European Journal of Nutrition & Food Safety

Volume 15, Issue 4, Page 30-36, 2023; Article no.EJNFS.98184
ISSN: 2347-5641

Evaluation of the Biochemical, Physicochemical and Microbiological Quality of Soft Drinks Sold in Some Elementary School of Williamsville (Abidjan, Côte d'Ivoire)

Philippe Krou Eba [a*], Athanase Kra Kouassi [b], Brice-Jean Gbakayoro [c] and Georges N'guessan Amani [a]

[a] *Laboratory of Food Biochemistry and Technology of Tropical Products (LBATPT), Nangui Abrogoua University, UFR of Food Science and Technology, 02 BP 801 Abidjan 02, Ivory Coast.*
[b] *Départment of Biochemistry and Microbiology, Agroforestery Unit, Jean Lorougnon Guede University, BP 150 Daloa, Ivory Coast.*
[c] *Brice-Jean Gbakayoro, Nutrition and Food Safety Laboratory, Nangui Abrogoua University, UFR of Food Science and Technology, Abidjan, Ivory Coast.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2023/v15i41305

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/98184

Original Research Article

Received: 03/02/2023
Accepted: 06/04/2023
Published: 14/04/2023

ABSTRACT

The sale of soft drinks in and around primary schools is recurrent in Côte d'Ivoire. The objective of this work is to evaluate the rate of some biochemical and physicochemical parameters and the health risks related to the consumption of soft drinks. The biochemical and physicochemical

**Corresponding author: Email: ebaphilippekrou@gmail.com;*

parameters were determined according to the standard SOXHLET technique, that of Kjeldhal and also that described by Dubois et al in1956. Potentially pathogenic and pathogenic germs were enumerated and researched according to reference methods described by AFNOR. The moisture content of the different beverages ranged from 3.9±0.05 to 3.2±0.05, and the sugar content from 26.06±2.05 to 5.96±1.60. For the acidity, the higher value was 0.93± 0.15 (Bissap juice) and the lowest was 0.64± 0.02 (Tamarind juice). For proteins, the high value was 44.15 ± 0.11 (Milk Mint Juice) and the low value was 38.15 ± 0.11 (Ginger Juice). As for dry matter, the highest value was found in ginger juice (44.76 ±0.02) and the lowest in bissap juice (40.96 ±0.01). Soft drinks sold in Williamsville schools contain such potentially pathogenic species as *Staphylococcus aureus* and *Bacillus cereus* with a wide range of loadings in the drinks. *Escherichia coli* was not identified. No *Salmonella* was observed in the different soft drinks analyzed. The presence of potentially pathogenic germs could pose a danger to school children.

Keywords: Soft drinks; primary schools; juice; pathogenic germs; children and adolescents.

1. INTRODUCTION

Diets and lifestyles are changing rapidly, and urbanization has accelerated over the past decade. This evolution has caused changes in eating habits, a decrease in physical activity and a corresponding increase in chronic diseases and obesity risks related to poor nutrition [1]. While the developed countries are confronted with the problems of obesity and diseases of all sorts related to poor nutrition, the developing countries are now facing those of infectious and chronic degenerative diseases, increasingly associated with the nutritional transition. This coexistence of infectious and chronic diseases would be associated with the level of economic development of countries, low food quality and poor living conditions. Many developing countries around the world have undergone a nutritional transition [2,3] urbanization and globalization and. This change has negative consequences even if access to food is increased and diversified, the problem of inappropriate food and chronic diseases is increasing. School age is an active growth phase of childhood [4], representing a dynamic period of physical growth as well as mental development. A healthy diet helps to improve or maintain good health and plays a crucial role in preventing the development of chronic diseases. Several individual and collective determinants [5] influence healthy eating in children and adolescents. Among these collective determinants, the school environment contributes to the establishment of eating habits because children spend more time there. The latter is known to have a strong influence on their eating behavior and physical activity. In addition, elementary school are increasingly witnessing the emergence of food provided outside the family, especially fruit juices. This situation is particularly noticeable in and around schools. Good school feeding contributes to increased school enrollment, increased school attendance and improved nutritional status of the child population. However, this issue is now a major concern for both parents and school officials. The objective of this work is to evaluate the rate of some biochemical, physicochemical parameters and health risks related to its consumption of soft drinks.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Description and selection of study sites

The schools were randomly selected from among the most unhealthy schools in the Williamsville suburbs. Thus, five elementary school were the subject of this study. They are (EEP Konaté, EEP LABAT A-B, EPP the Wonders, Saint School Group Kizito and School Group Jean Porquet).

