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DISSOLUTION RATES OF POWDERED ENAMEL TREATED WITH FLUORIDE

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·········》 국문초록 《·········

불소가 법랑질 용해도에 미치는 영향

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최근배 · 박재호 · 최부병 · 김철위 · 정태영

본 실험은 한국인 분말법랑질(120~200mesh)을 각 농도의 불소용액, 즉 NaF와 SnF_2용액에 일정시간 작용시킨후 각각의 pH범위내의 acetate buffer용액에 대한 용해도를 관찰하여 얻은 결과는 다음과 같다.

1. 실험한 모든 pH범위내에서 불소를 처리하지 않은 법랑질은 불소를 처리한 법랑질보다 용해도가 크다.
2. NaF농도가 증가하면 할수록 용해도는 감소된다.
3. SnF_2의 용해에 관한 억제효과는 모든 pH범위에서 NaF보다 현저하다.

The studies of acid dissolution rates on the dental enamel have engaged the attention of many investigators. The reduction of dissolution rates in acid has been the basis for many studies used to investigate potential anticariogenic agents. The interest in this procedure has arisen from the acidogenic theory of dental caries and the effect of fluoride ion in reducing dental caries.

Volker[1], Bibby[2], Muhler and Van Haysen[3] and Phillips and Muhler[4] have demonstrated that the acid dissolution rates of either powdered enamel or enamel fragment are reduced by treating enamel with fluoride ion. Knuston and Armstrong[5] have also reported that sodium fluoride, topically applied to the enamel, will cause a marked reduction in caries process. Phillips[6] has shown the hardness and impermeability of enamel was increased following exposure to fluoride solution. Gray[7] has found that the rate of dissolution increased with increasing the hydrogen ion and buffer concentration and buffer strength and be inhibited by the presence of the reaction products, calcium and phosphate, as well as most cations, such as tin, and a anions, such as fluoride.

This study is concerned with the effect of NaF and SnF_2 on the acid dissolution rates of Korean powdered enamel, 120~200 mesh sieve, by acetate buffers over the pH range of 3.0~

5.6.

MATERIALS AND METHODS

Preparation of enamel samples: The samples of enamel was obtained from 200 pooled teeth from dental clinics in Seoul area. After removal of carious lesions and fillings, the enamel was mechanically separated from the dentin, using chiesel and carborundam disc, and the separated enamel crushed to powder using a steel mortar and pestle, and then iron contamination removed with a magnet. Thereafter, only the enamel particle that passed through 100 mesh sieve and failed to pass 200 mesh sieve was selected by using Ro-Tap sieve shaker. The powdered enamel between 120~200 mesh sieve size were then dried in the oven at 105°C for 2 hours and stored in a desiccator.

Treatment of enamel with fluoride: Each 50 mg. of enamel in test tube were allowed 3.0 ml. of freshly prepared solution over the range of 0.1, 0.2, 0.5, and 1.0% sodium fluoride and 0.5% stannous fluoride at 20±2°C for 30 minutes, at that time the mixture was centrifuged at 3000 r.p.m. for 5 minutes. And treated enamel samples washed twice 3.0 ml. of distilled water and then dried at 105°C in the oven.

Decalcification and Analytical Methods: Duplicate enamel samples treating with fluoride were mechanically shaken continually in 10ml. of 0.1 M acetic acid-sodium acetate buffers at various pH ranges of 3.0~5.6 for 20 minutes at 20±2°C. At the end of a given times, the decalcifying medium was centrifuged at 3000 r.p.m. for 5 minutes and the supernants was analyzed for calcium. Calcium was determined by the Clark-Collip modification of the Kramer-Tisdal method[8] which involves of the oxalate with standardized potassium permanganate solution.

