

EROSIVE POTENTIAL: LABORATORY EVALUATION OF TOOTH DISSOLUTION IN COUGH SYRUPS

ABSTRACT

AIM: To evaluate the associated weight loss of extracted teeth after immersed in cough syrups for a period of time so as to predict the erosive potential of the liquid medicines. **MATERIAL AND METHODS:** pHs of the medicines were measured at the start of the study. 25 extracted test teeth were weighed to 0.01 mg and assigned at random to each syrup under evaluation. The test medicines were placed in 10 mL screw-cap plastic containers and the test teeth were weighed after 7 days. **RESULTS:** 88 % of the medicines caused reduction in weights of the test teeth after seven days of immersion. Weight loss of the test teeth also noticed with basic syrups. Also lowest pH syrup did not produce the greatest weight loss. **CONCLUSION:** Majority of the cough syrups caused loss of weight of the test teeth. Thus, they possess the potential to cause dental erosion.

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KEYWORDS

Dental erosion. Enamel dissolution. Acidic medication. Cough syrups.

INTRODUCTION

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^{1,2}.

In vitro model showed that primary teeth were as susceptible to erosion as permanent teeth.³ Erosion 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.²

The etiology of erosion is multifactorial and not fully understood. The most important sources of acids are those found in the diet, such as acidic foods and drinks. Currently, the increased consumption of acidic foods and soft drinks is becoming an important factor for the development of erosive wear.^{4,5} Therefore, most clinical research has focused on the dental impact of acidic drinks and foods.⁴

Chemical factors, such as pH, titratable acidity, phosphate and calcium concentration, and fluoride content are the prevalently used parameters of beverages in terms of their ability to affect dental erosion.⁶ Other in vitro methods of measuring enamel erosion include surface microhardness,^{7,8} loss of enamel weight,^{9,10} SEM or light microscope,¹¹ microradiograph or image analysis,¹² electron probe analysis,¹³ Profilometry,¹⁴ light induced fluorescence¹⁵ and computed controlled mapping.¹⁶

Hard tooth tissue dissolution and subsequent loss of weight are attributed to the dissolution of the enamel crystal when the hydrogen ion in an acidic solution comes in contact with the tooth surface. The un-ionised form of the acid also diffuses into the interprismatic areas of the enamel and dissolves the mineral in the subsurface region. This will lead to an outflow of mineral ions (calcium and phosphate) and subsequently to a local pH rise in the tooth structure in close proximity to the enamel surface.¹⁷ Hara and colleagues¹⁸ suggested that the events in dentine are in principle the same but are even more complex.

Cough suppressants and expectorants are medicinal drugs used to treat cough and related conditions. These medicines are widely available in the form of syrup, also known as linctus. In vitro studies have shown that pediatric medicaments¹⁹ and cough syrups²⁰ are acidic.

Acute respiratory infections (ARI) are the commonest cause of acute morbidity in children especially those under five in Nigeria.²¹ Typical features of ARI include but are not limited to cough, catarrh, fever, etc. Most parents are in the habit of self medication by purchasing the cough syrup to treat the symptoms of upper respiratory tract infection which is mostly cough. Presently, there are many brands of cough syrup in Nigeria and

they are purchased off counter most times without prescription. The aims of this study were to evaluate the loss of weight of human teeth specimen after immersion in different cough syrups available in Nigeria and also determine their potential to cause tooth erosion.

MATERIAL AND METHODS

This in vitro study was carried out in the Material Science Laboratory, Department of Metallurgical and Materials Science, Obafemi Awolowo University, Ile-Ife, Nigeria. Twenty five most common cough syrups were selected and purchased from accredited sales representatives of the companies involved.

The study was in two parts; The pHs and titratable acidity of the syrups were first evaluated and manuscript of the study by the same authors is in press. Secondly, the weight loss of the test teeth was determined; 25 caries-free human teeth extracted primarily for orthodontic or periodontal reasons were sterilized in a 5% sodium hypochlorite (NaClO) solution. Each specimen (test teeth) was weighed to 0.01 mg on a Mettler H20 decicentimilligram balance (Mettler- Toledo, Inc., Columbus, OH; 800. 638.8537). The teeth were assigned at random to the 25 syrups meant for evaluation. The control for the study was tap water. The study was performed at room temperature. The test syrups (Table I) and teeth were placed in 10 ml screw-cap

plastic containers and the specimens were weighed after 7 days. Prior to weighing, the teeth were blotted dry and air-syringed.

The test syrups were blinded to the laboratory scientists carrying out the experiment. That is, all identifications of each medicine were removed and labeled with Arabic numbers prior to their delivery to the laboratory.

Data was recorded in study-specific charts and authenticated before it was retrieved by the authors. Since the teeth specimens were not identical in size, percentage of weight loss was the response variable computed and considered for the study.

RESULTS

Table I shows that 22 (88 %) syrups caused loss of reduction in weights of the test teeth after 7 days evaluation period. Sample 24 (Kufdryl Expectorant & Mucolytic), 22 (Tuxil – N Cough linctus), 9 (Menthodex Cough Mixture) and Tap water caused no loss of weight of the test teeth immersed in them. Sample 6 (Tutolin Children Cough Syrup) caused the greatest weight loss followed by sample 2 (Benylin with Codeine) and 12 (Deshalom – Cof) respectively.

It should be noted that sample 6 and 2 caused about three times the loss weight observed with other samples. Despite having basic pHs, samples 1 (De-Shalom cough

expectorant) and 10 (Linctified F- Expectorant) caused loss of weight of the test teeth. Also the

syrup with the lowest pH value did not produce the greatest weight loss.

Table 1. Percentage weight loss of the test teeth in different cough medications.

