



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A158 357

THE EFFECTIVENESS OF THE IMPROVED
 $\text{NaHPO}_4\text{-SnF}_2\text{-ZrSiO}_4\text{-SiO}_2$ PROPHYLACTIC PASTE

Final Report

Virgil E. Whitehurst, Ph.D.

March 1976

Supported by

U.S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Fort Detrick, Frederick, Maryland 21701-5012

Contract No. DADA17-71-C-1119

Howard University
College of Dentistry Research
Washington, DC 20001

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. <i>AD-A158 357</i>	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE EFFECTIVENESS OF THE IMPROVED $\text{NaHPO}_4\text{-SnF}_2\text{-ZrSiO}_4\text{-SiO}_2$ PROPHYLACTIC PASTE		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Virgil E. Whitehurst, Ph.D.		8. CONTRACT OR GRANT NUMBER(s) DADA17-71-C-1119
9. PERFORMING ORGANIZATION NAME AND ADDRESS Howard University College of Dentistry Research Washington, DC 20001		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Medical Research and Development Command Fort Detrick, Frederick, MD 21701-5012		12. REPORT DATE March 1976
		13. NUMBER OF PAGES 10
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)		



**The Effectiveness of the Improved
 $\text{NaHPO}_4\text{-SnF}_2\text{-ZrSiO}_4\text{-SiO}_2$ Prophylactic Paste**

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Introduction

Stannous fluoride is an agent which has been used in solutions, dentifrices and prophylactic pastes to reduce the incidence of dental caries and there is little doubt that SnF_2 is effective in reducing dental caries. However, there is evidence to suggest that aging decreases SnF_2 compound's ability to reduce enamel solubility. The reduction in effectiveness of SnF_2 compounds is explained in part by the oxidation of stannous ion to the stannic ion. It has also been suggested that this stannic ion precipitation may have some effect on the fluoride ion. It is for this reason and others that dentists and dental scientists recommend that freshly made SnF_2 solutions be used for maximum effectiveness. This is also the reason that a reservoir of SnF_2 ions is incorporated into crest toothpastes and SnF_2 prophylactic pastes.

Rationale for this Study

In the early 60's, Muhler³ advanced the idea that if a tooth was highly polished, it would be more likely to resist plaque formation. From this idea a zirconium silicate - stannous fluoride prophylactic paste was developed. This prophylactic paste (a good polishing agent) was to be used as a preventive measure in reducing dental caries and periodontal

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disease. This $ZrSiO_4-SnF_2$ prophylactic paste was used in the Army Self Applied Fluoride Expedient Program. However, a great deal of time elapsed between the manufacturing of the prophylactic paste and its use. Therefore, there was a need to determine the effect of aging on this prophylactic paste.

Purpose of this Study

~~(1)~~ *The purpose of this study is*
To investigate by in-vivo enamel solubility techniques the effect of aging on Zirconium Silicate-Stannous Fluoride Prophylactic Paste,

1- Methods and Procedures

Four (4) different lots of factory prepared zirconium silicate-stannous fluoride prophylactic paste were used in this study. The enamel solubility tests were carried out on day 0 (day prophylactic paste was made), 1 and 2 weeks, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 months.

Young female rats were used throughout this study. A total of 180 rats (80-90 grams) were randomly divided into six (6) equal groups, i.e. four (4) experimental, one (1) control, and one (1) positive control. All rats received a 30 second topical treatment on each hemi-jaw. Distilled water was applied to the hemi-jaws of the control animals and crest toothpaste (fresh) was brushed on the hemi-jaws of the experimental control. The mouths of the rats were held open by a specially prepared wire rack which partially immobilized the rats. The rack did not harm the animals. One hour after the topical application the rats were sacrificed by chloroform inhalation, their hemi-jaws removed and carefully cleaned of gingival tissue and bone using a sharp scapel. The teeth were then embedded in acrylic to the gingival margin with the aid of a

embedding bar. A micro-layer of acrylic solution was used to cover the gingival margin and any exposed bone.

The determination of acid solubility of the topically treated enamel was conducted by using a colorimetric method first described by Fiske and Sublarow.⁴ This method was modified for use in in-vivo animal studies by Buttner and Muhler⁵.

A total of 10 milliliters of 0.2 normal sodium acetate buffer (ph 4.0) was utilized in this procedure. The buffer was placed in a beaker along with a single hemi-jaw and stirred with a electric stirring apparatus at 60 revolutions per minute for 20 minutes. The stirring rod was kept approximately one-half-inch above the hemi-jaw. At the end of the designated time, the hemi-jaw was removed from the buffer solution and analyzed for inorganic phosphorous.

The method for phosphorous analysis is based on the principle that inorganic phosphorous reacts with molybdate reagent and a blue color is formed when the resulting phosphomolybdic acid is reduced by p-aminonaphthol sulfonic acid.

