

The comparison study of Fluoride kinetics in saliva after the use of chewing gums containing different fluoride compounds In Iraqi subjects

Khalid Nassif Jassim

College of Dentistry, University of Al Mustansiriyia

الخلاصة:

توجد هناك علاقة بين استخدام الفلورايد وتقليل احتمالية تسوس الاسنان و زيادة سظاهرة الاصابة بالداء الفلوري (الفلورة) Fluorosis في اسنان الاطفال , ان الهدف من هذه الدراسة هو تحليل حركة الفلورايد في اللعاب بعد استخدام نوعين من اللبان (العلكة) النوع الاول يحتوي على فلوريد الصوديوم (NaF) والنوع الثاني على احادي فلورايد فوسفات الصوديوم (NaMFP) وهذه المواد هي الاكثر شيوعا كمصدر للفلورايد وكذلك علاقتها بظاهرة الداء الفلوري.

تم استخدام (15) متطوعا بعمر 5-7 سنوات وجمع اللعاب بفترات زمنية (صفر، 3، 6، 9، و15) دقيقة بعد استخدام قطعة لبان محتوية على (3.38) ملغم لكلا النوعين اعلاه لمدة (3) دقائق. وقد تم قياس كمية الفلورايد بصورة مباشرة بواسطة جهاز القطب الفلوريدي الخاص Flouride-specific electrode بعد اجراء التحلل الحامضي بواسطة حامض الهيدروكلوريك.

وجد ان كمية الفلورايد في اللعاب بلغت (0.4) ملغم لمادة NaMFP و (0.041) ملغم لمادة NaF كذلك وجد ان تركيز الفلورايد المتحرر في اللعاب من اللبان المحتوي على الصوديوم فلورايد يدل على وجود فرق معنوي على مستوى 0.05 مقارنة مع اللبانة المحتوي على NaMFP.

ان زيادة تركيز الفلورايد في اللعاب بعد استخدام اللبان المحتوي على NaMFP يؤدي الى احتمالية منع تسوس الاسنان وهذا يحتاج الى مزيد من البحوث, من الناحية الاخرى يجب تجنب استخدام اللبان المحتوي على NaMFP من قبل الاطفال لاحتمالية اصابة اسنانهم بالداء الفلوري (الفلورة).

Abstract:

There is a relationship between the use of fluoride, the reduction of dental caries and the increase of dental fluorosis. The purpose of this study was to analyze the fluoride kinetics in saliva after using two commercially available chewing gums with fluoride, which contains (3.38) mg of fluoride as marketed Sodium monofluorophosphate (NaMFP) and sodium fluoride (NaF) which are the two most common sources of fluoride used in currently fluoride dentifrices.

Fifteen 7-9 year-old volunteers were instructed to chew the fluoridated gums. Total saliva was collected, at 0, 3, 6, 9 and 15 minutes after 3 minutes

starting chewing. Salivary fluoride was analyzed with a fluoride-specific electrode (201 Fluoride E. HANNA instruments) after acid hydrolysis.

The fluoride amount in the saliva samples after the use of chewing gum which contains Sodium monofluorophosphate (NaMFP) was 0.4 mg which higher than after the use of chewing gum contains sodium fluoride (NaF) which was 0.041mg in all experimental periods,

The high fluoride presence in saliva after the use of chewing gum of (NaMFP) is significant to prevent dental caries and this should be evaluated in clinical researches. On the other hand, children at an age of risk for dental fluorosis should avoid the use of this kind of chewing gums.

Key words: Chewing flouride gum, fluoride kinetics, saliva, Sodium monofluorophosphate, sodium fluoride, fluorosis

Introduction:

Dental caries is a multifactorial disease and one of the main public health problems. As a result of several studies carried out to understand the dental caries process as well as its risk factors, dental treatment emphasis has been moved from corrective to preventive methods. Fluoride is an extensively proven effective agent for the control of dental caries. Its cariostatic effect is related to its presence in the aqueous phase of the apatite crystals^[1, 2, 3], which inhibits demineralization and activates remineralization^[4].

There are many studies supporting the frequent and repetitive use of low concentration and self-applied fluoride agents^[5,6], stimulating the search for alternative devices to apply it in the mouth, such as professional products, at high fluoride concentrations (solutions, gels, pastes and varnishes) or through home care products, like toothpastes, mouth washes ,fluoridated mucoadhesive tablets, and, more recently,fluoridated chewing gums^[7,8].

The use of chewing gum increases the salivary flow, which helps to clean the oral cavity^[9]. Chewing gums have been also introduced as useful vehicles for fluoride, calcium, phosphate and chlorhexidine delivery^[10]. Fluoride-containing chewing gums increase salivary and dental plaque pH, calcium and phosphate concentration and also act on enamel remineralization^[11].