2.1.2 Sampling

Altogether 50 samples were collected from the different elementary school for this work. Ten samples were collected per school. The samples consisted of Tamarind juice, Milk Mint juice, Baobab juice, Bissap juice and Ginger juice.

2.2 Methods

2.2.1 Determination of biochemical parameters

The fat of soft drinks was extracted by the A.O.A.C method, [6] using SOXHLET. Crude protein was deduced from the determination of total nitrogen according to the Kjeldhal Method (B.I.P.E.A, [7]). The determination of total sugars was done according to the method described by Dubois et al. [8]. As for reducing sugars, they were determined according to the method described by Bernfeld [9].

2.2.2 Determination of physico-chemical parameters

Moisture content, pH and ash content, titratable acidity and the Brix degree were determined according to the method described by (A.O.A.C, [10].

2.2.3 Microbiological analysis of samples

A 25 mL sample of soft drink was collected under aseptic conditions and added to 225 mL of sterile buffered peptone water. The resulting solution was stirred for 5 minutes and allowed to stand for thirty minutes. About 1 ml of the obtained suspension was taken around the flame and transferred into a test tube containing 9 ml of sterile distilled water. Successive dilutions were made until the desired ones were obtained (NF EN ISO 6887-1, [11].

● Listing of potentially pathogenic germs

A 0.1 mL of each decimal dilution concerned was placed in a Petri dish containing 20 mL of ready agar. The 0.1 mL was spread on the surface of the agar. Plates were incubated at 45°C for 24 h for *E. coli* enumeration on *E. coli* Rapid 2 medium (NF/ISO 16649-2, [12]). at 30°C for 24 to 48 h for the enumeration of *Bacillus* on Mossel medium (NF EN ISO 7932, [13]; NF EN ISO 21871, [14]) and at 37°C for 24 to 48 h for the enumeration of *Staphylococcus aureus* on Rapid Staph medium supplemented with egg yolk with potassium tellurite (NF EN ISO 6888/1, [15]).

● Search for *Salmonella*

For the search of *Salmonella 6*, the V08-52 standard provides 4 steps. These are pre-enrichment in EPT medium, enrichment in Vassiliadis Rappaport medium, isolation on Hektoen medium and identification from Leminor or API 20 E galleries.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Monitoring of physicochemical parameters

The parameters analyzed were all variable from one drink to another. Thus, the moisture and sugar content of different beverages also varied from one beverage to another. These ranged from 3.9±0.05 to 3.2±0.05 for moisture content, from 26.06±2.05 to 5.96±1.60 for sugar content. For acidity, the highest value was 0.93± 0.15 (Bissap juice) and the lowest was 0.64± 0.02 (Tamarind juice). As for pH, the lowest value was found in ginger juice (1.83±0.11) and the highest was found in Bissap juice (3.93±0.43) (Table 1).

Table 1. Physicochemical parameters of soft drinks

	Non-alcoholic beverages				
Physicochemical parameters	**Tamarind juice**	**Mint juice with milk**	**Baobab juice**	**Bissap juice**	**Ginger juice**
Humidity level	3.4±0.03	3.2±0.05	3.7±0.03	3.9±0.05	3.2±0.03
Titratable acidity (ml)	0.64±0.02	0.73±0.15	0.87±0.14	0.93±0.15	0.77±0.14
pH	3.59±0.02	3.82±0.49	3.40±0.12	3.93±0.43	1.83±0.11
Ash content	3.20±2.4	2.19±2.19	2.50±2.4	3.22±2.19	3.2 ±0.1
Brix degree	5.96±1.60	9.00±2.00	10.90±0.36	26.06±2.05	25.26±0.64

