ORAL HEALTH

TITRATABLE ACIDITY AND PH OF COMMERCIAL MOUTHWASHES: A COMPREHENSIVE ANALYSIS

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Abstract

The aim of this study was to measure and analyze the pH and titratable acidity (TA) of a wide range of commercial mouthwashes available in the Republic of North Macedonia, and to assess their potential erosive effects. Material and methods: A comprehensive market analysis was performed in the Republic of North Macedonia, including traditional markets (pharmacies, cosmetic chains, and consumer goods markets) as well as the online market. One to three packs of each mouthwash were purchased directly from vendors according to the inclusion and exclusion criteria, without requesting free samples from manufacturers or importers. A total of 81 mouthwashes were analyzed. pH and TA measurements were performed twice for each mouthwash, with results presented as Mean±SD. Results: The mean pH of the mouthwashes was 5.28±0.98 (range: 3.24 -7.74). More than half (n=48, 59.3%) had pH values below the critical threshold of 5.5. Only four (4.9%) had an initial pH ≥7. To neutralize acidic mouthwashes, an average of 5.75±10.29 ml of 0.1M NaOH was required (range: 0.01–81.20 ml). TA ranged from 0.01 to 162.4 mmol/l, with a mean of 11.50±20.58 mmol/l. Conclusion: A significant proportion of the mouthwashes (59.3%) had pH values below the critical threshold of 5.5. The titratable acidity values varied widely, with some mouthwashes exhibiting extremely high TA levels. Further research is needed to establish clear guidelines for safe use of mouthwashes with respect to their pH and titratable acidity values, especially to show the association between pH and TA of mouthwashes and the buffer capacity of saliva.

ОРАЛНО ЗДРАВЈЕ

ТИТРАЦИСКАТА КИСЕЛОСТ И РН НА КОМЕРЦИЈАЛНИ ВОДИЧКИ ЗА ПЛАКНЕЊЕ НА УСТА: ДЕТАЛНА АНАЛИЗА

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Клучни зборови: водички за плакнење на уста, рН, титрациска киселост, пуферски капацитет.

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Печатарски права: ©2025. Марија Андоновска, Влатко Коколански, Спиро Спасовски, Бојан Попоски, Ќиро Ивановски, Јулијана Николовска, Олга Гигопулу. Оваа статија е со отворен пристап дистрибуирана под условите на нелокализирана лиценца, која овозможува неограничена употреба, дистрибуција и репродукција на било кој медиум, доколку се цитираа оригиналниот(ите) автор(и) и изворот.

Конкурентски интереси: Авторот изјавува дека нема конкурентски интереси.

Извадок

Целта на оваа студија беше да се измери и анализира рН и титрациската киселост (ТК) на широк спектар на комерцијални водички за плакнење на устата, достапни во Република Северна Македонија, за да се процени нивниот потенцијален ерозивен ефект. Материјал и методи: Беше спроведена анализа на пазарот на Република Северна Македонија, вклучувајќи ги традиционалните пазари (аптеки, козметички ланци и маркети), како и онлајн пазарот. Беа купени 1 до 3 примероци од секоја водичка за плакнење на устата директно од продавачите, согласно критериумите за вклучување во и исклучување од студијата, без барање бесплатни примероци од производувачите или увозниците. Беше анализирана вкупно 81 водичка за плакнење на устата. Мерењата на рН и ТК беа изведени двапати за секоја водичка, а резултатите беа прикажани како Mean±SD. Резултати: Средната вредност на рН на водичките за плакнење на устата беше 5,28±0,98 (опсег: 3,24 -7,74). Повеќе од половина (n=48; 59,3%) имаа рН вредност под критичната граница 5,5. Само четири (4,9%) имаа иницијална рН ≥7. Просечно 5,75±10,29 ml (опсег: 0,01–81,20 ml) 0,1M NaOH беа потребни за неутрализација на киселите водички за плакнење. ТК варираше од 0,01 до 162,4 mmol/l, со средна вредност 11,50±20,58mmol/l. Заклучок: Значителен дел од водичките за плакнење на устата (59,3%) имаа рН вредности под критичната граница од 5,5. Вредностите на ТК варираа, при што некои водички покажаа екстремно високи нивоа на ТК. Неопходни се понатамошни истражувања за утврдување јасни насоки за безбедна употреба на овие производи, особено за истражување на поврзаноста меѓу рН, ТК и пуферскиот капацитет на плунката.

