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Research Article

Consumption Patterns and Nutritional Profiles of Non-Alcoholic Energy Drinks Among Students at Nangui ABROGOUA University in Côte d'Ivoire

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Abstract

Energy drinks (EDs) help consumers combat fatigue and enhance physical and mental performance. Nonetheless, they carry health risks and may contribute to tooth decay, obesity, and diabetes. This research aimed to investigate the consumption levels of non-alcoholic energy drinks among students at Nangui ABROGOUA University (UNA) and to assess the nutritional content of these beverages. Students completed a questionnaire, and we analyzed the biochemical composition (pH, titratable acidity, total sugars, and reducing sugars) of two widely consumed drinks, Cody's and Kapa, using AOAC methods. The contents of caffeine, taurine, and B-vitamins were analyzed using high-performance liquid chromatography (HPLC), and the corresponding energy value was calculated. The findings revealed that 86.7% of students consumed energy drinks, with Cody's and Kapa being the leading brands at 70% and 10%, respectively. The health risks mentioned included type II diabetes (59%) and cardiovascular disease (10.7%). The pH values for Cody's and Kapa were 4.13 ± 0.02 and 3.96 ± 0.01, respectively. Titratable acidity values were 157.78 ± 1.92 meq/L for Cody's and 141.11 ± 1.92 meq/L for Kapa. The measured values of total sugars in the two beverages are slightly higher than the label claims. Specifically, Cody's shows 13.62 g/100ml, while Kapa has 11.46 g/100ml. In contrast, the labels state the values as 12 g/ g/100ml for Cody's and 11 g/100ml for Kapa. Cody's had caffeine and taurine levels of 28.9 ±0.1 mg and 43 ±0.01 mg, while Kapa's levels were 32.73 ±0.06 mg and 35 ±0.01 mg, respectively. This study found that students frequently consume non-alcoholic energy drinks (EDs), which contain high levels of sugar and caffeine. Consequently, it is essential to inform students about the health risks linked to their consumption.

Keywords

Non-alcoholic Energy Drink, Students, Consumption, Nutritional Composition, Côte d'Ivoire

1. Introduction

Energy drinks refer to beverages or liquid concentrates that claim to contain a combination of ingredients designed to enhance energy and promote alertness [1]. They typically contain large amounts of caffeine, added sugars, guarana, taurine [2], glucuronolactone, ginseng, B vitamins, and Ginkgo biloba, which are believed to help consumers reduce

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fatigue while enhancing performance and concentration [3].

Energy drinks are experiencing rapid growth in production and consumption within the beverage industry [4]. Furthermore, energy drink sales data indicate that the global market was also valued at $53 billion in 2019 [5]. Studies conducted in Canadian schools revealed that some students consumed these drinks more than twice a day [6]. These individuals are reported to use them to enhance their athletic and cognitive performance, particularly during exams and study periods [7].

However, regarding health effects, it's important to note that excessive consumption of energy drinks can harm the body [8]. Indeed, the stimulant ingredients in these drinks can lead to dependency, elevated blood pressure, and cardiovascular issues [7]. Furthermore, the high sugar and calorie content of certain energy drinks may lead to weight gain and contribute to diseases like type 2 diabetes and obesity [9, 10].

Despite the health risks involved, along with the interministerial decree of March 2024 prohibiting the manufacture, import, and sale of alcoholic energy drinks, scientific studies on these products are scarce in Côte d'Ivoire. Indeed, there is limited information about these beverages. It is essential to recognize that understanding consumption levels and the nutritional composition of these beverages can promote consumer safety, facilitate informed food choices, and ensure compliance with health and food safety regulations. The data can also aid public health initiatives and policies.

Since young people are the largest consumers, the primary goal of this study was to determine the consumption levels of energy drinks among students at Nangui ABROGOUA University and to analyze the nutritional composition of these beverages.

2. Materials and Methodology

2.1. Survey

The research was carried out at Nangui ABROGOUA University in Abidjan, Côte d'Ivoire. The survey involved students from this university and was conducted from March to April 2024. Participants completed a self-administered questionnaire covering their socio-demographic details, knowledge, consumption frequency, purchase prices, packaging, availability, and health risks associated with energy drink consumption. The sample size was calculated using [11], resulting in 357 surveyed students. Participants voluntarily agreed to participate, provided written consent, and were assured that their information would be confidential. The Human Research Ethics Committee of Nangui ABROGOUA University approved the study.