Table 2. Biochemical parameters of soft drinks

	Non-alcoholic beverages				
Biochemical parameters	**Tamarind juice**	**Mint juice with milk**	**Baobab juice**	**Bissap juice**	**Ginger juice**
Protein	41.07± 0.47	44.15±0.11	34.15±0.11	42.15±0.11	38.15±0.11
Total sugars	5.77±0.14	6.83±0.15	0.77±0.14	0.83±0.15	0.77±0.14
Reducing sugars	5.06±0.10	4.32±0.08	4.06±0.10	5.32±0.08	5.06±0, 10
Fats	42.76±0.02	39.96±0.01	43.76±0.02	40.96±0.01	44.76±0.02
Dry matter	90.45±4.76	92.32±4.37	94.85±4.76	95.32±4,37	94.65±4.76

Table 3. Microbial load of potentially pathogenic germs in soft drinks

	Bacillus cereus	***Staphylococcus aureus***	***Escherichia coli***
Tamarind juice	$3.1.10^3 \pm 144.6$	$5.9.10^3 \pm 964.4$	0 ± 0
Mint juice with milk	$8.6.10^3 \pm 122.3$	$4.5.10^3 \pm 482.4$	0 ± 0
Baobab juice	$5.10^3 \pm 192.7$	$3.5.10^3 \pm 421.2$	0 ± 0
Bissap juice	$2.5.10^3 \pm 330.4$	$1.2.10^3 \pm 628.2$	0 ± 0
Ginger juice	$1.6.10^3 \pm 122.4$	$1.2.10^3 \pm 204.2$	0 ± 0
Microbiological criteria	**10^3 CFU/g**	**10^3 CFU/g**	**10 CFU/g**

Table 4. Search for *Salmonella* genus in non-alcoholic beverages analyzed

Sample sites	**Denominations**	**Presence of *Salmonella***
	Ginger Juice	-
	Tamarind Juice	-
EEP Konaté	Baobab Juice	-
	Mint Milk Juice	-
	Bissap Juice	-
	Ginger Juice	-
	Tamarind Juice	-
EEP LABAT A-B	Baobab Juice	-
	Mint Milk Juice	-
	Bissap Juice	-
	Ginger Juice	-
	Tamarind Juice	-
EPP the Wonders	Baobab Juice	-
	Mint Milk Juice	-
	Bissap Juice	-
	Ginger Juice	-
	Tamarind Juice	-
Saint Kizito School Group	Baobab Juice	-
	Mint Milk Juice	-
	Bissap Juice	-
	Ginger Juice	-
	Tamarind Juice	-
Jean Porquet School Group	Baobab Juice	-
	Mint Milk Juice	-
	Bissap Juice	-

3.1.2 Monitoring of biochemical parameters

The biochemical composition of the different soft drink samples is presented in Table 2. The results show that the total sugar content, reducing sugar content, fat content and protein content of soft drinks are variable. In terms of protein, the highest value was 44.15 ± 0.11 (Milk Mint Juice) and the lowest was 38.15 ± 0.11 (Ginger Juice). As for dry matter, the highest value was found in ginger juice (44.76 ±0.02) and the lowest in bissap juice (40.96 ±0.01).

3.1.3 Monitoring of potentially pathogenic germs

The soft drinks sold at the various Williamsville schools contained potentially pathogenic bacterial species such as *Staphylococcus aureus* and *Bacillus* with widely varying loads in the drinks. *Escherichia coli* was not present in any of the soft drinks tested (Table 3).

3.1.4 Monitoring of strict pathogens: *Salmonella*

Non-alcoholic beverages sold at the various Williamsville elementary schools did not contain pathogens, specifically the genus *Salmonella* as shown in Table 4.