Introduction

Mouthwashes are a widely used adjunct oral hygiene element with various beneficial effects, such as: mitigating plaque-associated oral diseases, teeth whitening, management of halitosis, as well as post-surgery and post-dental treatment[1,2]. To be considered suitable adjuncts to mechanical oral hygiene, mouthwashes should be safe for prolonged use, and their potential side effects should be well understood[3]. For example, prolonged use of mouthwashes containing chlorhexidine gluconate can result in tooth staining, loss of taste sensations, tongue irritation and sore mouth[4].

Tooth erosion, a pathological dissolving of the hard dental tissues induced by chemical acid exposure unrelated to bacterial biofilm, is a known side effect of mouthwash use 3,5. The critical pH of dental enamel demineralization is approximately 5.5 and any solution with a lower pH value may cause erosion if used frequently and for prolonged periods of time[6]. In the past, media attention was directed towards mouthwashes with pH values below 5.5 and their impact on tooth erosion[3]. The pH values of many mouthwashes have been tested and the majority of them were acidic, with some of them having a pH as low as[3,4 7].

Besides pH value, titratable acidity (TA) plays a critical role when it comes to dental erosion[8,9]. While pH is easy to measure, it lacks information regarding the concentrations of undissociated acids within the analyzed solution and it only provides information considering initial hydrogen ion dissociation[10]. Many researchers indicate that TA of a solution is a more accurate measure of the erosive potential on dental hard tissues[10]. Titratable acidity measures acidity by titrating a sample with a standardized base to a pH end point[11], and it determines the ability of a buffering agent, usually OH ions, to neutralize all available acid [10]. Authors emphasize that TA is a key factor for the time that salivary pH is maintained at low levels[12]. If a certain solution has a higher TA value, then the saliva will need more time to neutralize all acids within that solution[13].

The aim of this study was to measure and analyze the pH and titratable acidity (TA) of a wide range of commercial mouthwashes available in the Republic of North Macedonia, and to assess their potential erosive effects.

Material and methods

A comprehensive market analysis was performed in the Republic of North Macedonia, between January to October 2024, including traditional markets (pharmacies, cosmetic chains, and consumer goods markets) as well as the online market. One to three packs of each mouthwash were purchased directly from vendors according to the inclusion and exclusion criteria, without requesting free samples from manufacturers or importers.

Inclusion criteria: products intended for maintaining oral hygiene, preventing oral diseases, or having a therapeutic effect; available over the counter; and in the pharmaceutical forms of either solutions intended for direct use or concentrates to be dissolved in water, regardless of their regulatory status (medicine, medical device, cosmetic product).

Exclusion criteria: tablets that dissolve in water or other liquids, chewing tablets, saliva substitutes; products containing antibiotics, steroids, parasympathomimetic saliva stimulants, topical local anesthetics, and other prescription drugs; liquids taken orally but not intended for maintaining oral hygiene; liquids in the form of sprays, toothpastes, gels, powders, foams, homeopathic products, and products without a fully available composition.

A total of 81 mouthwashes were included in the study, which are listed in Appendix A.

Concentrate mouthwashes were dissolved according to the manufacturer instructions. The measurements of pH and titratable acidity (TA) were done twice, consecutively for each mouthwash. The results presented in this study are the average value of the two measurements, presented as Mean±SD. All measurements were done by the same researchers in the Biochemical and microbiological laboratory at the Department of Oral and Periodontal Diseases, Faculty of Dentistry – Skopje, Ss. Cyril and Methodius University in Skopje.

pH

Prior to each workday in the laboratory, the pH meter LLG-pH Meter 7 (LLG-Labware, Meckenheim, Germany) was calibrated using standard solutions (pH 4 and pH 7). The washed and dried electrode of the pH meter was immersed in a beaker filled with 50 ml of the mouthwash. The pH meter gives a visual signalization on the digital screen when the measurement is stable. Before each measurement, the electrode was washed with distilled water and dried.

Titratable acidity (TA)

To calculate the TA, first, we measured the amount of 0.1M sodium hydroxide (NaOH) (strong base) required to neutralize the pH of the mouthwash, i.e. to reach a pH 7 from its original starting pH, expressed in V/ml[8]. The titration was performed by using a micropipette (TopPette Pipettor – Dragonlab, Beijing, China), 0.1M NaOH (Alkaloid AD Skopje, Skopje, Republic of North Macedonia), a magnetic stirrer (Guardian 2000, OHAUS, Parsippany, New Jersey) and the aforementioned pH meter. The average value obtained from the duplicate measurements was used to calculate the titratable acidity using the following formula according to van Swaaij BWM *et al*.[8]: mmol/l = *MR x (V1/VM) x 1000*, where MR = molar concentration of the reagent (sodium hydroxide), mol/l (base); V1 = volume of sodium hydroxide added to pH 7, in ml; VM = volume sample MW (each 50 ml). The results were expressed in mmol/l.