2.2. Nutritional Analysis

Samples of two energy drinks, Cody's Energy and Kapa, commonly consumed by students, were collected from two beverage dispensers located on campus. These samples were examined for biochemical characteristics, including pH [12], titratable acidity [12], total sugars [13], reducing sugars [14], caffeine [15], taurine [16], and energy value [17]. All tests were conducted in triplicate.

2.3. Statistical Analysis

Data from the survey and biochemical analyses were analyzed using IBM SPSS Statistics 20.0 and Excel 2013. Descriptive statistics were applied to process the data. In contrast, biochemical analysis data were evaluated using Student's t-test to compare the means of the two independent samples and identify a significant difference at the specified threshold.

3. Results

3.1. Socio-demographic Characteristics

Table 1 presents the socio-demographic characteristics of the students surveyed at Nangui ABROGOUA University. The study population included both male and female participants. The majority (51.3%) of respondents were in the 21-25 age group, and 58% reported being physically active. Additionally, most respondents were undergraduates (72%).

Table 1. *Socio-demographic characteristics of surveyed students.*

Student characteristics	The number of students (n= 357)	Percentage (%)
Gender		
Female	129	36
Male	228	64
Age range		
16-20	117	32.70
21-25	183	51.30
30+	57	16.00
Academic level		
License	257	72.00
Master	83	23.30
PhD	17	4.70
Physical exercise		
Practice	210	58.70
Not practicing	147	41.30

3.2. Consumption Levels by Socio-demographic Characteristics

Figure 1 illustrates the rate of energy drink consumption among students. The results indicated that 86.7% of the respondents were consumers, while only 13.3% were non-consumers. Furthermore, Table 2, which presents consumption levels by socio-demographic characteristics, shows that 89.6% of men and 81.5% of women consume these drinks. The age groups with the highest consumption rates were 16-20-year-olds (87.8%) and 21-25-year-olds (87%). ED consumption was just as high among athletes (89.8%) as among non-athletes (82.3%).

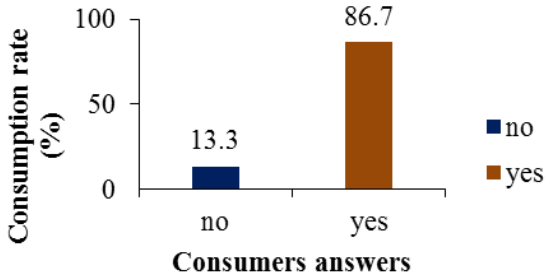

Figure 1. Energy drink consumption rates among UNA students.

Table 2. Percentage of energy drink consumption by socio-demographic characteristics.

Socio-demographic characteristics	Consumption rate (%)	
	Yes	No
Gender		
Male	89.6	10.4
Female	81.5	18.5
Age range		
16-20	87.8	12.2
21-25	87	13
30+	83.3	16.7
Study level		
License	86.1	13.9
Master	91.4	8.6
PhD	71.4	28.6
Physical activity		
Practice	89.8	10.2
Not practicing	82.3	17.7

3.3. Different Brands Consumed and Frequency of Consumption

Figures 2 and 3 illustrate the various energy drink brands favoured by students and the frequency of their consumption. The findings reveal that Cody's (70.7%) and Kapa (10.7%) are the most popular brands among students. Additionally, most students reported consuming these drinks occasionally (64.6%), while 18% consumed them only once a day.

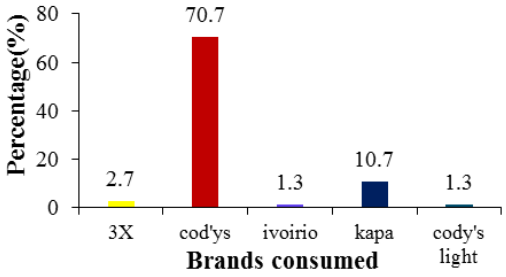

Figure 2. Different brands of energy drinks consumed by students.

