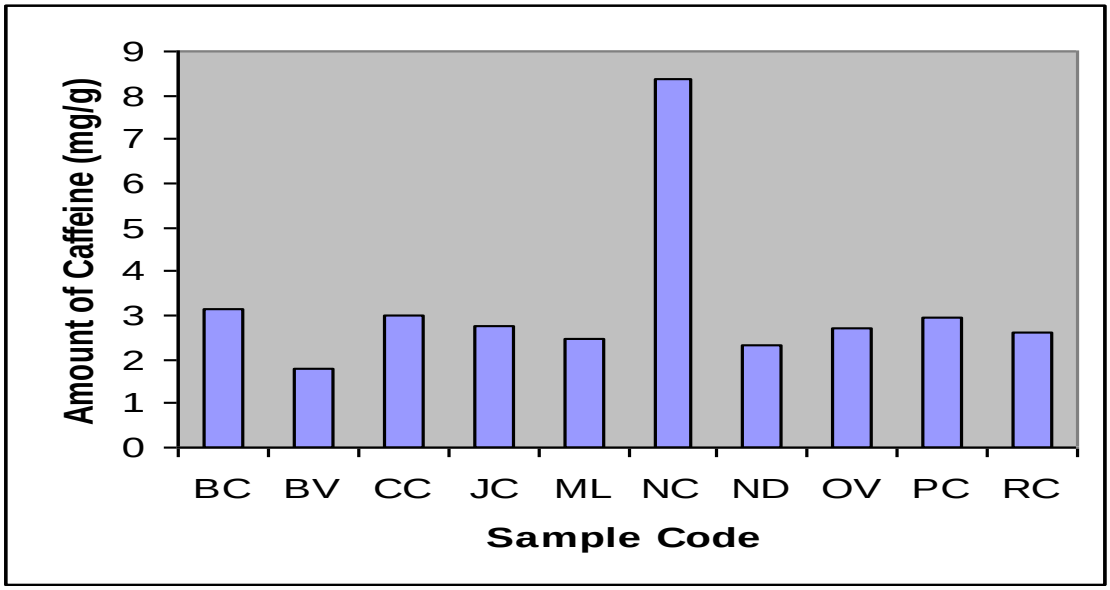

Figure 3: Chart Showing Amounts of Caffeine in the Various Samples

DISCUSSION OF RESULTS

The results of this analysis show that the amount of caffeine per gramme of the cocoa-based beverages ranged from 1.8 to 3.1 mg. For the coffee-based products, classic and decaffeinated coffee contained respectively, 8.4 mg and 2.3 mg caffeine per gramme of product. The amount of caffeine in food products varies according to the type of product and method of preparation. Generally, the coffee bean is higher in caffeine content than the cocoa bean; hence coffee products are expected to contain more caffeine than cocoa products. Also, dark-roast coffee may contain less caffeine than the lighter product because roasting reduces the caffeine content of the coffee bean (Lovett, 2005). Coffee is known as the topmost source of caffeine in adults.

The recommendation on the label of Nescafe Classic is that a 50 g pack should make 25 cups of coffee beverage (i.e. 2 g per cup). Based on this recommendation and using the results of this study, a cup of classic coffee will contain approximately 17 mg of caffeine while that of decaffeinated coffee would contain about 5 mg of caffeine. These values could be considered low and safe if we consider the US Food and Drugs Administration classification of caffeine consumption. Under this classification, caffeine intake of 130 - 300 mg/day is low/moderate, above 400 mg/day is high while above 6,000 mg/day is heavy. Low/moderate consumption is considered safe (U.S. Code of Federal Regulations, 2003). It will therefore take more than ten cups of classic coffee per day to exceed this limit.

Cocoa products are generally used in higher amounts per cup of beverage than coffee products. Using an average caffeine content of 2.5 mg/g (from results obtained) and 4 g of product per cup (double the amount of coffee product), a cup of the cocoa products would contain 10 mg of caffeine. This also is low and safe. However, safety levels are based on studies in healthy adults.

It is difficult to calculate the exact amount of caffeine consumed by individuals because the amount of product used per cup is usually not weighed/measured but dispensed by means of teaspoons. Also, there are a variety of cup sizes but use of a known amount of product would eliminate the importance of cup size. The amount of caffeine needed to produce effects varies from person to person according to body weight and individual sensitivity. Children for instance, due to their smaller weight, may manifest hyperactivity and other side effects if they regularly consume beverages with moderate caffeine content which are considered safe for adults (Benjamin, Rogers and Rosenbaum, 1991; www.kidshealth.org). Therefore, people who need caffeine restriction (pregnant women, people suffering from hypertension, diabetes, open angle

glaucoma, insomnia, etc.) should choose products with low caffeine content and avoid regular consumption.

Caffeine is an addictive substance, so regular consumption of products that contain even moderate amounts of caffeine may lead to addition to the products with withdrawal reactions like mood changes and flu-like symptoms. These include headaches, fatigue, irritability, difficulty in concentrating, depression, nausea/vomiting and muscle ache or stiffness (Juliano and Griffiths, 2004). These reactions may lead to increased intake of caffeine with increased adverse effects. Therefore, the use of caffeine should be regulated with a requirement for its presence in foods and drinks, along with amounts, to be clearly stated on the labels of such items.

CONCLUSION

It is shown from the results of this study that cocoa-based beverages widely consumed by the public, especially children, contain caffeine. Also, decaffeinated coffee has been found in this study to have caffeine contents in the same range as the cocoa-based beverages. However, the amounts found in the different products are low when weighed against established safety values and are therefore considered safe for healthy consumers. Since caffeine is an additive substance, manufacturers of caffeine-containing products should be required to indicate its presence and amounts on the product labels for information of the general public.

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