A total of 10 millimeters of the decalcifying buffer containing the inorganic phosphorous, in addition to 2.5 ml of molybdate reagent, 1.0 ml of p-aminonaphthol sulfonic acid were added and diluted with distilled water to 25.0 mls in a volumetric flask. The reactants were allowed to stand, at least 10 minutes, and the solution was then read on a

Klett-Summerson photoelectric colormeter, using a red filter, (66 mm), against a distilled water blank.

The per cent reduction in acid solubility was calculated as follows:

$$\frac{C-E}{C} \times 100 = \text{per cent effectiveness}$$

C = mean micrograms of phosphorous in the control group

E = mean micrograms of phosphorous in the experimental group

Example:

\bar{X} micrograms phosphorous, control = 65.0

\bar{X} micrograms phosphorous, experimental = 25.0

Calculations: percent reduction = $\frac{65-25}{65} = 61.5\%$
in acid solubility

Results and Discussion:

The mean protection per cent afforded by zirconium silicate-stannous fluoride prophylactic paste for enamel against dissolution is shown in Table I. Also shown are the standard errors of the mean and statistical analyses of these data.

These data show that freshly manufactured ZrSiO₄-SnF₂ prophylactic paste is very effective in inhibiting enamel solubility (79.8%) in the rat. These data further show that there are no significant changes in this prophylactic paste's ability to protect enamel against acid solubility for a period of 30 days. The first significant change in the protection of enamel afforded by this prophylactic paste is observed after 1 month (p=.05). However, it should be noted that the ZrSiO₄-SnF₂ paste is still quite effective and there are no further significant reductions in protection until the 5th month. Further significant changes in the

performance of this prophylactic paste are noted at 8 and 12 months.

Data in Table I clearly shows that at the end of 12 months, the effectiveness of this prophy paste against enamel solubility in the rat has been reduced by 52.1%. However, this prophy paste still is effective against enamel solubility (38.2%).

Results obtained in this study show that aging does have a deleterious effect on this SnF₂ prophy paste. Aging seems to have very little effect during the first 30 days after manufacture of the paste. These data agree with work reported by Hefferren⁶ who found that soluble stannous ions gradually decrease with age and that approximately 50% of the stannous ions may be lost during the first month. He further states that soluble fluoride ions decrease at a much less rapid rate over the same period. However, as the stannous ions are oxidized to stannic complexes, they may affect the soluble fluoride ions. The reduction in the soluble stannous ion concentration is thought to be pH dependent. This concentration is stable at pH levels of 3-4. As the pH increases to a range of 5-6, the stannous ion concentration is decreased and the effectiveness of the prophy paste against enamel dissolution is reduced.

As the prophy paste ages, the concentration of stannous and fluoride ions are reduced and thus the ability to protect enamel is decreased.

There are several studies^{7,8,9} whose purpose was to investigate the effect of aging on SnF₂ solutions. The results of these studies showed that the ability of SnF₂ preparations to inhibit enamel solubility is reduced by aging. However, this conclusion is by no means universally

accepted. Shannon¹⁰ reported no significant loss of protective effectiveness with SnF₂ solutions aged for 90 days. These were specially prepared SnF₂ solutions in order to protect the active agents against loss in effectiveness. Glycerin was incorporated into the solutions to slow the oxidization of the stannous ions. March¹¹ found that the ability of SnF₂ solutions to protect against acid decalcification was enhanced by age.

Summary

The marked effectiveness of freshly manufactured ZrSiO₄-SnF₂ prophy paste decreases significantly after a period of 30 days. As the prophy paste continues to age, it is decidedly less effective than freshly prepared prophy paste in reducing enamel solubility.

TABLE I

EFFECT OF AGE ON PROTECTIVE PERFORMANCE
OF PREVENTIVE DENTISTRY PROPHYLACTIC PASTE

<u>Age of Prophylactic Paste</u>	<u>Protection Per Cent</u>		<u>Statistical Analyses</u>	
	<u>Mean</u>	<u>S.E.</u>	<u>T</u>	<u>P</u>
Fresh	79.8	1.56	-	-
1 week	77.6	1.83	1.78	N.S.
2 weeks	76.0	1.20	1.93	N.S.
1 month	69.7	2.36	3.57	.05
2 months	67.1	2.45	3.69	.05
3 months	66.8	2.05	4.25	.05
4 months	61.7	2.90	6.25	.05
5 months	60.2	1.68	8.56	.001
6 months	62.0	1.79	5.59	.05
7 months	55.9	1.84	9.73	.001
8 months	51.2	2.23	10.51	.001
9 months	47.3	1.02	13.31	.001
10 months	42.8	1.72	16.81	.001
11 months	40.0	2.23	18.33	.001
12 months	38.2	1.12	21.67	.001

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