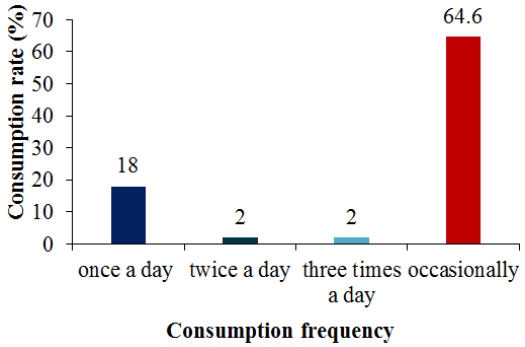

Figure 3. Frequency of consumption.

3.4. Motivation for Purchase and Sales Format

Table 3 illustrates different factors, including purchase motivations and sales formats for non-alcoholic beverages. The findings indicated that participants prioritized brand (41.6%) and price (22.7%) when selecting their beverages. Regarding sales formats, the most popular volumes purchased by students were 250mL (45.3%) and 330mL (22%).

Table 3. Motivation and purchased format.

Patterns	Proportion (%)
Reasons for choice	
Energy intake	10
Stimulating effect	1.3
Taste	6

Patterns	Proportion (%)
Brand	41.6
Mode	0.7
Price	22.7
Volume	4
No answer given	13.3
Format purchased	
250mL	45.3
300mL	0.7
330mL	22,7
350mL	1.3
500mL	8.7
650mL	0.7
No answer	20

3.5. Different Sensations Reported by Students Following Consumption of EDs

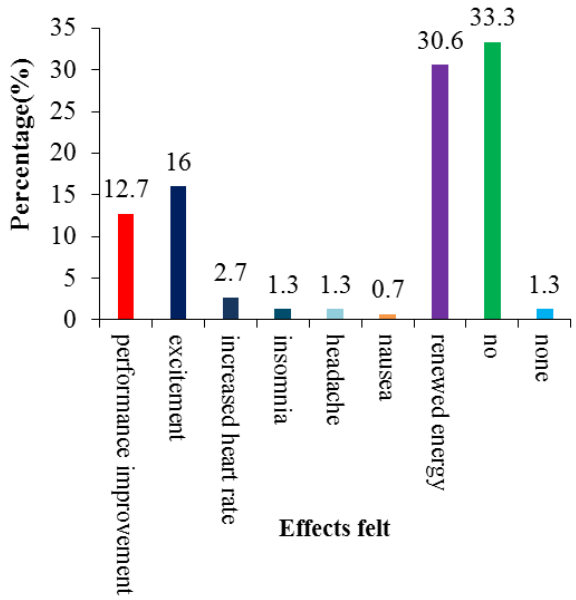

Figure 4. Impacts experienced after drinking energy beverages.

Figure 4 illustrates the various sensations experienced by students after consuming energy drinks. The findings indicated that enhanced physical performance (12.7%), excitement, and heightened energy (30%) were the most frequently reported sensations following the intake of energy beverages. Notably, 33% of students reported feeling no sensations at all.

3.6. Percentage of Students Knowledgeable About the Health Dangers of Frequent ED Consumption

Figure 5 illustrates the percentage of students recognizing the health risks linked to non-alcoholic beverages (BE). The findings indicate that 82.3% of consumers and non-consumers report being aware of the dangers associated with the excessive use of energy drinks. In contrast, 17.7% of both consumers and non-consumers lack this knowledge.

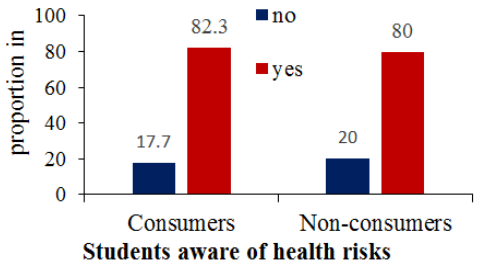

Figure 5. Awareness of the risks associated with regular consumption of energy drinks.

3.7. Evaluating Awareness of the Different Health Risks Linked to ED Consumption

Figure 6 illustrates the health risks recognized by the surveyed UNA students. The findings indicated that type II diabetes (59.9%) and cardiovascular disease (10%) were the most acknowledged risks. Additionally, risks such as obesity (4%), depression (4%), dental caries (2%), and kidney failure (0%) were mentioned, although at significantly lower rates.