Data were analyzed using the statistical software IBM SPSS Statistics [24].

Results

This study included 81 mouthwashes for which pH and TA were measured. A comprehensive list of these mouthwashes with their pH and TA values expressed as Mean±SD is provided in Appendix A.

The mean pH value of the mouthwashes was 5.28±0.98, ranging from 3.24 to 7.74 (Table 1, Figure 1). More than half of the mouthwashes (n=48, 59.3%) had a pH value lower than the critical pH 5.5, which were categorized as potentially erosive.

Table 1: pH of the mouthwashes

	Mean	Std. Dev.	Min	Max	Percentiles		
					25th	50th	75th
pH	5.28	0.98	3.24	7.74	4.43	5.27	5.87

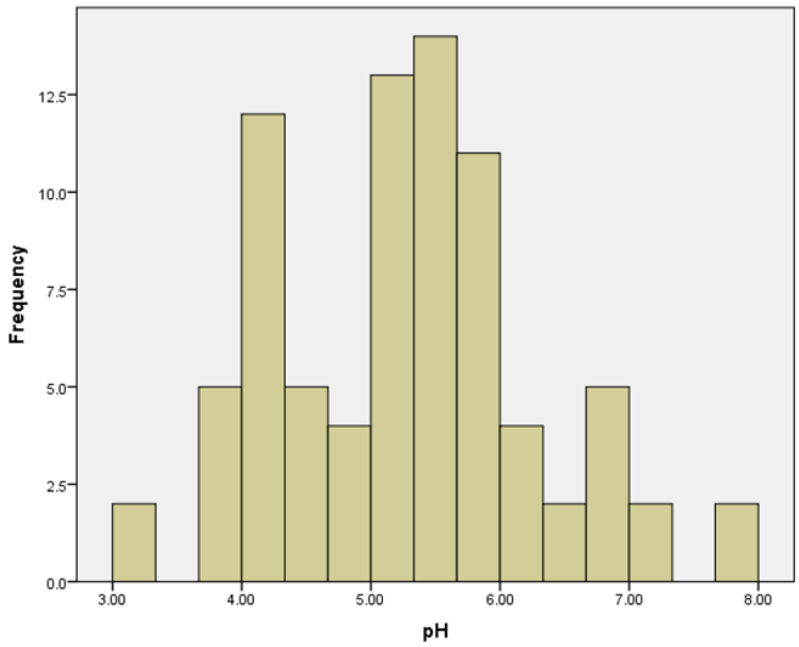


Figure 1: Distribution of pH values across the analyzed mouthwashes

Four mouthwashes (4.9%) presented an initial pH value ≥7 for which TA was not measured. A volume of 5.75±10.29 ml of 0.1M NaOH was needed to neutralize the acidic mouthwashes, ranging from 0.01 ml up to 81.20 ml (Table 2). The interquartile range (IQR) for the volume of NaOH needed to neutralize the mouthwashes was 7.2925 (0.5400–7.8325).

Table 2: Volume of NaOH used to neutralize the mouthwashes (ml)

	Mean	Std. Dev.	Min	Max	Percentiles		
					25th	50th	75th
NaOH	5.75	10.29	0.01	81.2	0.54	2.82	7.83

The titratable acidity ranged from 0.01 to 162.4 mmol/l, with a mean TA of 11.50±20.58 mmol/l (Table 3, Figure 2). The interquartile range (IQR) for titratable acidity was 14.4 (1.0800–15.4800). Outliers were identified using the 1.5 × IQR rule, with values exceeding 37.08 mmol/l considered extreme.