The chewing gums of (NaMFP) and (NaF) were recently introduced in the marketplace as an additional agent to prevent dental caries. Each piece of the product contains 3.38 mg of fluoride as monofluorophosphate or sodium fluoride, despite the possibility of helping to prevent dental caries, a concern arises about its contribution as an additional source of fluoride intake when consumed by children in the age of risk for dental fluorosis.

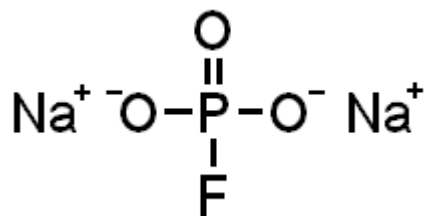
Dental fluorosis is a health condition caused by a child receiving too much fluoride during tooth development. The critical period of exposure is between 1 and 4 years old is more risky than children over 8 years old^[12]. In its mild form, which is the most common, fluorosis appears as tiny white streaks

or specks that are often unnoticeable. In its severe form it is characterized by black and brown stains, as well as cracking and pitting of the teeth^[13].

The severity of dental fluorosis depends on the amount of fluoride exposure, the age of the child, individual response, and nutritional and other factors^[12]. Although water fluoridation can cause fluorosis, most of this is mild (0.7- 1.2 mg of fluoride/ L) and not usually of aesthetic concern^[14]. Severe cases can be caused by exposure to water that is naturally fluoridated to levels well above the recommended levels, or by exposure to other fluoride sources such as brick tea or pollution from high fluoride coal^[15].

According to the centers for diseases control, 32% of American children now have some form of dental fluorosis, with 2 to 4% of the children having the moderate to severe stage (CDC 2005 USA).

Thus, the aim of the present study was to analyze the amount of fluoride released in saliva after chewing the gums of (NaMFP) and (NaF) in Iraqi subjects.



Chemical Structure of Sodium monofluorophosphate

Materials and Methods:

Experimental design:

The study was carried out with fifteen 7-12 year-old children. All of them had good general health; the children chewed the fluoridated gum, each piece containing 4.2 mg of fluoride as monofluorophosphate or sodium fluoride.

The saliva was collected in cooled plastic containers at (0, 3, 6, 9, and 15 min) after 3 minutes starting chewing gum. During this period, the volunteers remained seated and were not allowed to have any food or drink. The samples obtained were stored in freeze at -5 °C until fluoride analysis.

Fluoride analysis:

Acid hydrolysis:

The acid hydrolysis of fluoride was done because the samples of chewing gums contain fluoride as monofluorophosphate and sodium fluoride which form complex with some of saliva components. The method used was adapted from the method proposed by Cury^[16] modified by Orth *et al.*^[17] for the analysis of monofluorophosphate and sodium fluoride in saliva after using a dentifrice containing both these fluoridated compounds. To 0.25 ml of each saliva sample, 0.25 ml of 2 mol L⁻¹ hydrochloric acid (Analytical reagent, Gainland chemical company, UK) was added, and the samples were kept for 1 hour at 45°C under

agitation in water bath. Then, neutralization was accomplished with 0.5 ml of 1 mol L⁻¹ sodium hydroxide (Analtical reagent, Gainland chemical company, UK).

Fluoride measurement

Fluoride was analyzed by the direct method, using a fluoride specific electrode (201 Fluoride E. HANNA instrument, China) and an ion analyzer. Prior to the samples analysis, a set of standards (ranging between 0.025-3.2 ppm F) was prepared in triplicate, using serial dilution from a 100 ppm NaF stock solution (E.Merck, Darmstadt, Germany). The millivoltage potentials were converted to µg F using a standard curve.

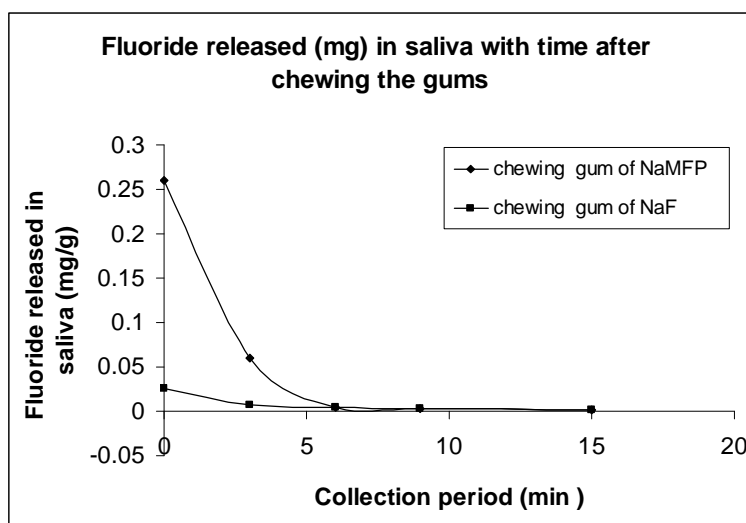


Figure-1: The kinetic released of fluoride (mg/g) in saliva from chewing gum of NaMFP and NaF respectively at different periods (min).