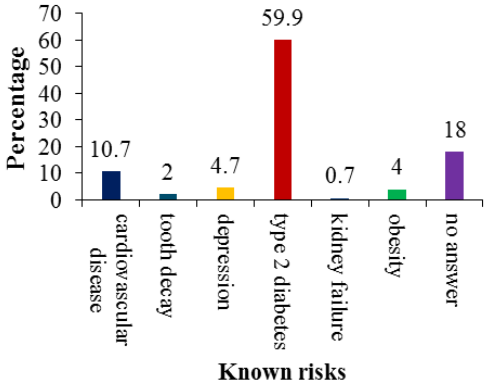

Figure 6. Identified health risks.

3.8. Analysis of the Biochemical Composition of Non-alcoholic Energy Drinks Compared to Packaging Information

Table 4 presents the biochemical characteristics of the ana-

lyzed non-alcoholic energy drinks (*Cody's* and *Kapa*). The results indicate significant differences between the samples for specific biochemical parameters, such as pH, titratable acidity, caffeine, taurine, B vitamins, and reducing sugars. The *Cody's* sample is particularly rich in taurine (43±0.01 mg/100ml), vitamin B2 (0.43±0.02), vitamin B3 (7.41±0.01), total sugars, and reducing sugars. Its pH (4.13±0.02) and titratable acidity (157.78±1.92 meq/L) are considerably higher than those of the *Kapa* brand. On the other hand, *Kapa* contains the highest levels of caffeine (32.73±0.06 mg/100ml), vitamin B5 (2.13±0.15 mg/100ml), and vitamin B12 (3.80±0.02 mg/100ml). A comparison of the obtained data with the values listed on the label shows discrepancies; the actual concentrations may be higher or lower than what is indicated, depending on the constituents.

Table 4. *Biochemical traits of Cody's and Kapa energy drinks, analyzed in the lab and detailed in the packaging value table.*

Nutritional parameters	Laboratory		Label	
	Cody's	***kapa***	***Cody's***	***kapa***
pH	4.13 ±0.02 [b]	3.96 ±0.01 [a]	-	-
Titratable acidity (meq/L)	157.78 ±1.92[b]	141.11 ±1.92[a]	-	-
Caffeine (mg/100ml)	28.9 ±0.01 [a]	32,73 ±0.06 [b]	30	-
Taurine (mg/100ml)	43±0.01 [b]	35±0.01 [a]	-	-
Vitamin B1 (mg/100ml)	0.20 ±0.02 [a]	0.29 ±0.36 [b]	-	-
Vitamin B2 (mg/100ml)	0.43±0.02 [b]	0.28±0.02 [a]	-	0.39
Vitamin B3 (mg/100ml)	7.41±0.01 [b]	6.38±0.02 [a]	8	7
Vitamin B5 (mg/100ml)	1.51 ±0.01 [a]	2.13 ±0.15 [b]	2	2
Vitamin B6 (mg/100ml)	1.69±0.02 [b]	1.19 ±0.01 [a]	2	1.4
Vitamin B12 (µg/100ml)	2.22 ±0.03 [a]	3.80 ±0.02 [b]	2	5
Reducing sugars (g/100ml)	13.45 ±0.05 [b]	11.14 ±0.01 [a]	12	11
Total sugars (g/100ml)	13.62 ±0.31 [b]	11.46 ±0.02 [a]	12	11
Energy value (*Kcal* /100ml)	54.52 ±0.05 [b]	45.84 ±0.01 [a]	52	48

Means ± deviations assigned to different letters on the same line are significantly different at the threshold according to Student's t test.

4. Discussion

This study revealed that students at Nangui ABROGOUA University (UNA) regularly consume non-alcoholic energy drinks. They reported doing so to alleviate post-class fatigue and to enhance their cognitive performance during exams, as noted by some authors [18]. The authors [19] in their research on the impact of energy drink consumption on health in the USA, found that the short-term advantages of energy drinks involved increased alertness, enhanced mental and physical endurance, and diminished fatigue in both adults and adolescents.

