Physicochemical and Pulp Tissue Dissolution Properties of Some Household Bleach Brands Compared with a Dental Sodium Hypochlorite Solution

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Abstract

Introduction: Many clinicians use household bleach to irrigate root canals. Sodium hypochlorite solutions are also available from dental suppliers. We compared physicochemical features of these products and investigated their impact on pulp tissue dissolution. **Methods:** Six different brands of household bleach were bought from drugstores. These were compared with Chlor-XTRA and technical NaOCl solutions of controlled concentration and alkalinity regarding their chlorine content (wt% NaOCl), pH, alkaline capacity, osmolarity, surface tension (Wilhelmy plate method), and price. Bovine pulp tissue (n = 10 specimens per group) dissolution at 37°C by test and control solutions adjusted to 1.0% NaOCl was assessed. Reduction in tissue weight was compared between groups by one-way analysis of variance, followed by Bonferroni correction ($P < .05$). **Results:** The pH of undiluted solutions ranged between 11.1 and 12.7. Batches of the same product differed in NaOCl content. No product contained more than an equivalent of 0.1 mol/L NaOH. One household bleach brand (Safeway Bleach Summit Fresh) was slightly alkalized; the other solutions under investigation were not. Osmolarity was similar between products. The surface tension of Chlor-XTRA and Safeway Bleach Summit Fresh was about half that of the other solutions. Tissue dissolution was statistically similar ($P > .05$) among all solutions. Price was about 100-fold higher per liter of Chlor-XTRA compared with household bleach. **Conclusions:** Other than its price, the Chlor-XTRA solution had no unique features. In contrast to an earlier report, reduced surface tension did not result in greater soft tissue dissolution by NaOCl. *(J Endod 2012;38:372–375)*

Key Words

Household bleach, NaOCl, tissue dissolution

In endodontic treatment, sodium hypochlorite (NaOCl) solutions are the most frequently recommended root canal irrigants for the protein-rich, partly or totally infected, hard tissue–confined space that is the root canal system (1). Currently, no other irrigant can challenge NaOCl solutions in their position as the main rinsing agents. However, for clinicians, not only effectiveness but also price is an issue that is considered when choosing a root canal irrigant. NaOCl solutions are readily available from many sources (2). Thus, clinicians in the United States and elsewhere use household bleach obtained from drugstores instead of medical supply companies to irrigate root canals. However, solutions currently available in the U.S. have not been assessed in terms of some key features affecting their effectiveness in endodontics.

The main factor driving the antimicrobial and proteolytic properties of NaOCl solutions is their content of free available chlorine (3, 4). Further factors are pH (5, 6), alkaline capacity (7), and contact time (4). Stojicic et al (8) claim that surface tension, which is lowered in some commercial products explicitly sold for the dental market, also affects the performance of NaOCl solutions. A sodium hypochlorite solution with added surfactant was more effective in necrotic soft tissue dissolution than counterparts with unaltered surface tension. However, the authors did not control the content of available chlorine in the solutions, and thus, this point remains questionable.

It was the aim of the current investigation to assess physicochemical properties of different brands of household bleach and to investigate their ability to dissolve necrotic pulp tissue after the content of available chlorine was leveled. For comparison, a dental NaOCl solution with lowered surface tension was subjected to the same tests.

Materials and Methods

NaOCl Solutions

Six different brands of household bleach were bought from drugstores in San Francisco, California. In addition, 2 bottles of Chlor-XTRA (Vista Dental, Racine, WI) of different batches were bought from a dental supplier. Prices were recorded and calculated as US$ per liter. Immediately after purchase, the solutions were transferred into amber glass bottles and stored at 5°C until further use. For comparison, a concentrated (9% NaOCl, wt/vol) technical-grade solution was obtained from a Swiss pharmacy (Kantonslabor, Zürich, Switzerland) and used to produce pure control solutions.

Two assessment series were carried out with these solutions. In the first part, the products were analyzed in their original formulation. Free available chlorine, pH, and alkaline capacity of the undiluted solutions were assessed. The technical NaOCl solution was mixed with pure water and/or a 2 mol/L NaOH (sodium hydroxide, lye) solution to obtain 3 control solutions. These contained 5% NaOCl each (which is roughly the

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TABLE 1. Characteristics of the Undiluted Solutions Tested in the Current Study

Solution (batch number)	Price (US$/L)	Concentration (wt% NaOCl)	pH	Alkaline capacity* (mL 0.1 mol/L HCl/mL)
Safeway Bleach Regular (16257 19:25 613 S1678)	0.70	6.0 ± 0.0	12.2	4.0 ± 0.0
Safeway Bleach Summit Fresh (10251 18:38 6 HE261 S1678)	0.70	2.6 ± 0.0	12.7	3.0 ± 0.0
Clorox Regular (A8003306 5813-CA3)	1.29	5.5 ± 0.0	11.4	3.7 ± 0.0
Clorox Germicidal Bleach (A8021812 3813-CA3)	1.05	6.4 ± 0.0	11.1	4.0 ± 0.0
CVS Bleach Fresh Scent (10168 08:24 GF61)	0.91	2.8 ± 0.0	11.8	1.7 ± 0.0
Walgreens Bleach Regular (10214 06:32 6 6104 CA02)	0.70	5.8 ± 0.0	12.1	3.5 ± 0.0
Walgreens Bleach Regular (09343 19:20 6 L26 CA02)	0.70	4.8 ± 0.0	12.1	4.0 ± 0.0
Chlor-XTRA (2010-8159)	128.86	5.0 ± 0.0	12.5	4.0 ± 0.0
Chlor-XTRA (2010-8838)	128.86	5.3 ± 0.0	12.5	4.2 ± 0.0
Control solution, 1 mol/L NaOH	–	5.0 ± 0.0	13.4	13.7 ± 0.0
Control solution, 0.1 mol/L NaOH	–	5.0 ± 0.0	12.9	5.3 ± 0.0
Control solution, no NaOH	–	5.0 ± 0.0	12.5	4.0 ± 0.0