RESULTS

Table 1 and Figure 1 showed the effect of different NaF concentration on acid dissolution rate of powdered enamel(120~200 mesh sieve) in acetate buffers at various pH ranges for 20 minutes. It showed that the slopes of curves of treating enamel with fluoride became parallel with the curve of untreating enamel with fluoride, but more effective than that of untreating enamel in reducing the dissolution rate. In other words, the amount of dissolved Ca of untreating enamel in acetate buffers at various pH ranges was greater than that of treating enamel with fluoride and increased along acidity of buffer increases than that of treating enamel. The higher the concentration of NaF solution, the more effective it was in reducing acid dissolution rate. Table 2 was showed the comparison of effect with the same concentra-

Table. 1. Effect of NaF on Acid Solubility of Powdered Enamel

pH of Acetate Buffer	No. of Sample	Amounts of Calcium dissolved (mgs. Ca/50 mg. Powdered Enamel (S.D.)				
		No treated	0.1% NaF	0.2% NaF	0.5% NaF	1.0% NaF
3.0	5	3.98(0.04)	3.10(0.05)	2.90(0.03)	2.78(0.06)	2.46(0.03)
3.6	5	3.48(0.01)	2.30(0.01)	2.18(0.04)	2.06(0.06)	1.90(0.05)
4.0	5	2.40(0.04)	1.68(0.05)	1.56(0.02)	1.40(0.02)	1.30(0.03)
4.6	5	1.54(0.07)	1.20(0.05)	1.00(0.01)	0.90(0.06)	0.86(0.02)
5.6	5	0.56(0.05)	0.48(0.02)	0.40(0.04)	0.36(0.04)	0.32(0.01)

Table. 2. Comparison of the Effect of 0.5% NaF and 0.5% SnF_2 on Acid Solubility of Powdered Enamel

pH of Acetate Buffer	No. of Sample	Amounts of Calcium dissolved (mgs. Ca/50 mg. Powdered Enamel (S.D.)		
		No treated	0.5% NaF	0.5% SnF_2
3.0	5	3.98(0.04)	2.78(0.01)	1.08(0.07)
3.6	5	3.48(0.01)	2.06(0.01)	0.74(0.07)
4.0	5	2.40(0.04)	1.40(0.02)	0.58(0.02)
4.6	5	1.54(0.07)	0.90(0.06)	0.44(0.04)
5.6	5	0.56(0.05)	0.36(0.04)	0.36(0.05)

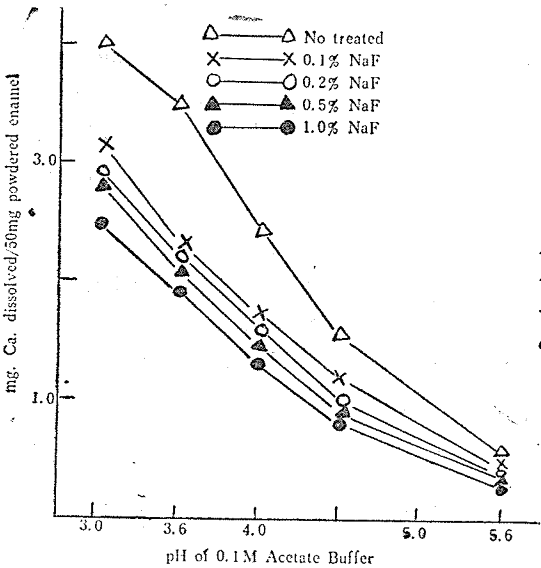

Fig. 1. Effect of Different NaF Concentration on Acid Dissolution Rate of Powdered Enamel

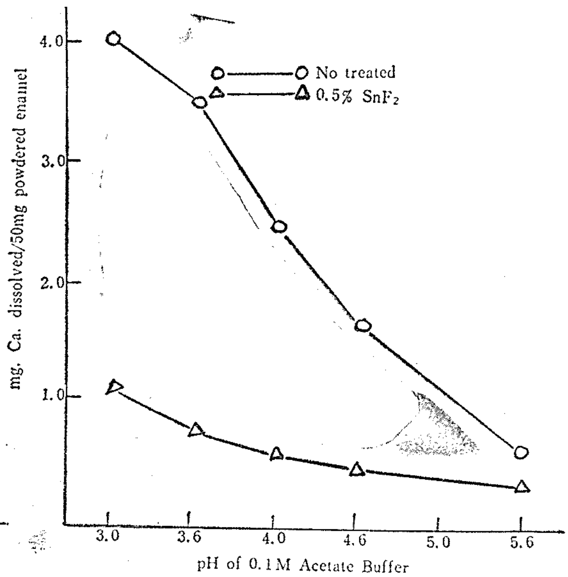

Fig. 2. Effect of 0.5% SnF_2 on Acid Dissolution Rate of Powdered Enamel.

