ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at:www.ijdsir.com
Volume – 7, Issue – 5, October – 2024, Page No. : 277 - 283

Endogenous pH Value of Children's Mouth Rinses

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Citation of this Article: Ralitsa Bogovska-Gigova, Krasimir Hristov, "Endogenous pH Value of Children's Mouth Rinses", IJDSIR- October – 2024, Volume –7, Issue - 5, P. No. 277 – 283.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Mouthwashes are topical agents that can be used to maintain good oral health in children. However, their endogenous acidity varies widely, with some products showing a pH below the critical value of 5.5. Our study aims to make a laboratory assessment of the endogenous pH of children's mouthwashes, which are commercially available in Bulgaria. Eight mouthwashes were tested – five samples each. The pH and temperature of each sample were measured using an electronic pH meter. The pH values of the tested mouthwashes varied significantly—from 3.32 to 6,67. Most of them have pH values above the critical level for enamel dissolution. However, dentists should consider their acidic potential, especially for children at a higher risk of tooth decay, because some of them can weaken tooth enamel or cause erosion if used for prolonged periods in the oral cavity.

Keywords: Children Mouthwash, Acidity, Ph Value, Erosive Potential, Oral Rinse

Introduction

Mouthwashes are topical agents that can be used to maintain good oral health (1). Plaque control by mechanical and chemical methods is paramount in preventing dental caries and gingival disease (2). Children need more dexterity in using mechanical brushes and dental floss, and there is often a lower motivation to maintain adequate oral hygiene (2, 3). Hard-to-reach areas in the oral cavity, such as the subgingival and interproximal spaces, require additional chemotherapeutic agents for good cleaning (4). For these reasons, rinse water can be an additional mechanical cleaning means and help prevent oral diseases – caries, periodontal problems, mucositis, halitosis, and others (3).

Depending on its purpose, different active ingredients can be added to the mouth rinse's composition - antibiotics, antiseptics, probiotics, and others (1). Chlorhexidine is the "gold standard" among chemotherapeutic agents used in mouthwashes, but it is not recommended for children under the age of six (5). In addition, side effects have been reported with its use, such as brown discoloration of the teeth, bitter or metallic taste, and mucosal erosions (6).

Fluoride mouthwashes are the most commonly used mouthwashes in childhood. Rinsing the mouth with a fluoride solution effectively prevents dental caries and protects all tooth surfaces (7). For this reason, school programs in various parts of the world include gargling with such water as a preventive measure (8).

Encouraging results have been reported for herbal mouthwashes in reducing the number of cariogenic microorganisms and controlling gingival disease and plaque. Their composition usually includes active components such as flavonoids, tannins, sanguinarine, propolis, neem, green tea, charcoal, cloves, and others (9). They can have a wide variety of effects, including anti-caries, antiseptic, and remineralizing (9).

The hydrogen index (pH) is a parameter of the alkalinity or acidity of a given solution or product, determining its chemical character (10). It is measured using a logarithmic scale known as the pH scale, which expresses the acidity or alkalinity of a solution. At pH values less than 7, the solution is considered acidic, and a solution with a pH above 7 is alkaline (11). *Endogenous pH* is a crucial variable providing information on pharmaceuticals' cariogenic and erosive potential (12).

Numerous oral care products are sold over the counter and are increasingly used by children (11). According to the ANSI/ADA 116 standard, the average pH value of products is between 3.0 and 10.5. When an oral rinse solution has a pH below the critical value of 5.5, ANSI/ADA Standard 116 requires additional demonstration of product safety (13). A literature review shows that the acidity of different mouthwashes varies widely, with 43% of products tested showing a pH value below 5.5 (14). Research from 2010 shows that the prevalence of dental erosion in childhood varies widely - 65% in 4–6-year-olds in the UK, 71% in 8–11-year-olds in Germany, and 78% in 5–15-year-olds in Australia (15). The presence of gastroesophageal reflux disease, consumption of acidic food and drinks, and holding beverages in the mouth while drinking and snacking regularly were significantly associated with the presence of erosive toothwear (16).

Although mouthwashes stay for a short time in the oral cavity, our study aims to make a laboratory assessment of the endogenous pH of children's mouthwashes, which are commercially available in Bulgaria.

