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Evaluation of the erosive potential of selected non-carbonated powdered sachet fruit drinks on the human enamel

Bisiriyu, M. T., Koleola, A. A., Salau, R. B. and D. U. James. Department of Chemistry, School of Physical Sciences, Federal University of Technology, PMB 65, Minna, Nigeria

Abstract

This study was carried out to evaluate the erosive potentials of selected non-carbonated powdered sachet fruit drinks on the human dentition using physical examination and standard analytical procedures involving measurements of some physicochemical parameters such as pH, electrical conductivity and buffering capacity. The results of the physical examination revealed that all the fruit drinks complied with the NAFDAC specifications except that 50% of the drinks had no NAFDAC registration number while the results of the physicochemical analyses showed that the pH of the fruit drinks ranged from 2.635±0.22 to 2.25±0.13, electrical conductivity ranges between 1631±0.05 and 493±0.0 µS/cm and buffering capacity ranged from 3.80±0.05 to 0.75±0.11cm^3 *of NaOH, respectively. The results showed that all fruit drinks analyzed were highly acidic as the pH values of the prepared solutions were less than the threshold pH (5.5) for enamel dissolution. Therefore, prolong retention of such drinks in the mouth might result into enamel wearing and tooth decay as such food and drinks with high sugar content should only be taken in small quantity.*

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Introduction

Fruit drinks have evolved over the years contributing to the dietary needs of human being. They also play great role as a food supplements as well as energy bank. These drinks are classified as carbonated and non carbonated drinks and are sold in various media. The main components of these drinks include water, sugar and several additives which are opened to choice. The continuous intake and preference for these drinks among other factors have drawn the attention of scientists to the potential danger of these drinks to the human enamel as the components of these drinks have been known to vary and intake level is continually on the increase (Barac *et al.*, 2015).

Dental erosion according to Barac *et al.* (2015), is the gradual and irreparable loss of dental structure by prolonged chemical phenomenon without bacterial activities. The resultant effect such as this would be dependent on some factors which include continuous or excessive intake of drinks and prolonged retention of drinks in the mouth for such effect to manifest. Dental erosion is commonly associated with developed countries, civilized societies and different age groups. It has been recognized to be the cause of dental ware due to acidity (Bamise and Oderinu, 2013). This has been attributed to the increased intake of sugar alongside other additives (Wanjek, 2007; Obunwo and Bull, 2013). In the buccal cavity, bacteria living on the teeth usually convert dietary sugar into acid that is responsible for dental erosion. The susceptibility to dental erosion increases as the quantity and rate of sugar intake increases (British Dental Association, 2015). The causes of dental erosion are grouped into two categories: extrinsic and intrinsic causes. Intrinsic causes are associated with recurrent vomiting which might be linked to gastric influx and chronic alcoholism or bulimia while extrinsic causes are numerous and it includes consumption of acid food, drinks and inhalation of corrosive industrial fumes (Bamise and Oderinu, 2013).

Many in vitro studies has been conducted to ascertain the factors responsible for the dissolution of the enamel in the bucal cavity of humans (Larsen and Nyvad, 1999; Obunwo and Bull, 2013), which include factors such as pH and electrical conductivity as well as concentration of some organic acids like lactic acid, citric, phosphoric acid and malic acid and many other parameters such as buffering capacity, calcium and phosphate concentration which also help to give insight into its effect on the enamel (Hughes *et al*., 2000; Obunwo and Bull, 2013).

pH and buffering capacity are the two most commonly used parameters for soft drink erosive potential (Obunwo and Bull, 2013). pH values are equivalent to the equilibrium measure of the hydrogen ion concentration, without indicating the total acid content of the drink or food while buffering capacity gives an exact measure of all free hydrogen ions available to cause erosion. These are physical and chemical characteristics which are associated with enamel erosion and is mostly observed on the surface (Benjakul and Chuenarrom, 2011; Cairns *et al*., 2013; Barac *et al*., 2015).

The emergence of new and variants of non-carbonated drink such as powdered sachet fruit drinks which have different flavours examples of which include pineapple, banana, mango, citric etc. have opened up a wide gap and it is important for further studies to be carried out on these brands and flavours. This study was carried out to evaluate the erosive potential of selected non-carbonated powdered sachet fruit drinks on the human enamel.

Material and Methods

Material

Twelve samples of powdered sachet fruit drinks were analyzed using standard analytical procedures.

