Quantifying the Acidic Content of Commercial Yoghurt Drinks in Nigeria

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Abstract

Objectives: To measure the pH and titratable acidity of registered commercial yogurt drinks manufactured in Nigeria and to compare the values with an acidic cola drink.

Method: (1) The pH, measured by a digital pH meter on opening of the packaging can. (2) The volume of 1.0M sodium hydroxide required to raise the pH of 25 mls of the yoghurt drinks to pH 7.0 and pH 10.0 was determined by titration.

Results: The pHs on opening ranged from 3.51 to 4.12. Despite having the lowest pH value on opening, the acidic cola drink used as control needed the least sodium hydroxide base to raise its pH to 7.0 and 10.0.

Conclusion: All the pHs were well below the pH of enamel dissolution enamel and needed the most base to neutralize the phosphoric acid acidulated cola drink (coke). Improper consumption and overuse may cause dental erosion especially on immature teeth.

INTRODUCTION

Tooth wear is becoming more commonly recognised in both adults and children, with recent studies suggesting a prevalence of 98% in adults. [1] The triad of erosion, attrition and abrasion has been known for many years, but erosion is currently believed to be the major factor involved in tooth wear and its contribution may be increasing.

Dental erosion has been defined as a progressive irreversible loss of dental hard tissue by a chemical process, usually by acids other than those produced by plaque bacteria. [2,3]

Dental erosion is a relatively new risk factor for dental health, introduced by today's lifestyle. [4] Its process can lead to reduction in size of teeth and depending upon the severity and length of exposure, may lead to the total destruction of the dentition. [3]

Mair (1992), reported that erosion may originate from the following sources; dietary, environmental and regurgitation. [5] Dental erosion is commonly caused by dietary factors, especially food or drinks that contain citric acid which may chelate as well as dissolve calcium ions. [6,7,8,9,10] In modern societies the extrinsic factor is becoming more important, due to the increased consumption of acid drinks as soft drinks, sport drinks, fruit juices and fruit teas. [11]

Examination of dental erosion was included for the first time in the study carried by the United Kingdom 1993 National Survey of Child Dental Health. [12] In this study, 17,061 children were examined. Over half of the 5 and 6 year olds had erosion, 25% with dentinal involvement of the primary dentition. In the 11+ year age group, almost 25% had erosion, 2% with dentinal involvement in the mixed dentition. In a study of 1035 14-year-old children randomly selected from a Liverpool population, 30% had exposed incisal dentin. Another 8% had exposed dentin on occlusal or lingual surfaces. [13]

In the US, association of the escalating use of food drink and beverages (an increase of 56%, rising approximately 2–3% per year) with increasing dental effects among children and adolescent has been found. [14] Forty percent of pre-school children drink more than 250 ml (8.0 ounces) of soft drinks per day, while among 12 to19-year-old males consumption was 28 ounces per day, and among 12 to 19-year-old females the rate of intake was 21 ounces per day.[15,16]

Data such as these have caused oral health care providers in the United Kingdom to consider dental erosion as a public health problem, citing high consumption of acidic beverages as the major etiologic agent. [17] This situation led to the outlining of dental erosion as an oral health problem in the National Clinical Guidelines and Policy Documents 1999 for Paediatric Dentistry of the Dental Practice Board for England and Wales. [18] The causes were noted as all acids, whether from within the body or from external sources, capable of demineralising tooth tissue, and therefore causing erosion. The intrinsic causes include intrinsic acids from gastric reflux and vomiting. Extrinsic causes are soft drinks, and some dry wines, alcopops and soft drinks.