Material and methods

Six mouthwashes were tested - table. 1.

Table 1: Composition of children's mouthwashes

Number	Name	Manufacturer	Composition/ Ingredients
1	Elgydium Emoji Junior Red Berris 7-12 years	Pierre Fabre Oral Care	Aqua, Glycerin, Peg-40 Hydrogenated Castor Oil, Ci 16255, Benzyl Alcohol, Aroma, Nicotinyl Alcohol Hf, Peg-12, Peg-12 Allyl Ether, Peg-12 Dimethicone, Potassium Sorbate, Sodium Saccharin, Xylitol

2	Aquafresh Kids Big Teeth Mouthwash Fruity Flavour 6+ years	Haleon	Aqua, Glycerin, Sorbitol, Poloxamer 338, PEG-60 Hydrogenated Castor Oil, Aroma, Allantoin, Cetylpyridinium Chloride, Methylparaben, Sodium Benzoate, Sodium Fluoride, Sodium Saccharin, Disodium Phosphate, Sodium Phosphate, Limonene, CI 17200. Contains: Sodium Fluoride 0.05% w/w (225 ppm fluoride).
3	Bilka homeopathy kids mouthwash 6+ years	Bilka lifestyle LTD	Aqua, Sorbitol, PEG-40 Hydrogenated Castor Oil, Eupatorium Rebaudianum Leaf Extract, Disodium EDTA, Aroma, Sodium Benzoate, Limonene, Citral, Geraniol, Linalool
4	Listerine smart rinse mild berry 6+ years	Johnson & Johnson GmbH	Aqua, Alcohol, Sorbitol, Poloxamer 407, Benzoic Acid, Eucalyptol, Zinc Chloride, Methyl Salicylate, Thymol, Sodium Benzoate, Sodium Fluoride, Menthol, Sucralose, Aroma, Sodium Saccharin, CI 42090
5	Elmex Junior 6 – 12 years	Colgate-Palmolive Manufacturing (Poland)	aqua (water), glycerin, sorbitol, propylene glycol, olaflur, sodium benzoate, peg-40 hydrogenate castor oil, aroma (flavor - menthol), saccharin, sodium fluoride
6	Dentility Kids Mouthwash strawberry 6+ years	Lily drogerie	Aqua, glycerin, sodium citrate, sodium benzoate, polysorbate 20, sodium fluoride, cetylpyridiunium chloride, sodium saccharine, citric acid, CI 14720, CI47005
7	Professional Dental Kids teeth mouthwash 6+ years	Rubella Beauty	Aqua, peg-40 hydrogenate castor oil, xylitol, calcium lactate, panthenol, propylene glycol, aroma, stevia rebaudiana leaf extract, cetylpyridinium chloride, 2-bromo-2-nitropropane-1,3-diol
8	DM Dontodent Junior Mund-Spulung 6+ years	dm-drogerie markt GmbH	aqua, glycerin, sorbitol, disodium phosphate, propylene glycol, allantoin, chamomilla recutita flower extract, xylitol, olaflur, sodium fluoride, sodium saccharin, citric acid, aroma, sodium benzoate, potassium sorbate

From each mouthwash, five samples of 5 ml were taken. For this purpose, sterile volumetric flasks of appropriate volume were used. The pH and temperature of the rinses were measured on each test sample using an electronic pH meter (model pHTestr 50S Spear-Tip Waterproof Pocket tester, Premium 50 Series, Oakton, USA). Before each test, the pH meter was calibrated using two standard solutions of pH=4 and pH=7. The pH meter electrode was immersed in the solution for one minute while the solution was stirred continuously, and the pH value was measured. The measuring probe was rinsed with deionized water after each measurement. The mean pH value, the mean value of temperature, and the standard deviation were calculated from the results obtained from each sample. The experiment was carried out under carefully controlled conditions of almost constant room temperature, ensuring that the results on the acidity of the solution were not affected.

Statistical analysis

Statistical analysis was conducted with a statistical computer software SPSS v.19.0 (SPSS Inc., Chicago, IL, USA). The significance level was set at p = 0.05.