Instruments: The instruments used were pH Meter (CH REX 125) and Conductivity meter (Jan Way 4010).

Sample collection

Twelve (12) flavour varieties of powdered sachet fruit drinks were bought from the market and examined.

Methods

Physical examination

The physical examination of the labeling information was carried out according to NAFDAC specification for food and drugs (Oyeku *et al.,* 2001; Mustapha *et al*., 2015).

Preparation of powdered sachet fruit drinks solution.

The solution of each powdered sachet fruit juice was prepared according to manufacturer's specification. Sample A and B were dissolved with distilled water in 1000 cm^3 volumetric flask and diluted with distilled water to the mark, sample C, D, E, F, G, H, I, and J were also dissolved and made up with distilled water to 1500 cm^3, while sample K and L were dissolved and diluted to 2000 cm^3 mark, respectively.

Determination of physicochemical characteristics of fruit drinks

pH

The pH meter (CH REX 125) was first calibrated with buffer 4.6 and 6.8. The solution was then homogenized with a nonmagnetic stirrer. The electrode was inserted into the prepared drink solution (50.00 cm^3) in a beaker and the stable and constant reading was recorded. Triplicate readings were recorded for each of the drink sample.

Electrical conductivity

The conducting meter (Jan Way 4010) was first calibrated. The solution was then homogenized with a nonmagnetic stirrer. The electrode was dipped into the prepared drink solution (50.00 cm^3) in a beaker and was observed until stable reading was noted. Three reading were taken for each of the drinks.

Buffering capacity

Fruit drink (50.00 cm^3) was titrated with NaOH (1.0 M, 0.20 cm^3) with increments until the pH reached 7. This was done by adding 0.20 cm^3 NaOH to the fruit drink and stirred continuously until pH 7 was reached and this gives the total titratable acidity while the volume of NaOH used was noted. Titration was carried in triplicate for each sachet drink solution (Obunwo and Bull, 2013).

Results and Discussion

Results

Physical examination of powdered sachet drinks

The results of the physical examination of powdered sachet fruit drinks are presented in Table 1 and that of the physicochemical characteristics of non-carbonated powdered sacket drinks are presented in table 2.

Table 1: Result of the physical examination of powdered sachet fruit drink

S/N	Sample	Product Name	Manufacturer Address	Manufacturing Date	Batch Number	Expiry Date	NAFDAC Number	Acidulant
1	A	++	++	++	++	++	++	++
2	B	++	++	++	++	++	++	++
3	C	++	++	++	++	++	**	++
4	D	++	++	++	++	++	**	++
5	E	++	++	++	++	++	**	++
6	F	++	++	++	++	++	**	++
7	G	++	++	++	++	++	**	++
8	H	++	++	++	++	++	**	++
9	I	++	++	++	++	++	++	++
10	J	++	++	++	++	++	++	++
11	K	++	++	++	++	++	++	++
12	L	++	++	++	++	++	++	++

++= indicated **= not indicated

Table 2: Result of physicochemical characteristics of powdered sachet drinks

S/N	Sample	pH	Electrical conductivity (μS/cm)	Buffering capacity (cm^3 NaOH)
1	A	2.51±0.16	805±0.96	1.90±0.01
2	B	2.25±0.13	1218±0.0	3.80±0.05
3	C	2.48±0.08	866±0.10	1.75±0.03
4	D	2.41±0.11	787±0.03	1.24±0.16
5	E	2.45±0.11	820±0.05	1.87±0.04
6	F	2.37±0.11	1631±0.05	1.97±0.02
7	G	2.33±0.14	853±0.03	1.66±0.10
8	H	2.36±0.22	883±0.02	1.77±0.10
9	I	2.63±0.22	504±0.01	0.89±0.13
10	J	2.60±0.25	493±0.0	0.75±0.11
11	K	2.44±0.04	979±0.01	1.32±0.04
12	L	2.37±0.05	950±0.0	1.70±0.05

Discussion

The use of fruit drinks as food supplement or an energy bank, continuous intake and preference for this drinks among other factors have drawn the attention of scientists to the potential danger of this drinks on the human enamel as component of this drinks have been found to vary and intake level is continually on the increase (Barac *et al.,* 2015).