Table 3: Titratable acidity of the mouthwashes (mmol/l)

	Mean	Std. Dev.	Min	Max	Percentiles		
					25th	50th	75th
TA	11.5	20.58	0.01	162.4	1.08	5.65	15.48

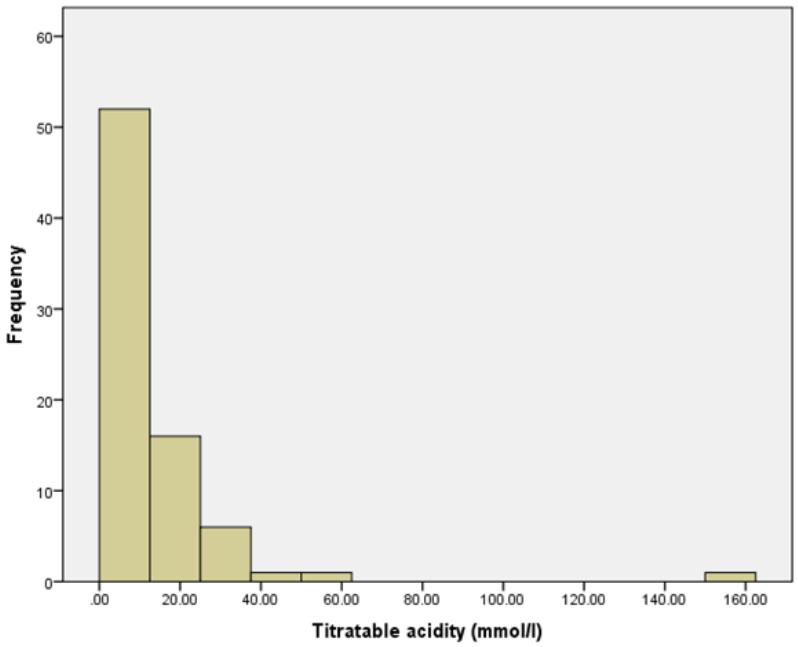


Figure 2: Distribution of titratable acidity values across the analyzed mouthwashes

Discussion

In addition to being prescribed by dentists, mouthwashes are frequently used by patients without medical supervision, who are unaware of the potential side effects of these products[14]. Usually, mouthwashes containing chlorhexidine (CHX) are associated with numerous side effects, including xerostomia, loss of taste, discoloration of the tongue, burning sensations of the tongue, and the most common concern for the patients – tooth discoloration due to the non-enzymatic Maillard reaction[15].

Dental erosion (DE) is defined as loss of the dental structure by acid dissolution that does not involve bacteria, caused by acidic substances from different sources[16]. Some mouthwashes are acidic, and data suggest that pH value and titratable acidity are two important factors which influence the erosive potential of the mouthwashes[17].

In our study, 48 of the 81 mouthwashes analyzed had a pH lower than 5.5. While it is considered that the critical pH for dental erosion is pH 5.5 for hydroxyapatite and 4.5 for fluorapatite, it is important to mention that the critical pH for dental erosion is not a fixed number and is influenced by several factors, including: frequency and duration of exposure of the acidic substance, presence of phosphates,

calcium, fluorides and other soluble solid content in the solution, titratable acidity, buffering capacity and viscosity[17–22]. It is challenging to predict the erosive potential of mouthwashes due to the fact that mouthwashes are not simple solutions and may contain molecules which inhibit the demineralization process, such as numerous natural peptides and polymers[23]. Considering low pH as a potentially erosive factor, it is important to note that even though low pH levels are harmful to the hydroxyapatite, they are important for the chemical stability of the mouthwash ingredients and facilitation of the incorporation of fluoride ions into the hydroxyapatite[8]. Some data[21] even suggest that mouthwashes with low pH increase the pH levels of plaque and saliva, suggesting that they do not have a negative impact on the saliva's buffering ability. Cavalcanti *et al.*[24] identified 3 out of 10 commercial mouthwashes as potentially erosive, B W M van Swaaij *et al.*[8] 20 out of 54, Garib *et al.*[6] out of 11 mouthwashes[17].

Since low pH plays a significant role in the incorporation of fluoride ions in the enamel, if a mouthwash has a low pH and no fluoride content it can be considered harmful to dental tissues if not used carefully[24]. Mouthwashes with low pH should not be considered for long-term use and never before brushing[25].

In addition to low pH, titratable acidity is a key factor contributing to the erosive potential of mouthwashes[17] and is considered to be a more accurate measure of the total acid content of a solution, i.e. a more realistic parameter for predicting the erosive potential of a mouthwash[26]. Mouthwashes with low titratable acidity are easily neutralized by saliva, while those with high titratable acidity cause a prolonged decrease in pH and have a larger erosive potential[25].

Among the analyzed mouthwashes in our study, three exhibited significantly high titratable acidity values, classifying them as outliers. These mouthwashes required notably higher volumes of NaOH for neutralization: 81.20 ml (Product #7), 27.67 ml (Product #29) and 22.60 ml (Product #30), corresponding to the titratable acidity values of: 162.4 (Product #7), 53.33 (Product #29) and 45.20 (Product #30).