3.2 Discussion

The physicochemical analysis carried out on the acidity of soft drinks showed very variable and very acidic results. However, the acidity of ginger juice was 1.83±0.11, higher than the other drinks. This acidity is thought to be due to the release of numerous organic acids such as succinic, oxalic, tartaric, and malic acids contained in the rhizome into water Shimoda et al. [16]; Colleen et al. [17]. Nevertheless, the pH was satisfactory according to CODEX-STAN 243- 2003, which recommends that the pH of fruit juices and soft drinks should be below 4.5. Also, the average Brix level of ginger and bissap juice was very high. The Brix degree gives information on the sugar content in the dry matter. These high values of Brix degree could be explained by the fact that during the manufacture of the drink, the producers would add the quantities of sugar at their convenience. For many producers, the sweeter the drink, the better it is appreciated by consumers. But overconsumption of these highly sweetened juices could have adverse health effects and lead to cardiovascular disease, tooth decay, obesity Yang et al. [18], and especially diabetes Basu et al. [19]. Microorganisms could grow easily in the said drink despite the relatively low pH. Indeed, at pH close to 4, germs are not eliminated but their growth is slowed down.

This increase in sugar content would make the substrate available for the development of microorganisms. This development of microorganisms is perfectly in agreement with the work of Omoruyi et al. [20] which showed that, the more a food contains sugars the more quickly it will degrade.

Regarding proteins, a low temperature favors the increase of their levels in soft drinks. This assertion contradicts those of Bimbinet et al. [21] who demonstrated that proteins risk denaturation each time the temperature of the wet product approaches or exceeds the maximum threshold of 80°C. The total ash content of soft drinks was observed to vary between 2.19± 2.19 and 3.22± 2.19. This total ash content could probably be due to the stability of the total ash during storage when the soft drinks are sold which gives them this stability character Bimbinet et al. [21].

The different analyses performed on the soft drink samples revealed the absence of *Salmonella* in the samples. This is due to the fact that the water used to make the beverages was water that was not contaminated with *Salmonella*. These results are consistent with those obtained by Oulaï et al. [22] who also showed the absence of these germs in some foods sold in the streets.

For the potentially pathogenic species, the different non-alcoholic beverages analyzed were contaminated by *Staphylococcus aureus* and *Bacillus cereus, but not by* . These results are in conformity with the norm (10^2 CFU/g). Our results are similar to those of (Berghofer *et al.* [23]; Le Loir & Gautier, [24]) who have shown in recent studies that the presence of *Staphylococcus aureus* could also be due to human contamination of foodstuffs, given that this bacterium is commensal to the skin and mucous membranes of humans. This would indicate non-compliance with good hygienic practices and inefficiency of the product in these different markets Berghofer et al. [23].

The results of the microbiological analysis of *Escherichia coli* revealed an absence of these germs in all the non-alcoholic beverages, these results respect the microbiological criteria (10 CFU/g). The absence of *Escherichia coli* in all samples attests the absence of contamination of fecal origin. The results of this study are consistent with those performed by Degnon *et al.* [25].

4. CONCLUSION

This study was conducted to assess the health risk associated with the consumption of soft drinks sold in some elementary school in Williamsville, a suburb of Abidjan. The lack of good hygiene practices in the places of sale and manufacture of the juice of these drinks would predispose to all forms of contamination. Poor preparation, use of water for drinks, sieves, use of hands for mixing are all subject to microbial contamination. Microbiological analyses showed that soft drinks sold in elementary schools were highly contaminated with potentially pathogenic germs. It should be noted that the presence of pathogenic species such as coagulase-positive *Staphylococcus aureus* and *Bacillus cereus* in soft drinks sold in elementary school would represent a danger to school children.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO /WHO. Joint FAO/WHO Food Standards Programme. Codex Alimentarius Commission, 32nd Session

Rome (Italy), 29 June-4 July 2009. Report of the 30th Session of the Codex Committee on Nutrition and Foods for Special Dietary Uses Cape Town, South Africa. 2008; 223.