The data collected showed a difference in the drinking habits of men and women, indicating that a slightly higher percentage of men consume these beverages than women. The gap between men and women in consumption has already been highlighted by [20]. In their study, men's beverage consumption averaged 67, while women's averaged 58. This slight difference in beverage consumption habits may be attributed to the varying physical and professional activities of men and women. The consumption rates of beverages among students aged 16-20 and 21-25 are significantly higher than those of other age groups, reflecting a notable trend. Young adults exhibit a pronounced preference for these drinks, prompting various beverage brands to target their advertising efforts at this demographic. These outcomes align with those of [21], who indicate that, alongside young adults, teenagers are also significant consumers.

Student athletes consumed these beverages at a higher rate than non-athletes. They reported using them post-activity to replenish energy lost during exertion. According to [22], about 49% of consumers said they engage in sports or physical exercise at least twice a week.

Cody's and *Kapa* emerged as the top brands favoured by students, largely due to their appealing combination of pop-

ularity and affordability. Among various formats, the 250 ml can size stood out as the preferred option for students. According to [22], the 250 ml can is the most popular choice, accounting for 71% of responses. Another popular option is the 330 ml format, which has a consumption rate of 22%.

This study revealed that most students consume these beverages occasionally, suggesting an increasing awareness of the health risks associated with excessive consumption [23] noted the sporadic use of energy drinks by youth. Students appeared knowledgeable about health risks, particularly those related to type II diabetes and heart disease. The availability of media and social networks provides students with ample information regarding these beverages.

This study revealed notable differences in the biochemical properties of *Cody's* and *Kapa* drinks, particularly in energy value, caffeine levels, taurine, sugar, and vitamins B1, B2, B3, B5, B6, and B12. The biochemical distinction between these two drinks is believed to relate to the ingredients and methods of preparation employed [24]. This disparity may arise from globalization, leading to intense competition among companies to keep existing customers and attract new ones. It also compels producers to innovate, enabling them to make informed market decisions [25].

The World Health Organization (WHO) and the European Food Safety Authority (EFSA) [26] suggest a daily consumption of 25 grams of sugar (about 6 teaspoons) and 400 milligrams of caffeine. Nevertheless, studies have revealed that a 250 ml can contains sugar well above the advised limit [27]. Even though the caffeine levels in these drinks are under the suggested limit [7], they may present a health hazard if eaten often and in excess [19]. Elevated sugar and caffeine levels, combined with minimal taurine, raise concerns about their potential effects on consumer health. According to a study by [28] Research indicates that consuming sugar-sweetened beverages leads to increased weight gain, higher body mass index, and a greater risk of type 2 diabetes among children and adolescents. Additionally, these energy drinks are associated with elevated levels of added sugar and contain significantly more caffeine compared to cola-type beverages [29]. Biochemical and statistical evaluations revealed that the measured values for the two drinks were not significantly different from those listed on their labels, despite minor variations. These results align with those of [30], A study on energy drink consumption among University of Ibadan students revealed that the data collected did not significantly differ from the information presented on the labels of the four analyzed brands: P. Horse, Emerge, Red Bull, and Matador.

5. Conclusion

This study aimed to determine the consumption levels of non-alcoholic energy drinks among students at Nangui ABROGOUA University, examine the biochemical composition of these beverages, and compare this composition with the values stated on their packaging. The findings revealed that over half of the surveyed students consume energy drinks. Additionally, the study found that most students know the risks associated with excessive consumption of these beverages. The biochemical compositions of the two analyzed energy drinks differed significantly. It is important to know the consumption of energy drinks in other universities in Côte d'Ivoire and to raise awareness among students about the health risks to which they would be exposed by consuming them.

Abbreviations

ED	Energy Drinks
UNA	Nangui ABROGOUA University
AOAC	Association of Official Analytical Chemists
HPLC	High-performance Liquid Chromatography
LBATPT	Laboratory of Food Biochemistry and Technology of Tropical Products

Author Contributions

Aïssatou Coulibaly: Conceptualization, Data curation, Methodology, Resources, Visualization, Writing – original draft, Writing – review & editing

Adam Camille Kouamé: Conceptualization, Writing – review & editing

Adjoba Marie Jeanine Wognin: Conceptualization, Investigation, Writing – original draft, Writing – review & editing

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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