Vivek *et al.*[26] expressed the titratable acidity as ml of NaOH needed for the pH of the mouthwashes to reach a value of 7 or higher, where the values ranged from 0.2 to 1.2 ml. A similar study by Cavalcanti *et al.*[24] used 0.1M potassium hydroxide to neutralize the mouthwashes and presented values ranging from 0.007 to 0.530. Both studies exhibited a lower range of the volume of base needed to neutralize the mouthwashes, compared to our results [5.75±10.29 ml, ranging from 0.01 ml to 81.20 ml with an IQR of 7.29 (0.54-7.83)]. Another difference between these studies is that the study by Vivek et al. included only 11 mouthwashes[26], while the study by Cavalcanti et al. included 10 mouthwashes[24], compared to the 81 mouthwashes analyzed in our study.

In contrast to the previously discussed studies that expressed titratable acidity as the volume of base required for neutralization of the mouthwashes, Swaaij *et al.*[8] expressed the titratable acidity in

mmol/l. The reported range for the titratable acidity of mouthwashes varied from 0 to 48 mmol/l. Similarly, our study also expressed titratable acidity results in mmol/. However, we observed a broader range of values, with titratable acidity varying from 0.01 to 162.40, compared to the findings of Swaaij *et al.*[8]. Goyal *et al.*[27] presented TA values ranging from 0.1 to 16.67, using 0.05N NaOH to neutralize 10 ml of the mouthwashes.

In addition to the findings presented, it is important to consider the broader regulatory and public health context surrounding mouthwash formulation and labeling. In today's global market, there is a need for precise product information[8]. The International Organization for Standardization (ISO) defined a standard regarding oral care products, specifically for oral rinses ISO 16408 (2015)[28]. ISO recommends that oral rinses should have a pH value between 3.0 and 10.5. If the pH value of an oral rinse is below 5.5 it should pass a screening test as specified in ISO 28888 (2013)[29]. This International Standard describes a screening method for assessing the erosion potential of dental hard tissues associated with the use of oral rinses and the primary aim is to provide methodology for screening oral rinses for the potential for tooth erosion. The dentist and consumer should be aware that mouthwashes may cause adverse effects[8,30].

Overall, the complexity of commercial acidic product formulations makes it difficult to separate the contributions of pH and titratable acidity from their overall effect on dental erosion[31]. We previously noted that a low pH helps maintain the stability of mouthwashes and facilitates the incorporation of fluoride ions into hydroxyapatite. However, it is essential to weigh the cost-benefit of the use of these products, as they can contribute to dental erosion. Additionally, the dynamic nature of the oral environment complicates our understanding of how mouthwashes interact with saliva. Salivary flow rate, composition, and buffer capacity could influence the dental erosion process[6,32]. Clinically, the use of such mouthwashes should be reserved for specific indications, with a great caution in patients with xerostomia, due to their diminished salivary protective capacity. These individuals should be thoroughly informed about the potential risks associated with their use[33].

Conclusion

This comprehensive study of 81 commercial mouthwashes revealed that a significant proportion (59.3%) had pH values below the critical threshold of 5.5, potentially contributing to dental erosion. The titratable acidity values varied widely, with some mouthwashes exhibiting extremely high TA levels. Further research is needed to establish clear guidelines for the safe use of mouthwashes with respect to their pH and titratable acidity values, especially to show the association between pH and TA of mouthwashes and the buffer capacity of saliva.

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Appendix A: pH and TA values of the mouthwashes