2. McIntyre J, Vidal AE, McLenigan MP, Bomar MG, Curti E, Mc-Donald JP, Plosky BS, Ohashi E, Woodgate R. Ubiquitin mediates the physical and functional interaction between human DNA polymerases and Nucleic Acids Res. 2013;41:1649 -1660.
3. Vorster HH, Venter CS, Wissing MP, Margetts BM. The nutrition and health transition in the North West Province of South Africa: A review of the THUSA (Transition and Health during Urbanisation of South Africans) study. Public Health Nutrition. 2005;8(5):480-90.
4. Condon EM, Ctrepinsek MK, Fox MK. School meals: Types of foods offered to and consumed by children at lunch and breakfast. American Dietetic Association. 2009;109S(2): 67-78.
5. Taylor JP, Evers S, Mckenna ML. Determinants of healthy eating in children and youth Canadian Journal of Public Health. 2005;96: 3.
6. AOAC. Official methods of analysis, 17th edn. Association of Official Analytical Chemists, Washington DC. 2000;687.
7. BIPEA. International Bureau of Analytical Studies. Compendium of analytical methods of the European Economic Communities. 1st edition, Brussels. 1976;67-114.
8. Dubois M, Gilles AK, Hamilton JK, Ribers PA, Smith F. Colorimetric method for determination of sugars and related substances. Chemistry. 1956;28:350-356.
9. Berfeld P. Alpha and beta-amylases. In, Methods in Enzymology, colowick S.P and Kaplan N, eds Accademic Press, New York. 1955;1:149-158.
10. AOAC. Official methods of analysis, 15th edn. Association of Official Analytical Chemists, Washington DC. 1990; 774.
11. NF EN ISO 6887-1. Food microbiology - Preparation of samples, stock suspension and decimal dilutions for microbiological examination - Part 1: general rules for the preparation of stock suspension and decimal dilutions. 2017;20.
12. NF ISO 16649-2. Food microbiology - Horizontal method for the enumeration of β-glucuronidase-positive *Escherichia coli*. Part 2: Colony counting technique at 44°C using 5-bromo-4-chloro-3-indolyl-β-D-glucuronate acid. 2001;55.
13. NF EN ISO 7932. Microbiology of food. Horizontal method for the enumeration of presumptive Bacillus cereus. Colony counting technique at 30 °C; July 2005.
14. NF EN ISO 21871. Microbiology of foods. Horizontal method for the enumeration of presumptive *Bacillus cereus* in small numbers. Most probable number technique and method of investigation; July 2006.
15. NF EN ISO 6888-1. Microbiology of foods. Horizontal method for the enumeration of coagulase positive staphylococci (*Staphylococcus aureus* and other species). Part 1: Technique using Baird-Parker agar medium. 1999;45.
16. Shimoda Y, Yamaguchi Y, Okamura T, Taniguchi A, Yamaguchi Y. Prediction of greenhouse gas reduction potential in Japanese residential sector by residential energy end-use model. Applied Energy. 2010;87:1944-1952.
17. Colleen PK, Scott DS, Gaskin JE. I am proud of it: Consumer technology appropriation and psychological ownership. The Journal of Marketing Theory and Practice. 2012;23(2):166-184.
18. Yang RY, Tsou SC. Enhancing iron biovailability of vegetables through proper preparation principles and applications. Journal of International Cooperation. 2006;1:107-119.
19. Basu R, Preeta B, Elizabeth S. Frugal Innovation: Core Competencies to Address Global Sustainability. Journal of Management for Global Sustainability. 2013;1(2):63-82.
20. Omoruyi FO, Dilworth L, Asemota HN. Anti-nutritional factors, zinc, iron and calcium in some Caribbean tuber crops and the effect of boiling or roasting. Nutrition & Food Science. 2007;37(1): 8-15.
21. Bimbinet J.J, Duquenoy A, Trystram G. Food process engineering: from basics to bases applications. Dunod, Paris. 2002;10-16.
22. Oulaï FS, Koffi AR, Koussemon M, Dje M, Kakou C, Kamenou A. Evaluation of the microbiological quality of traditionally smoked *Ehtmalosa fimbriata* and *Sardinella aurita* fish. Microbiol. Hyg. 2007;19: 55.

23. Berghofer LK, Hocking AD, Miskelly D, Jansson E. Microbiology of wheat and flour milling in Australia. International Journal of Food Microbiology. 2003;85:137-49.
24. Le Loir Y, Gautier M. *Staphylococcus aureus*. Tec & Doc, EMinter, Lavoisier. France. 2010;150.
25. Degnon RG, Dahouenon-ahoussi E, Adjou ES, Sohounhloue DCK. Artisanal processing of shrimp (*Penaeus* spp) in southern Benin: evaluation of technical performance of smoking equipment and processes. Nature & Technology. 2013;08: 23-31.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/98184