tion, 0.5% NaF and 0.5% SnF_2, on acid dissolution rate. It showed that reducing effect of SnF_2 was more effective than that of NaF. At pH 3.0, the reducing effect of SnF_2 was about 3.4 times of that of NaF, and at pH 5.6, in contrast to the behavior at pH 3.0, both samples showed approximately same dissolution rate. As showed in Table 2, the dissolution rate reduction of SnF_2-treating enamel was greater than that of NaF-treating enamel over the all pH ranges.

DISCUSSION

This study of acid dissolution rate was conducted by dissolving samples of treating enamel with fluoride in aceate buffered acidic solutions over the pH range of 3.0~5.6 at 20 ±2°C for definite period of time. Bibby[2] demonstrated that enamel solubility reduction by fluoride was pH dependent, and that maximal effectiveness was to be noted at about pH 4.0. Phillips and Mühler[4] observed that the lower the pH of the NaF solution, the more effective it was in reducing enamel solubility. Several mechanisms for the reaction of fluoride with hard tissues have been suggested. Neuman et al.[9] have shown that fluoroapatite is formed below the solubility product of calcium fluoried. Falkenheim et al.[10] and Volker et al.[11] have shown that surface adsorption of fluoride take place. The double decomposition of apatite with high levels of fluoride has been demonstrated by Gerould,[12] and Scout et al.[13] Assuming the previous mentioned mechanism, McCann and Bullock[14] suggested that fluoride ion reacts with hard tissue, mainly enamel, dentin, and bone in several different ways; namely, (1) possible exchange with CO_2 on the crystal surfaces, (2) direct adsorption, (3) precipitation as magnesium fluoride of the magnesium released from the crystal surfaces, (4) double decomposition at high fluoride levels to from CaF_2 and Na_2HP0_4, and (5) formation of fluoroapatite by exchange with hydroxyl ion. In recent, it is generally accepted that Fluoride ion of NaF replaced the less stable OH^- of the hydroxyapatite and forms calcium fluoride, resisting the action of acid dissolution,

It has been established that SnF_2 renders enamel highly resistant to acid dissolution but exact mechanism of action has not been surely identified. Cooley[15] found that most of the tin was deposited as a uniform coat on the surface of enamel, when enamel was treated with SnF_2. In the later studies,[16] this tenacious layer identified as primarily tin phosphate. Kurahashi and Matsumiya[17] have studied that the effect of SnF_2 enamel solmbility was produced mainly by the action of stannous ions. When stannous fluoride is placed in aqueous solution the hydrolysis products are $SnOH^-$ and H^+ ion. Further reaction may lead to the formation of hydrated stannous oxide. Hydrogen ion production initiated enamel dissolution, calcium ions are released and reprecipitated as CaF_2, and HPO_4^{--} and $H_2PO_4^-$ ions are left to react with the stannous ion to form insoluble phosphates. Myers[18] feels that the stability of the the crystalline surface of enamel is maintained.

In present study of effect of stannous fluoride and sodium fluoride on enamel dissolution rate in acid buffers, it has been shown that treating enamel with same concentration of stannous fluoride reduced acid dissolution rate more than did treating enamel with that of sodium fluoride, although both agents were effective, and that the quantitative positions of the curves could be shifted by increasing treating concentration, acid strength, or enamel particle size.

SUMMARY

This study is concerned with the effect of sodium fluoride and stannous fluoride on the acid dissolution rates of Korean powered enamel, 120∼200 mesh sieve, by 0.1 M acetate buffers over the pH range of 3.0∼5.6 for 20 minutes at 20±2°C.

These results were as follows.

1. At all pH ranges, the dissolution rate of untreating enamel was greater than that of treating enamel with fluoride.
2. The higher the concentration of NaF solution, the more effective it was in reducing acid dissolution rate.
3. The reducing effect of stannous fluoride was more effective than that of sodium fluoride over the all pH ranges.

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