A number of studies have shown that the erosive potential of soft drinks depend on the physicochemical parameters which include pH, electrical conductivity, buffering capacity, calcium and phosphate concentrations (Lussi e*t al*., 1993; Larsen and Nyvad, 1999; Hemingway e*t al*., 2006; Obunwo and Bull, 2013). Findings on determinants and control of soft drinks-mediated dental erosion also revealed that various factors which includes pH were key to the erosion of the enamel (Bamise e*t al.,* 2009; Obunwo and Bull, 2013), while an investigation on sport and energy drinks also showed that they are prone to dissolution of enamel (von Fraunhofer and Rogers, 2005; Obunwo and Bull, 2013).

Physical examination

According to the National Agency for Food and Drug Administration and Control (NAFDAC), all foods and drugs labeling should be informative and accurate. These labeling information are Product name, Manufacture address, Batch number, Nutritional information, Expiry date (Best before date), NAFDAC registration number and Manufacturing date (Dada, 2009; Musa *et al.*, 2014; Mustapha *et al*., 2015). The results of the physical examination presented in Table 1 showed that there was 100 % compliance with NAFDAC specifications which were indication of product name, manufacturing address, batch number, nutritional information, NAFDAC registration number, manufacture and expiry dates, while 50 % (six) out of the twelve samples had no NAFDAC number. The non-indication of NAFDAC number which is the seal for standard and compliance could be that the manufacturers of such drinks were yet to be granted the approval to sell and may have a negative impact on the health of its consumers. This information are necessary to guarantee consumer safety.

Physicochemical parameters

pH

pH is the equilibrium measure of the hydrogen ion concentration and not the exact acid content present in food or drinks. The results of physicochemical parameters presented in Table 2 shows that the mean pH of the fruit drinks ranged between 2.25±0.13 and 2.63±0.22 which is highly acidic. The high acidity might be due to the presence of polybasic acid (citric acid) present in all the drinks. However, this pH values were close to those of the branded soft drinks reported by (von Fraunhofer and Rogers, 2004; Obunwo and Bull, 2013). Various studies on the impact of soft drinks with low pH on the surface of human enamel have shown that they have the potential to cause enamel dissolution (Eygen *et al*., 2005; West *et al*., 2001; Seles-Peres *et al*., 2007; Obunwo and Bull, 2013). Bamise *et al*. (2007) also concluded that drinks with pH 5.5 and below could erode and damage the enamel surface. This suggests that the fruit drinks might have the potential to erode the enamel surface.

Electrical conductivity

Electrical conductivity is a measure of the ability of a solution to conduct electricity i.e act as an electrolyte and is dependent on the nature and number of the ionic species in the solution (Reda, 2016). Table 2 show that the electrical conductivity of the fruit drinks ranged between 493±0.0 and 1631 ± 0.05 µS/cm. This were higher than those of branded soft drinks (300 ± 0.50 - 750 ± 0.25 µS/cm) reported by Obunwo and Bull, (2013), indicating that there were more ions in the sachet fruit drinks than the branded soft drinks. While there is no known stipulated standard on the electrical conductivity of drinks, it is believed that the relatively higher values of the electrical conductivity of drinks might result to enamel dissolution.

Buffering capacity

Buffering capacity indicates the total acid content of a solution corresponding to the hydrogen ion present in the solution. It is a key factor in erosion determination because it provides information on the actual hydrogen ions available for interaction with the tooth surface (West *et al*., 2000; Zero, 1996; von Fraunhofer and Rogers, 2004). It measure gives a more reliable and accurate means of predicting erosive potential (Grobler *et al*., 1985; Edwards *et al*., 1999; Cairns *et al*., 2002;Davani *et al*., 2003; von Fraunhofer and Rogers, 2004). The data obtained on buffering capacity presented in Table 2 shows that mean buffering capacity ranged from 0.75 ± 0.11 - 3.80 ± 0.05 cm^3 NaOH. This values were relatively lower than those of the branded soft drinks (4.00 – 6.00 cm^3 NaOH), investigated by Obunwo and Bull (2013). The result of the study shows that the polybasic acid (citric acid) added to the sachet fruit drinks exhibited buffering capacity that resisted the pH below the threshold value (5.5) despite of the marked dilution to manufacturer's specification (Davani *et al*., 2003, von Fraunhofer and Rogers, 2004).

Conclusion

The results on pH, electrical conductivity and buffering capacity showed that the evaluated powdered sachet fruit drinks may have deleterious effect on the human enamel. Therefore, prolong retention of such drinks in the mouth might result into enamel wearing and tooth decay as such; food and drinks with high sugar content should only be taken in small *quantity*.

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