Result:

Figure-2 shows the mean total fluoride released (mg) with time. The comparisons showed that the chewing gum which contains (NaMFP) released significantly higher amounts of fluoride when compared to chewing gum which contains (NaF), up to the 15 min collection time. The amount released decreased with time.

Table -1 represents the total amount of fluoride released in saliva (mg), during the whole experiment, for the two gums, a significantly higher amount of fluoride was released when chewing gum which contains (NaMFP) was chewed (0.4) mg of fluoride when compared to chewing gum which contains NaF (0.041) mg of fluoride.

Collection period (min)	Fluoride conc. Released from NaMFP chewing gum(mg)	Fluoride conc. Released from NaF chewing gum(mg)
0.0	0.26	0.025
3	0.06	0.007
6	0.004	0.005
9	0.003	0.003
15	0.001	0.001
Total	0.4	0.041

Table-1: The concentration of fluoride which released in saliva from fluoridated chewing gum which indicated a significant increase ($P < 0.05$) in release from NaMFP compared with NaF.

The contribution as a percentage, of one piece of each chewing gum to the maximum daily recommended fluoride intake (0.07 mg of fluoride/kg of body weight)^[18]. For 1 to 7 years old children a single tablet of chewing gum of NaMFP represent 57% and 23.8% and for NaF chewing gum represents 5.85 % and 2.56 % of the maximum daily fluoride ingestion recommended for children aged 1 and 7 years old, respectively.

Discussion:

It is known that the frequent and repeated use of low fluoride concentration products, which promote low and constant salivary fluoride levels, is the most efficient way to prevent dental caries^{[11],[19],[10]}. Levels between 1 and 10 ppm of fluoride reduce the enamel solubility and increase the remineralization rate, facilitating the precipitation of minerals on the enamel surface^{[11],[19]}.

Sjögren *et al*^[10] (1997) found the greatest fluoride values in saliva between 5 and 10 minutes after the use of a fluoridated chewing gum. In the subsequent periods, the fluoride concentration in saliva decreased gradually. In this study, the fluoride release was significantly higher at 0, 3 min compared to 6, 9 and 15 min when the fluoridated gum was chewed. Although Sjögren *et al*^[10] (1997) also suggest that the salivary flow stimulation may have a negative effect on the fluoride retention in the mouth, Bruun *et al*^[13].(1982) demonstrated that a single chewing gum tablet with 0.5 mg of fluoride can maintain high fluoride levels in saliva for at least 60 min.

Lamb *et al*^[11].(1993) sustained in their study that chewing a fluoridated gum with only 0.1 mg of fluoride five times a day favors the remineralization of initial dental caries lesions, and that this frequency could maintain high fluoride levels in saliva during most part of the day.

Silva *et al*^[20]. (2003) evaluated the effect of two commercially available chewing gums with fluoride on the cariogenic micro biota of saliva and dental plaque. The gum Fluorite showed a faster pH recovery and a F release to saliva after up to 30 minutes.

The potential anticariogenic effect of chewing gums containing fluoride has been proposed by Lamb *et al*.^[11] (1993) and Sjögren *et al*^[10].(1997). However, there are no data regarding the fluorosis risk that this type of product may promote. It has been suggested that the incidence and severity of dental fluorosis have become greater in the last decade in both optimally fluoridated and non-fluoridated areas in many countries, as well as in Brazil^[21, 22, 23, 24, 25].

This has been attributed to an increase in the fluoride level of foods and beverages through processing with fluoridated water, inadvertent ingestion of fluoride toothpaste, and the inappropriate use of dietary supplements^[7].

Considering that the highest risk factor for the development of dental fluorosis is the total amount of fluoride ingested, and that nowadays there are several available sources, the chewing gum of NaMFP can cause concern for children at the age of risk for dental fluorosis, which comprises 1 to 7 years of age.