Johansson et al. reported a strong correlation between the presence of dental erosion and a high level of consumption of cola-type and other soft drinks. [19] Although there is increasing evidence of the role of soft drinks in the development of erosion, it is not just drinks that contain acid. There are also other potential dietary sources such as fresh fruit, pickles, and sauces, lactovegetarian foods and yogurt. [20]

Yogurt, fruits and soft drinks may seem like harmless snacks and beverages, but improper consumption and overuse may lead to devastating and permanent damage to teeth. [21] Yogurt is a dairy product produced by bacterial fermentation of milk. Fermentation of the milk sugar (lactose) produces lactic acid, which acts on milk protein to give yoghurt its texture and its characteristic tang. It is made by introducing specific bacteria strains into milk, which is subsequently fermented under controlled temperatures and environmental conditions (inside a bioreactor), especially in industrial production. The bacteria ingest natural milk sugars and release lactic acid as a waste product. The increased acidity causes milk proteins to tangle into a solid mass (curd in a process called denaturation). The increased acidity (pH=4–5) also prevents the proliferation of potentially pathogenic bacteria. [22]

Various features of soft drinks and beverages relevant to dental health had been identified. The erosive capacity of fruit juices and beverages have been found to be related to their pH and titrated acidity. [23,24,25,] Also the total acid level, acid type, concentration of phosphate, calcium and fluoride in food drinks have been mentioned to have a modifying effect on the development of dental erosion. [24,26,27]

In evaluating the erosive potential of acidic drinks, some workers have suggested that the total acid level (titratable acid) be considered as more important than pH level, [24,28]

because it will determine the actual H+ available to interact with the tooth surface. [28]

The titratable acidity is the amount of alkali (base) needed to be added to an acid to bring it up to a neutral pH. It therefore represents the amount of available acid and is an indication of strength and thus of erosive potential. [17]

Yogurt is an example of a food with a low pH (approximately 4.0) [29] which has the potential to demineralise teeth if it reaches the mouth. It widely accepted and used in the Nigeria which may account for the recent growth of the manufacturing companies. Yogurt drinks are packaged in different volumes and varieties of containers especially in attractive paper packs which are popular among adolescents and young adults.

It is our aim in this study to measure the pH and titratable acidity of registered commercial yogurt drinks manufactured in Nigeria and to compare the values with an acidic cola drink.

METHODOLOGY

Seven commercially available yogurt drinks in the Nigerian market were selected. Table I. The selection was based on products manufactured by Nigerian companies and duly registered products by the National Agency for Food, Drug Administration and Control (NAFDAC) at the time of this study. The procedure was carried out in the Central Science Laboratory of the Obafemi Awolowo University, Ile-Ife.

Table shows the selected yogurt drinks.

Firstly, the pH of the drinks was measured by a digital pH meter (WPA, CD70 Cambridge, UK). This was determined by pouring about 50mls of each drink in a conical flask and inserting the probe of the pH meter.

On another occasion to determine the volume of 1.0M sodium hydroxide (base) required to raise the pH of 25 ml of the drinks to pH 7.0 and 10.0. The base was prepared by dissolving 4g of sodium hydroxide pellets in 100mls of distilled water. The sodium hydroxide was then titrated against 25mls of each drink to raise the pH on opening to 7.0 and 10.0.

Figure 1

Table 1: Yoghurt Drinks tested

S/N	Yogurt Drink	Manufacturer	Ingredients	Packaging
	Carbonated cola drink (Coke®)	Nigerian Bottling Plc		Bottle
1	Strawberry Fanyogo® Strawberry flavoured yoghurt drink	FanMilk Plc	Sugar, Milk solids-non fat, Veg fat, Stabilizer (1422/471/401/412/407/440), Flavour, Colour (E124)	Polythene
2	Fanyogo® Yoghurt drink	FanMilk Plc	Sugar, Milk solids-non fat, Veg fat, Stabilizer (1422/471/401/412/407/), Flavour.	Paper
3	Holandia Yoghurt® (plain sweetened)	CHI Limited	Yoghurt base, sugar, Stabilizer (E 440), Water	Paper
4	Holandia Yoghurt® (black currant)	CHI Limited	Yoghurt base, Sugar, Black currant concentrate, Stabizers, Colouring agent	Paper
5	Holandia Yoghurt ®(strawberry)	CHI Limited	Yoghurt base, Sugar, Strawberry concentrate, Stabilizers, Colouring agent	Paper
6	Fine Merit Yoghurt®	Merit Resources Limited	Skimmed milk, Sucrose, Stabilizer, Water	Bottle
7	AHMRAFAB sweetened Yoghurt®	AHMRAFAB (Nigeria) Enterprise	Wholemilk powder, Sugar, Water	Plastic bottle