	Commercial name	pH 1	pH 2	Dif	Mean	SD	B1 in ml	B2 in ml	TA 1 Mmol/L	TA 2 Mmol/L	Dif	Mean TA Mmol/L	SD
1	Doctor's Mint Mouth Wash	5.55	5.54	-0.01	**5.55**	0	**1.49**	1.49	2.98	2.98	0	2.98	0
2	Doctor's Herbal Mouth Wash	5.52	5.55	0.03	**5.54**	0.02	**1.17**	1.18	2.34	2.36	0.01	2.35	0.01
3	Doctor's Antitartar Mouth Wash	5.47	5.49	0.02	**5.48**	0.01	**0.61**	0.63	1.22	1.26	0.02	1.24	0.02
4	Doctor's Propolis Mouth Wash	5.74	5.7	-0.04	**5.72**	0.02	**0.71**	0.71	1.42	1.42	0	1.42	0
5	Doctor's Smokers Mouth Wash	5.95	5.93	-0.02	**5.94**	0.01	**0.46**	0.46	0.92	0.92	0	0.92	0
6	Alur Care Mouthwash cool mint	5.65	5.69	0.04	**5.67**	0.02	**0.7**	0.6	1.4	1.2	-0.1	1.3	0.14
7	Bilka Dent Expert Classic Parodont Protect	4	4.01	0.01	**4.01**	0	**81.4**	81	162.8	162	-0.4	162.4	0.56
8	Alverde Pro Climate 5 in 1 Mondspulung	4.65	4.67	0.02	**4.66**	0.01	**6.45**	6.89	12.9	13.78	0.44	13.34	0.62
9	Dontodent Protect & Care 10 in 1 Rundumschutz	5.66	5.7	0.04	**5.68**	0.02	**2.39**	2.48	4.78	4.96	0.09	4.87	0.12
10	Dontoent Zahnfleisch Intensiv - Pflege	5.24	5.25	0.01	**5.25**	0	**3.15**	3.08	6.3	6.16	-0.07	6.23	0.09
11	Dontodent Sensitive Intensiv - Schutz	5.04	5.06	0.02	**5.05**	0.01	**13.62**	13.31	27.24	26.62	-0.31	26.93	0.43
12	Dontodent Neue Rezeptur Mundwasser Konzentrat	3.97	3.98	0.01	**3.98**	0	**0.25**	0.26	0.5	0.52	0.01	0.51	0.01
13	Bilka Homeopathy Grapefruit Mouthwash	5.57	5.59	0.02	**5.58**	0.01	**1.95**	2.22	3.9	4.44	0.27	4.17	0.38
14	Dontodent Junior Lernneffekt - spulung	5.51	5.54	0.03	**5.53**	0.02	**1.24**	1.34	2.48	2.68	0.1	2.58	0.14
15	Dontodent Junior mund - spulung	6.01	5.96	-0.05	**5.99**	0.03	**8.12**	8	16.24	16	-0.12	16.12	0.16
16	Parodontax Active Gum Health	6.73	6.74	0.01	**6.74**	0	**0.28**	0.27	0.56	0.54	-0.01	0.55	0.01
17	Betadine Gargle	3.26	3.27	0.01	**3.27**	0	**0.55**	0.53	1.1	1.06	-0.02	1.08	0.02
18	Stomatidin	5.04	5.07	0.03	**5.06**	0.02	**1.44**	1.71	2.88	3.42	0.27	3.15	0.38
19	Oralsept	6.4	6.4	0	**6.40**	0	**0.11**	0.11	0.22	0.22	0	0.22	0
20	Elmex Caries Protection	4.43	4.44	0.01	**4.44**	0	**7.25**	7.6	14.5	15.2	0.35	14.85	0.49
21	Elmex Sensitive	4.45	4.46	0.01	**4.46**	0	**7.73**	7.7	15.46	15.4	-0.03	15.43	0.04
22	Colgate Plax Ice	5.55	5.54	-0.01	**5.55**	0	**0.26**	0.26	0.52	0.52	0	0.52	0
23	Lacalut Micellar Sensitive Mouthwash	5.45	5.5	0.05	**5.48**	0.03	**1.35**	1.46	2.7	2.92	0.11	2.81	0.15
24	Lacalut Micellar tartar protection micellar water	5.58	5.53	-0.05	**5.56**	0.03	**14.47**	14.2	28.94	28.4	-0.27	28.67	0.38
25	Listerine Total Care Clean Mint 6 in 1 Mild Taste	4.18	4.14	-0.04	**4.16**	0.02	**7.74**	8.15	15.48	16.3	0.41	15.89	0.57
26	Listerine Total Care Clean Mint 6 in 1	3.97	4.04	0.07	**4.01**	0.04	**10**	10.35	20	20.7	0.35	20.35	0.49
27	Listerine Natural Enamel protect	4.02	3.97	-0.05	**4.00**	0.03	**3.8**	3.85	7.6	7.7	0.05	7.65	0.07
28	Listerine Naturals Sabor Suave	3.85	3.85	0	**3.85**	0	**3.52**	3.83	7.04	7.66	0.31	7.35	0.43
29	Listerine Advanced Defence Sensitive	4.18	4.13	-0.05	**4.16**	0.03	**27.58**	27.75	55.16	55.5	0.17	55.33	0.24