Results

Table 2: Mean pH values of 8 pediatric mouthrinsec

Result / Product name	pH Mean ± SD	Temperature ºC Mean ± SD
1 - Elgydium	4.96 ± 0.27	22.21 ± 0.52
2 - Aquafresh	6.01 ± 0.15	22.18 ± 0.56
3 - Bilka	6.22 ± 0.06	22.14 ± 0.63
4 - Listerine	3.32 ± 0.06	22.08 ± 0.64
5 - Elmex	4.74 ± 0.08	21.93 ± 0.63
6 - Dentility	6.47 ± 0.05	22.95 ± 0.58
7 - Professional Dental Kids	5.54 ± 0.05	21.18 ± 0.69
8 – DM Dontodent	6.06 ±0.03	22.15 ± 0.62

The data in Table 2 show that the results for all mouthwashes tested varied significantly. The lowest endogenous pH was measured in Listerine mouthwash (3.32), and the highest and closest to neutral - in Dentililty 6.47. Most products showed values above the critical pH of 5.5 for the oral cavity, but some mouthwashes reported values below 5. No mouthwash showed a neutral or alkaline pH.

Discussion

Understanding the pH levels of children's mouthwashes is crucial, especially for those at a higher risk of tooth decay. Some mouthwashes, due to their acidic nature, can potentially weaken tooth enamel or cause erosion. Our study, therefore, focused on investigating the pH values of the most commonly used children's mouthwashes in the Bulgarian market.

Maintaining a pH above the critical level for enamel dissolution would facilitate tooth remineralization (17). A mouthwash with a neutral or alkaline pH and a fluoride ingredient is good (17). Most of the rinses we tested contain fluoride - Aquafresh, Elmex, Dentility, and Dontodent. At the same time, their pH value varies widely, with the highest value reported for Dentility. Controlled regular use of fluoride mouthwash by children and adolescents significantly reduces caries in permanent teeth (18). Acidulated phosphate fluoride has

been found to etch the enamel surface and increase roughness after application (19). Therefore, lower pH values would favor the incorporation of fluoride ions into the hydroxyapatite lattice (14). Products with a high fluoride content and a slightly acidic pH value are sometimes better at absorbing fluoride ions from solutions with a neutral pH. However, its use is a recommended preventive measure, especially in children at high risk of caries development. The selection of its type must be consistent with the active fluoride ingredient, the erosive potential, and the endogenous pH value.

Xylitol is a 5-carbon sugar alcohol with a crystalline structure that is added to a variety of products such as gums, syrups, lozenges, sprays, mouthwashes, gels, toothpaste, candies, and polishes (20). Sugar alcohols have been shown in various tests to be non-acidogenic or hypoacidogenic and, therefore, extremely low or non-cariogenic products (21). Several studies have analyzed the impact of xylitol on oral health, prevention of dental caries, control of plaque, and other risk factors for caries development and proved its positive effects (22). Our study included three xylitol-containing mouthwashes - DM Dontodent, Professional Dental Kids, and Elgydium. Their endogenous pH ranges between 5 and 6, which makes them a suitable choice as an additional oral hygiene agent.

The herbal mouthwashes we examined also included several DM Dontodent, Professional Dental Kids, and Bilka, and all of them had an endogenous pH value above critical 5.5. They are an excellent alternative to mechanical teeth cleaning for children for whom fluoride mouthwash is not recommended.

Listerine kids showed the lowest values of endogenous pH in our study (Table 2). Similar results were published by colleagues who reported values for different types of Listerine mouthwash between 3.43 and 3.98 (23). It is evident that some mouthwashes have a pH lower than the critical pH of enamel and dentin and that they can exert their erosive potential on hard tooth structures.

Saliva plays a pivotal role in maintaining oral pH and homeostasis (24). Intraoral pH levels typically range between pH 6.5 – 7.8 and can be influenced by various factors such as diet, certain diseases, xerostomia, smoking, and medication intake. Understanding the physicochemical characteristics of all oral products, including mouthwashes, is crucial in childhood (24). Further in vivo studies are needed to understand how their use can affect intraoral pH values.

Conclusion: The pH values of the tested mouthwashes varied significantly—from 3.32 to 6,67. Most of them have pH values above the critical level for enamel dissolution. However, dentists should consider their acidic potential, especially for children at a higher risk of tooth decay, when recommending them because some of them can potentially weaken tooth enamel or cause erosion if they are used for prolonged periods in the oral cavity.

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