One tablet of NaMFP chewing gum could represent 57%, (NaMFP is easily soluble in water with strong hygroscopy, its solubility is 42gm\100 gm water at 25°C) while one tablet of NaF chewing gum could represent 5.85% only of the maximum daily fluoride ingestion (the relative constant solubility rate of NaF makes it an ideal source for the fluoride ion in treatment of municipal water supplies ,solubility 0.76g\100gm water at 25°C), This maximum daily ingestion was calculated, based on the literature, as being 0.07 mg of fluoride/kg of body weight^[18] and considering the use of a single tablet. Unfortunately, there is no data available on the consumption of chewing gum by children. However, it is possible that children use more than one tablet per day, which increases the risk of dental fluorosis development.

Hattab *et al*.^[26] (1989) demonstrated a mild increase of fluoride plasma levels after the use of a fluoridated chewing gum and concluded that this product offers a minimal risk of adverse effects. However, this study was carried out in fluoride deficient areas and with adult subjects, using a chewing gum with smaller amounts of fluoride (0.113 mg) when compared to that used by the present study (approximately 3.38 mg, according to the manufacturer).

Therefore, other studies with children living in optimally fluoridated areas are necessary to observe the effect of chewing gum which contains NaMFP on the plasma fluoride levels.

Conclusion:

This study indicated that:

- 1- The fluoride concentration in saliva samples after the use of chewing gum which contains (NaMFP) was significantly higher than that observed after

the use of chewing gum which contains (NaF) in all the experimental times. The fluoride release during the experiment was 0.4 mg for chewing gum which contains (NaMFP) and 0.041 mg for chewing gum which contains (NaF).

- 2- The high fluoride concentration in saliva after the use of chewing gum which contains (NaMFP) may be important on dental caries prevention in children or adults, especially for individuals with compromised salivary flow or the ones who live in deficient fluoride areas. However, further clinical research is necessary to clarify this issue.
- 3- The use of chewing gum which contains (NaMFP) should be avoided by children at the age of risk for dental fluorosis because the fluoride release varied from 57% to 23.8% of the maximum recommended daily intake for children aged 1 and 7 years old, respectively
- 4- The use of fluoridated gum should be used to patient with high risk to caries.

References:

- 1- Fejerskov, O.; Thylstrup, A. and Larsen, M.J. (1981). Rational use of fluoride in caries prevention. *Acta Odontol Scand* 39(4):241-9.
- 2- Jenkins, G. N. and Edgar, W. M. (1989). The effect of daily gum-chewing on salivary flow rates in man. *J Dent Res* 68:786-90.
- 3- Tencate, J. M. (1983). Influence of fluoride on tooth demineralization. *J Dent Res* 17:193-9.
- 4- Arends, J. and Christoffersen, J. (1990). Nature and role of loosely bound fluoride in dental caries. *J Dent Res*;69:601-5.
- 5- Clark, J.W.; Corpron, R. E.; More, F. G.; Easton, J.W.; Merrill, D.F. and Kowalski, C.J. (1988). Comparison of the effects of two topical fluoride regimens on demineralized enamel *in vivo*. *J Dent Res* 67(6):954-8.
- 6- Feathersonte, J. D. B.; O'Reilly, M. M.; Shariati, M. and Brugler, S. (1986). Enhancement of remineralization *in vitro* and *in vivo*. In: Leach SA (ed). *Factors relating to demineralization and remineralization of the teeth*. Oxford: IRL Press; p. 22-34.
- 7- Mascarenhas, A.K. (2000). Risk factors for dental fluorosis: a review of the recent literature. *Pediatr Dent* 22(4):269-77.
- 8- Rölla, G. (1988). On the role of calcium fluoride in the cariostatic mechanism of fluoride. *Acta Odontol Scand*;46:341-5.
- 9- Lamb, W.J.; Corpron, R.E.; More, F.G.; Beltran, E.D.; Straghan, D.S. and Kowalski, C.J. (1993). *In situ* remineralization of subsurface enamel lesion after use of fluoride chewing gum. *Caries Res*;27:111-6.
- 10- Sjögren, K.; Lingstrom, P.; Lundberg, A.B. and Birkhed, D. (1997). Salivary fluoride concentration and plaque pH after using a fluoride-containing chewing gum. *Caries Res*; 31:366-72.