RESULTS

PH ON OPENING

The pH on opening of the yoghurt drinks ranged from 3.51 to 4.12. Table II. The pH in ascending order; Ahmrafab sweetened Yoghurt®, Fine Merit Yoghurt®, Fanyogo® Yoghurt drink, Fanyogo® Strawberry flavoured yoghurt drink, Holandia Yoghurt® (black currant), Holandia Yoghurt® (plain sweetened) and Holandia Yoghurt ® (strawberry). All the drinks have pHs higher than the control cola drinks but lower than the pH at which enamel dissolves (5.5).

Figure 2

Table 2: pH on Opening the drinks and the Volume of NaOH Needed to raise the pH of each Drink to 7.0 and 10.0

S/N	Yogurt	pH on opening	Volume (mls) of base needed to increase pH to:	
			7.0	10.0
Control	Carbonated cola drink (Coke®)	2.79	0.75	1.35
1	Fanyogo® Strawberry flavoured yoghurt drink	3.86	1.00	1.75
2	Fanyogo® Yoghurt drink	3.82	1.75	2.00
3	Holandia Yoghurt® (plain sweetened)	4.11	1.75	2.25
4	Holandia Yoghurt® (black currant)	4.08	2.00	2.75
5	Holandia Yoghurt ®(strawberry)	4.12	1.50	2.35
6	Fine Merit Yoghurt®	3.71	2.75	3.50
7	Ahmrafab sweetened Yoghurt®	3.57	2.00	2.50

TITRATABLE ACID

Results showed that the volume of sodium hydroxide base needed to raise the pH of the drinks to 7.0 ranged from 1 to 2.75mls. Also, 1.75 to 3.50 mls of the base was needed to raise the pH of the drinks to 10.0. Table II. Fine-Merit yoghurt needed the most base to raise its pH to 7.0 and 10.0 while Fanyogo® Strawberry flavoured yoghurt drink needed the lowest volume of base to raise its pH to 7.0 and 10.0.

The acidic cola drink served as control, despite having the lowest pH on opening needed the least volume of sodium hydroxide to raise its pH to 7.0 and 10.0.

DISCUSSION

There has been a continuing increase in soft drink and beverages consumption among adolescents globally [14] which has raised a concern about the health effects of soft drinks and beverages. They are sugar-containing drinks that can be cariogenic [30] and their low pH can cause erosion in teeth. [31]

In general, two methods to quantify the acid content of a drink are the pH and the titratable acid. The pH is a measure of the hydrogen ion concentration, while titrable acid (TA) is the total number of acid molecules and determines the actual hydrogen ion availability for interaction with the tooth surface. [32]

Beverages with lower pH values generally have greater erosive effects on tooth structure; however, some workers have suggested that the total acid level (TA) be considered as more important than pH level, [24,28]

The greater the TA, the longer time it will take for saliva to restore the pH value (salivary clearance). [33] Carbonated cola beverages, sports and high energy drinks have been reported to have a low pH and a high buffering capacity. They are sweetened with highly refined carbohydrates and contain additional additives which together with sugar substitutes can contribute to enamel surface dissolution. [34,35,36,37]

The total acid level, acid type, concentration of phosphate, calcium and fluoride in food drinks have been mentioned to similarly have a modifying effect on the development of dental erosion. [24,26,27]