	Syrup (brand or generic) names	pHs of the syrups	Initial weight	Final weight	Loss in weight	% loss in weight
1	De-Shalom cough expectorant	8.4	.209	.202	.007	3.3
2	Benylin with Codeine	4.88	.165	.100	.065	39.4
3	Benylin for Children	4.82	.303	.287	.016	5.3
4	Neofylin Cough Syrup	5.36	.339	.321	.018	5.3
5	Benylin Expectorant	5.12	.338	.320	.018	5.3
6	Tutolin Children Cough Syrup	5.84	.280	.157	.123	43.9
7	Diphenkof Sirop Enfant	6.02	.298	.264	.034	11.4
8	Piriton Expectorant Linctus	4.58	.368	.362	.006	1.6
9	Menthodex Cough Mixture	5.70	.263	.263	.000	0.0
10	Linctified F- Expectorant	7.10	.520	.509	.011	2.1
11	Zedex	3.26	.502	.478	.024	4.8
12	Deshalom - Cof	3.06	.177	.155	.022	12.4
13	Diphenkof expectorant	6.02	.510	.487	.023	4.5
14	Tutolin Expectorant	3.78	.523	.485	.038	7.3
15	Emzolyn Expectorant	4.40	.174	.166	.008	4.6
16	Dr. Meyer's Coflin Cough Linctus	5.14	.502	.471	.031	6.2
17	Coflax Children Cough Syrup	5.18	.495	.461	.034	6.9
18	Dr. Meyer's Cofmix with Codeine	5.58	.315	.298	.017	5.3
19	Emzolyn Cough Syrup for Children	4.58	.585	.545	.040	6.8
20	Cofta Non- drowsy	4.08	.248	.243	.005	2.0
21	Dr. Meyer's Cofmix Cough Syrup	5.56	.298	.290	.008	2.7
22	Tuxil - N Cough linctus	5.02	.252	.252	.000	0.0
23	Dr. Meyer's Cofmix Junior	5.68	.151	.140	.011	7.3
24	Kufdryl Expectorant & Mucolytic	5.18	.194	.194	.000	0.0
25	D- Koff Cough Expectorant	5.68	.463	.451	.012	2.6

DISCUSSION

This experiment exposed caries-free whole tooth to a range of popular cough medications continuously over a period of 7 days. Measuring the loss of weight after a period of immersion is designed to be a simple, rapid and inexpensive method of evaluating the dental erosive potential of these medicines.

Apparently, this method does not yield absolutely accurate amount of hard dental tissue loss, i.e., enamel, dentine or cementum loss compared to experiments where enamel,

dentine or cementum discs and blocks were used. However, measuring the percentage weight loss is sufficient for quantitative evaluation of hard dental tissue loss after a period of exposure to demineralization (acidic) agents. Thus the erosive potentials of the syrups as disclosed by their demineralizing actions can be estimated by percentage weight loss computed.

Furthermore, due to the high content of organic material in dentine, ditto cementum, the diffusion of demineralising agent into deeper regions is said to be hindered by the

abundant matrix and so is the outward flux of dissolved tooth mineral.¹⁸ This explains the use of entire tooth exposure to the liquid medications in this experiment.

As regards the 7 days test period, realistic testing of enamel dissolution in liquid medicines is demanding because of the inherent challenges of running the study for a complete course of cough medication. Cough medicines are taken for about one to two weeks and are usually associated with overuse and/or inappropriate use.

Despite obvious limitations that can be advanced for such in vitro study, certain significant results are observable. Firstly, twenty two out of twenty five cough medication under investigation caused loss of weight of the teeth immersed in them. This is in accordance with study of von Fraunhofer and Roges⁹ (2004) and Jain et al.¹⁰ (2007) where in vitro experiments have been used to assess the dissolution of dental hard tissues by evaluating the loss of weight after a period of immersion.

We want to therefore opine that these liquid medicines dissolve hard dental tissues, thus possess the potential to incite dental erosion. This is of considerable importance because of the extensive commercial distribution and the use of cough medicines in Nigeria.

Findings show there was no strict relationship between the pH and the

percentage loss of weight. For example, sample 22 which has the same pH value as sample 19 caused no loss of weight. Also, sample 12 has the lowest pH but did not cause the greatest weight loss.

This observation would appear to suggest there are other factors besides pH responsible for the loss of weight of the test teeth in vitro. This is strongly supported by the fact that basic syrup samples (De-Shalom cough expectorant and Linctifed F-Expectorant) caused weight loss in the test teeth.

In vitro studies of the acidic properties of acidic foods and beverages have a long history and have been increasingly utilized in recent times. However, the translation of the findings of in vitro studies to the human mouth is highly problematic. Possible hard dental tissue dissolution effect of transient exposure to liquid medicines in the human mouth is influenced by factors that cannot be accounted for in in vitro models.

Furthermore, it is evident from the literature that other factors such as type of acid, chelating properties, calcium and phosphate concentrations, temperature, exposure time and frequency of exposure contribute to enamel erosion and demineralization. The protective factors such as saliva also play a role in the dynamism of dental erosive process. Saliva is known to modify dental erosion by causing the

formation of an enamel pellicle, which protects the surface from dissolution.²² Considering the limitations of laboratory studies, thus in reality, the potential to cause dental erosion by these medicines may not be as strong as what was revealed in the findings.

CONCLUSION

Most of the cough medicines investigated caused dissolution and bulk loss of sound dental hard tissues after seven day immersion of test human teeth. Thus they possess sufficient potential to cause dental erosion. Inappropriate use and bizarre habits can greatly enhance their dental erosive potential. It is therefore appropriate to advice against inappropriate use of cough medicines especially in patients with compromised dentition. Patients should be advised to rinse the mouth with water immediately after the ingestion of these liquid medicines.

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