30	Listerine Advanced White Mouthwash Mild Taste	5.98	5.97	-0.01	**5.98**	0	**22.7**	22.5	45.4	45	-0.2	45.2	0.28
31	Listerine Green Tea Mild Taste	4.03	4.04	0.01	**4.04**	0	**3.88**	3.92	7.76	7.84	0.04	7.8	0.05
32	Listerine Total Care Tartar Protect	4.23	4.3	0.07	**4.27**	0.04	**7.74**	7.74	15.48	15.48	0	15.48	0
33	Listerine Teeth&Gum Defence	4.2	4.23	0.03	**4.22**	0.02	**7.4**	7.32	14.8	14.64	-0.08	14.72	0.11
34	Listerine Smart Rinse	3.26	3.21	-0.05	**3.24**	0.03	**3.72**	3.82	7.44	7.64	0.1	7.54	0.14
35	Listerine Cool Mint	4.05	4.1	0.05	**4.08**	0.03	**4.43**	4.4	8.86	8.8	-0.03	8.83	0.04
36	Listerine Fresh Burst	3.99	3.95	-0.04	**3.97**	0.02	**1.25**	1.35	2.5	2.7	0.1	2.6	0.14
37	Astera Total All-in-one	6.25	6.25	0	**6.25**	0	**2.07**	2.17	4.14	4.34	0.1	4.24	0.14
38	Parodont Active	4.58	4.54	-0.04	**4.56**	0.02	**16.07**	15.8	32.14	31.6	-0.27	31.87	0.38
39	Oral B Pro-Expert	4.31	4.32	0.01	**4.32**	0	**0.27**	0.25	0.54	0.5	-0.02	0.52	0.02
40	Gengigel Oral Solution	6.12	6.08	-0.04	**6.10**	0.02	**3.62**	3.72	7.24	7.44	0.1	7.34	0.14
41	Colgate Cool Mint	5.41	5.37	-0.04	**5.39**	0.02	**0.39**	0.38	0.78	0.76	-0.01	0.77	0.01
42	Colgate plax white+charcoal	7.73	7.73	0	**7.73**	0					0		
43	Colgate max white	7.74	7.74	0	**7.74**	0					0		
44	Colgate plax soft mint	5.34	5.38	0.04	**5.36**	0.02	**0.4**	0.4	0.8	0.8	0	0.8	0
45	Edel+White Fresh+Protect	5.41	5.38	-0.03	**5.40**	0.02	**0.84**	0.8	1.68	1.6	-0.04	1.64	0.05
46	Lacalut Micellar Whitening Mouthwash	5.17	5.22	0.05	**5.20**	0.03	**14.15**	14.1	28.3	28.2	-0.05	28.25	0.07
47	Lacalut Multi-Effect Micellar Mouthwash	5.17	5.12	-0.05	**5.15**	0.03	**13.3**	13.45	26.6	26.9	0.15	26.75	0.21
48	Lacalut Flora	5.04	5.1	0.06	**5.07**	0.04	**2.02**	2.02	4.04	4.04	0	4.04	0
49	Lacalut Aktiv	4.33	4.32	-0.01	**4.33**	0	**4.82**	4.7	9.64	9.4	-0.12	9.52	0.16
50	Lacalut white	6.91	6.95	0.04	**6.93**	0.02	**0.43**	0.45	0.86	0.9	0.02	0.88	0.02
51	Lacalut Sensitive	4.18	4.22	0.04	**4.20**	0.02	**6.33**	6.47	12.66	12.94	0.14	12.8	0.19
52	Curaprox Perio Plus Balance CHX 0.05	5.85	5.81	-0.04	**5.83**	0.02	**0.08**	0.12	0.16	0.24	0.04	0.2	0.05
53	Curaprox Perio Plus + Protect CHX 0.12	5.74	5.74	0	**5.74**	0	**0.12**	0.14	0.24	0.28	0.02	0.26	0.02
54	Curaprox Perio Plus Forte CHX 0.20	5.62	5.65	0.03	**5.64**	0.02	**0.07**	0.12	0.14	0.24	0.05	0.19	0.07
55	Curaprox Regenerate CHX 0.09	6.94	6.95	0.01	**6.95**	0	**0.06**	0.08	0.12	0.16	0.02	0.14	0.02
56	Alkmene Tea Tree Mouthwash	5.27	5.28	0.01	**5.28**	0	**2.33**	2.32	4.66	4.64	-0.01	4.65	0.01
57	Aquafresh Fresh & Minty	6.68	6.67	-0.01	**6.68**	0	**0.44**	0.44	0.88	0.88	0	0.88	0
58	Ben & Anna Natural Mouthwash Sensitive	5.25	5.24	-0.01	**5.25**	0	**6.04**	6.01	12.08	12.02	-0.03	12.05	0.04
59	Eco Denta Refresh & Protect Mouthwash	4.76	4.78	0.02	**4.77**	0.01	**10.15**	10.35	20.3	20.7	0.2	20.5	0.28
60	Natura Siberica Whitening & Enamel Protection	5.17	5.17	0	**5.17**	0	**10.75**	10.53	21.5	21.06	-0.22	21.28	0.31
61	Natura Siberica Plaque Control & Fresh Breath	5.16	5.09	-0.07	**5.13**	0.04	**5.25**	5.44	10.5	10.88	0.19	10.69	0.26
62	Natura Siberica Strong Teeth & Gums	5.13	5.11	-0.02	**5.12**	0.01	**7.83**	8.02	15.66	16.04	0.19	15.85	0.26
63	Cosmos Organic People Mouthwash Coconut & Mint	4.96	4.96	0	**4.96**	0	**12.85**	13.16	25.7	26.32	0.31	26.01	0.43
64	Maxlab Silver Water	4.99	5.05	0.06	**5.02**	0.04	**0.28**	0.24	0.56	0.48	-0.04	0.52	0.05
65	Aquafresh Big Teeth Mouthwash	5.9	5.87	-0.03	**5.89**	0.02	**0.62**	0.56	1.24	1.12	-0.06	1.18	0.08