Other factors involved with enamel surface dissolution and clinical erosion include the chelating properties of the beverage ingredients, exposure frequency, duration of the exposure and temperature. [34]

The results from the present study indicate that all the yoghurt drinks evaluated have pH on opening below the critical pH (5.5) of enamel dissolution. Also, they needed the most base to raise their pH to neutral pH more than acidic cola drink variously suggested to possess considerable erosive potential. [19,38,39]

Yogurt or yoghurt-based drinks are dairy products with low

pH values that have the potential to demineralise teeth if it reaches the mouth. It is produced by adding a "starter" of active yogurt containing a mixed culture of Lactobacillus bulgaricus (or occasionally L. acidophilus) and Streptococcus thermophilus. These produce lactic acid during fermentation of lactose. The lactic acid lowers the pH. [40] Suffice to mention that regurgitated lactic acid fermented from food lying within an achalasic oesophagus has been found to cause dental erosion. [41]

Reviewed literature showed incongruous reports about association of Yoghurt consumption and dental erosion. Although multiple regression analysis revealed no relationship between dental erosion and children who consumed fruit yogurt, 36% of the children who consumed fruit yoghurt had erosive lesions in a study to evaluate the prevalence, clinical manifestations, and etiology of dental erosion among 11-year-old children in Istanbul. [42]

Conversely, the following studies doubted the possibility of inducing dental erosion on enamel surface. [43,44]

A more interesting observation in this study was the greater amount of titratable acid in the yoghurt drinks than acidic cola drink. It can therefore be suggested that that the yoghurt drinks assessed in the present study have greater erosive potential. Cola drinks are usually acidulated with phosphoric acid while non-cola drinks are acidulated with citric, maleic and any other acid. [45] Yoghurts contains lactic acid, an acid which has been found to be one the most erosive acidizing agents [46,47] and to cause linear release of calcium and phosphorus while phosphoric acid caused only the release of calcium. [47]

There is growing evidence of a considerable increase in consumption of potentially erosive foodstuffs and drinks especially among children and adolescent [48] Since consumption of these food drinks and beverages includes younger age groups, a great deal of attention should be focused on the susceptibility of immature teeth to erosion and the intake of drinks. Studies have shown that immature teeth are porous and are more easily dissolved by acids until "conditioned" from continual exposure to salivary ions, causing enamel to become harder and less penetrable to acid assault. [49,50]

Although yoghurt is considered a healthy snack (especially among children and adolescent), most parents don't realise that this nutritious food could be causing severe damage to their kid's teeth. This is because yoghurts are acidic with the potential to cause irreversible damage to the teeth.

However, it is unrealistic to expect children to drink nothing but water and milk.

With the preponderant of hawkers and vending of yoghurt drinks in major towns and villages in Nigeria, children should be advised and encouraged to keep yoghurt drinks to mealtimes if possible and to drink them down in one go rather than sip them over a long period.

It should be however noted that factors like chemical (pK_a values, adhesion and chelating properties, calcium, phosphate and fluoride content), behavioural (eating and drinking habits, life style, excessive consumption of acids) and biological (flow rate, buffering capacity, composition of saliva, pellicle formation, tooth composition, dental and soft tissue anatomy) modify erosive process.

Within the limitations of this study, it can be concluded that all the yoghurt drinks evaluated have pH well below the pH of dissolution of enamel and needed the most base to neutralize than the phosphoric acid acidulated cola drink (coke). It can be said that improper consumption and overuse of this drinks may lead to devastating and permanent damage to teeth especially in children and adolescent with immature teeth.

Conclusion: All the yoghurt drinks evaluated have pH well below the pH of dissolution of enamel and needed the most base to neutralize than the phosphoric acid acidulated drink cola drink (coke). Improper consumption and overuse of these drinks may cause dental erosion especially on immature teeth. This information would be particularly useful to dental practitioners and oral hygienists when counseling patient with dental erosion

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