Determinations of physical and chemical parameters were done in triplicate, and mean values (± standard deviation) are reported here.

*Alkaline capacity is indicated as consumption of 0.1 mol/L HCl solution until pH 7.5 (pKa of hypochlorous acid) was reached.

concentration of most "full-strength" bleach solutions) but differed in alkali content: free of NaOH, 0.1 mol/L NaOH, and 1 mol/L NaOH.

In the second part of the study, the household bleach solutions were diluted in ultrapure water to a concentration of 1.0% NaOCl. This was done to be able to compare factors other than free available chlorine; pH, alkaline capacity, osmolarity, and surface tension were studied. Furthermore, it could be assessed whether these factors affected tissue dissolution. A 1% NaOCl solution prepared from the technical NaOCl solution (free of NaOH) served as control in this part.

Chemical Assessments

Content of available chlorine in each product was iodometrically titrated. To test the alkaline capacity of the solutions, these were titrated by using 0.1 mol/L HCl in an automated titration device (Titroprocessor 686; Metrohm, Zofingen, Switzerland). The pH was determined by using a calibrated pH electrode (Model 6.0210.100; Metrohm). The drift was set at 1 mV/min, titration volume at 0.5 mL per step, and stop at pH 1.5. The volume of 0.1 mol/L HCl necessary to reach pH 7.5 in the solution, ie, the pK_a value of HOCl, was measured.

Osmolarity Assay

The osmolarity of the solutions adjusted to 1% NaOCl content was measured with a freezing point depression osmometer (Fiske 110, Needham Heights, MA).

Surface Tension Assay

Surface tension was measured by using the Wilhelmy plate method at 20°C. For each measurement a platinum plate of known perimeter was annealed over a butane flame to eliminate any possible contaminant. The plate was allowed to cool down to ambient temperature (20°C) and mounted vertically into the precision balance of the tensiometer (Tensiometer K100; Krüss, Hamburg, Germany). The plate was lowered into the solution, and the force on the plate due to wetting was recorded.

Tissue Dissolution Assay

One hundred ten pulps were obtained by splitting bovine teeth. Pulps were carefully elevated in one piece by using an anatomic forceps. Specimens were stored in a humid environment at 4°C until further use. The pulps were of similar size and were divided into 11 similar groups (n = 10). The pulps in 10 groups were immersed in the respective NaOCl solutions under investigation. As a control treatment, the remaining 10 pulps were immersed in physiological saline solution (B. Braun, Melsungen, Germany). Before immersion, the pulps were blotted dry with a cellulose membrane and weighed by using a precision balance (AT 261; Mettler Instrumente AG, Nänikon-Uster, Switzerland). Then each pulp was transferred into an individual, pre-tempered (37°C), reclosable test tube containing 2 mL of the according test solution. After insertion of the specimens, the tubes were constantly agitated at 1.1 Hz and amplitude of 3.5 cm for 3 minutes in a water bath (Lauda A 120A; Lauda Co, Lauda-Königshofen, Germany) at 37°C. The specimens were then removed from the tubes, rinsed with ultrapure water for 30 seconds, gently blotted dry, and weighed again. Remaining tissue weight was calculated as percent of initial tissue weight.

Data Presentation and Analysis

All physicochemical assessments were performed at room temperature in triplicate, and mean values ± standard deviation were noted. Values pertaining to remaining tissue weight (n = 10) in percent were statistically compared between test and control solutions. These values were evenly distributed (Shapiro-Wilk test). Consequently, parametric statistics were applied to compare mean values between groups: one-way analysis of variance, followed by the Bonferroni correction for multiple testing. The alpha-type error was set at .05 ($P < .05$).

Results

The original (undiluted) bleach solutions had a concentration of roughly 5%–6% NaOCl, with the exception of the products with added perfume (Safeway Bleach Summit Fresh [Safeway Inc, Pleasonton, CA] and CVS Bleach Fresh Scent [CVS Pharmacy, Inc, Woonsocket, RI]). These contained about half the amount of NaOCl (Table 1). Two batches of the dental NaOCl solution (Chlor-XTRA) and of one of the household bleach brands under investigation (Walgreens Bleach Regular [Walgreens, Deerfield, IL]) were compared with test for product consistency. The 2 batches of each product differed markedly in their available chlorine content (Table 1). Alkaline capacity and pH were related to the NaOCl content in most household bleaches and in