66	Intermed Unisept Mouth-wash	5.98	6	0.02	**5.99**	0.01	**1.21**	1.12	2.42	2.24	-0.09	2.33	0.12
67	Intermed Chlorhexil Extra 0,20% Mouthwash	5.4	5.47	0.07	**5.44**	0.04	**0.56**	0.52	1.12	1.04	-0.04	1.08	0.05
68	Intermed Chlorhexil 0.12% Mouthwash	6.12	5.92	-0.2	**6.02**	0.01	**9.06**	8.93	18.12	17.86	-0.13	17.99	0.18
69	Intermed Kids Mouthwash	4.94	4.89	-0.05	**4.92**	0.03	**2.82**	2.83	5.64	5.66	0.01	5.65	0.01
70	ESI Aloe Fresh Collutorio	4.93	4.89	-0.04	**4.91**	0.02	**10.2**	10.41	20.4	20.82	0.21	20.61	0.29
71	Limes Rosa Fresh Concen-trate	5.91	5.83	-0.08	**5.87**	0.05	**0.006**	0.01	0.012	0.02	0.004	0.016	0.005
72	Dr. Silver Mouthwash Total Care	5.27	5.24	-0.03	**5.26**	0.02	**12.4**	12.4	24.8	24.8	0	24.8	0
73	Green Fresh Concentrate Mouthwash	6.55	6.53	-0.02	**6.54**	0.01	**0.005**	0.007	0.01	0.014	0.002	0.012	0.002
74	FrezyDerm Sensitive Teeth Mouthwash	7.14	7.14	0	**7.14**	0					0		
75	FrezyDerm Plaque&Tartar Mouthwash	5.4	5.4	0	**5.40**	0	**5.65**	5.6	11.3	11.2	-0.05	11.25	0.07
76	Oral B Gum & Enamel Care Fresh Mint	4.29	4.36	0.07	**4.33**	0.04	**1.67**	1.7	3.34	3.4	0.03	3.37	0.04
77	Dental Dream Black & White	7.24	7.24	0	**7.24**	0					0		
78	Dental Dream Parodont Protect	3.9	3.95	0.05	**3.93**	0.03	**8.85**	8.92	17.7	17.84	0.07	17.77	0.09
79	Dental Dream Adcance White	4.44	4.42	-0.02	**4.43**	0.01	**3.24**	3.2	6.48	6.4	-0.04	6.44	0.05
80	Dental Dream Sensitive Teeth	6.1	6.06	-0.04	**6.08**	0.02	**3.26**	3.26	6.52	6.52	0	6.52	0
81	Dental Dream Enamel Repair	6.72	6.64	-0.08	**6.68**	0.05	**0.46**	0.49	0.92	0.98	0.03	0.95	0.04

B1=Buffer 1; B2=Buffer 2

Titratable acidity calculated at pH 7.