- 11- Lamb, W.J.; Corpron, R.E.; More, F.G.; Beltran, E.D.; Straghan, D.S. and Kowalski, C.J. (1993). In situ remineralization of subsurface enamel lesion after use of fluoride chewing gum. *Caries Res*;27:111-6.
- 12- Alvarez, J. A.; Rezende, K. M. P. C.; Marocho, S. M. S.; Alves, F. B.T.; Celiberti, P. and Ciamponi,A.L.(2009). "Dental fluorosis: exposure, prevention and management" (PDF). *Med Oral Patol Oral Cir Bucal* 14 (2): E103–7. PMID19179949. <http://medicinaoral.com/medoralfree01/v14i2/medoralv14i2p103.pdf>. Enamel fluorosis. American Academy of Pediatric Dentistry. <http://www.aapd.org/publications/brochures/fluorosis.asp>. Retrieved.2009-02-04
- 13- Yeung, C.A. (2008). A systematic review of the efficacy and safety of fluoridation. *Evid Based Dent* 9 (2): 39–43. doi:10.1038/sj.ebd.6400578. PMID 18584000. Lay summary – NHMRC (2007). The full report is at: A systematic review of the efficacy and safety of fluoridation (PDF). Australian National Health and Medical Research Council. 2007. http://www.nhmrc.gov.au/PUBLICATIONS/synopses/_files/eh41.pdf. Retrieved 2008-12-09.
- 14- Fawell, J.; Bailey, K.; Chilton, J.; Dahi, E.; Fewtrell, L. and Magara, Y. (2006). "Environmental occurrence, geochemistry and exposure" (PDF). *Fluoride in Drinking-water*. World Health Organization. pp. 5–27. ISBN 92-4-156319-2. http://www.who.int/water_sanitation_health/publications/fluoride_drinkinwater_full.pdf. Retrieved 2009-01-24.
- 15- Fluoridation Facts. American Dental Association. (2005). pp. 28–29. http://web.archive.org/web/20070307065553/http://www.ada.org.au/media/Fluoridenow/Documents/AmDA+fluoridation_factsRO.pdf.
- 16- Cury, J. A.; Apud, Conde, N. C. O.; Rebelo, M. A. B. and Cury, J. A. (2003). Avaliação de um gel dentifrício contendo xilitol e flúor. *Rev Bras Odontol* 1987;44:36-40 Evaluation of the fluoride stability of dentifrices sold in Manaus, AM, Brazil. *Pesqui Odontol Bras*; 17 (3):247-53.
- 17- Orth, M.R.; Assaf, A.V.; Zanin, L.; Mialhe, F.L.; Klein, A.L.and Medina, M.R.J. (2001). *et al.* Concentração de flúor nos principais dentifrícios comercializados no Brasil e impacto da nova portaria de regulamentação. *Revista Odonto Ciência*; 16: 27-33.
- 18- Burt, B.A. (1992). The changing patterns of systemic fluoride intake. *J Dent Res*; 71 (5): 1228-37.
- 19- Oliveby, A.; Ekstrand, F.and Lagerlöf, F.(1987). Effect of salivary flow rate on salivary fluoride clearance after use of a fluoride-containing chewing gum. *Caries Res*;21:393-401.
- 20- Silva, P.R.; D'Antonio, G.M.;Cury, J.A.and Saliba, N.A.(2003). Avaliação do efeito de duas gomas de mascar fluoretadas na microbiota cariogênica da saliva e na placa. *Rev Assoc Paul Cir Dent*;57(1):58-62.
- 21- Correia, Sampaio, F.; Ramm, von, der, Fehr, F.; Arneberg , P.; Petrucci, Gigante, D. and Hatloy, A. (1999). Dental fluorosis and nutritional status of

- 6-to 11-year-old children living in rural areas of Paraiba, Brazil. *Caries Res*; 33 (1):66-71.
- 22- Fomon, S. J.; Ekstrand, J. and Ziegler, E. E. (2000). Fluoride intake and prevalence of dental fluorosis: trends in fluoride intake with special attention to infants. *J Public Health Dent*; 60 (3):131-9.
- 23- Levy, S. M.; Warren, J. J.; Davis, C. S.; Kirchner, H. L.; Kanellis, M. J. and Wefel, J. S.(2001). Patterns of fluoride intake from birth to 36 months. *J Public Health Dent*; 61:70-7.
- 24- Paiva, S.M.; Lima, Y.B.O.and Cury, J.A. (2003). Fluoride intake by Brazilian children from two communities with fluoridated water. *Caries Res*; 31: 1-8.
- 25- Pessan, J.P.; Silva, S.M.B.and Buzalaf, M.A.R. (2003). Evaluation of the total fluoride intake of 4-7-year-old children from diet and dentifrice. *J Appl Oral Sci*;11(2):150-6.
- 26- Hattab, F. N.; Green, R. M.; Pang, K. M. and Mok, Y. C. (1989). Effect of fluoride-containing chewing gum on remineralization of carious lesions and on fluoride uptake in man. *Clin Prev Dent*; 11 (6): 6-11.