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A simple Gas Chromatography Method Developed for Fluoride Content Quantification in Oral Hygiene Formulations by Using Capillary Column

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ABSTRACT: An innovative GC method developed for oral hygiene products. Triethylchlorosilane used to derivative the fluoride ion. This method can quantify the fluoride ranges from 8ppm to 2000ppm. The method was optimized by using flame ionization detector which can produce repeatable, accurate, linear, precise and robust results.

KEYWORDS: Fluoride, Gas chromatography, Capillary column, ZB-624, Triethylchlorosilane.

I. INTRODUCTION

In recent time the fluorinated products importance has increased in Oral hygiene. Fluoride is more essential element for tooth development, but can increase the probability of dental fluorosis or osteosarcoma when consumed excess [1]. The fluoride ion quantification in fine formulations is very much essential as regulatory concerns. Fluoride compounds and their combinations have been tested by using the standards like sodium fluoride, stannous fluoride, sodium monofluorophosphate, calcium fluoride and amine fluoride [2].To determine the fluoride ions in the fine formulations, the regulatory bodies have established sever methods like using Ion selective method[3] and gas chromatography[4][5][6][7] techniques. The traditional methods have some limitations in terms of sample preparation, repeatability and accuracy. Present developed method can be used for fluorinated and non fluorinated products.

In this method fluoride ion derivitized with triethylchlorosilane in to triethylfluorosilane in the presence of hydrochloric acid then extracted by Xylene and using cyclohexane an internal standard and then analysed by gas chromatography. In gas chromatography ZB-624 capillary column used for analysis, based on that achieved good repeatability, accuracy, linearity and robust results without interference, with faster and low cost of analysis.

$(C2H5)_3SiCl + H2O + H^+ \longrightarrow (C2H5)_3Si(OH) + HCl$

(Triethylchlorosilane)

$(C2H5)_3Si(OH) + F^- \longrightarrow (C2H5)_3SiF + OH^-$

(Triethylfluorosilane)

II. MATERIALS AND METHODS

Apparatus:

Gas chromatography with FID and AOC-20i Auto injector (model:GC-2010 Plus, make: Shimadzu),Water bath shaker (model:FDCM-1112,make: Electrotechnic Ltd), Cyclomixer (Model:CM101,make:Remi Equipments), Centrifuge equipment (model:R8C,make:Remi Equipments),Column-DB-624(length-30m,diam-0.32mm,Film-1.80µm,make-Agilent),15mL capacities of tarsons-3graduated plastic centrifuge tubes.

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Chemicals and reagents:
Sodiumfluoride(AR-grade,Make:Rankem) ,Hydro chloric acid AR-grade, Make:Rankem), Cyclohexane (AR-grade,Make:Rankem), Xylene (AR-grade,Make:Rankem), Triethylchlorosilane (AR-grade,Make:Fluka), and water(HPLC-grade).

Instrumentation:
GC Conditions:

Column	:	ZB-624
Length	:	30m
Inner diameter	:	0.32mm
Film	:	1.80µm
Initial temperature	:	80^0C
Hold time-1	:	7.0 minutes
Rate	:	20^0C per minute
Final temperature	:	250 ^{0}C
Hold time-2	:	4.0 minutes
Injector temperature	:	150^0C
Detector temperature	:	250^0C
Column flow rate	:	1.5 mL/ min
Split ratio	:	1:10
Detector	:	FID
Nitrogen flow	:	30mL/min
Hydrogen flow	:	40mL/min
Air flow	:	400mL/min
Total run time	:	19.5 minutes
Injection Volume	:	1 µl

Methods:
(A).Standard solution preparation:
Solution-A: Accurately 138.1mg of sodium fluoride was weighed and transferred in to 250ml volumetric flask, dissolved in water and filled up to the mark with water. This solution contains 0.25mg of fluoride in 1mL.
Solution-B: 20mL ofsolution-A was transferred to 100mL volumetric flask and filled up to the mark with water. It contains 0.05mg of fluoride in 1mL.

(B).Internal standard solution: Prepared the mixture of 1mL cyclohexane and 5mL of Xylene.

(C).Triethylchlorosilane and internal standard solution: Transferred the 1.5Ml of Triethylchlorosilane and 0.3ml of the internal standard solution in to a 25Ml volumetric flask and filled up to the mark with xylene.

Calibration graph: Transferred in to a series of six centrifuge tubes 0, 0.5,1,2,3 and 4mL of the fluoride by pipette standard solution-B. 3mL of water was added to each centrifuged tube and mixed well. Then frequently 1mL of xylene, 3mL of concentrated hydrochloric acid and 0.5mL of triethylchlorosilane and internal standard solution were added.

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Closed the tubes with screw caps and mixed thoroughly with cyclomixer up to 5minutes each one. After mixing centrifuged tubes were shaking up to one hour using shaker. After shaking centrifuged the tubes up to 15minutes at an appropriate speed (2800rpm) to produce a clear separation of the organic phase.1µL of the organic phase was injected in to the GC and calculated the peak area ratio (Area of triethylfluorosilane/area of cyclohexane). A calibration graph plotted correlating the mass of fluoride in the standard solution and the peak area ratio (Area of triethylfluorosilane/area of cyclohexane).

Sample analysis:

Weighed 100-150mg of sample to be tested in to a clean plastic centrifuged tube and added 3mL of water, then frequently 1mL of xylene, 3mL of concentrated hydrochloric acid and 0.5mL of triethylchlorosilane and internal standard solution were added. Closed the centrifuged tubes with screw caps and mixed thoroughly with cyclomixer up to 5minutes each one. After mixing centrifuged tubes were shaking up to one hour using shaker. After shaking centrifuged the tubes up to 15minutes at an appropriate speed (2700rpm) to separate the clear organic layer.1µL of the organic layer was injected in to the GC and calculated the peak area ratio (Area of triethylfluorosilane/area of cyclohexane).Based on this ratio value calculated the amount of fluoride present in the sample by using calibration graph.

III.CALCULATIONS

Calculated the fluoride content of the sample as a percent by mass from the following equation.

$$\text{Amount of fluoride (M1 in mg)} = \frac{(R - \text{Intercept})}{(\text{Slope})}$$

Where:

R = Ratio of (area of triethylfluorosilane/ area of cyclohexane).

M1

$$\text{Fluoride content (\% by mass)} = \frac{M1}{M} \times 100$$

Where:

M: Weight of the sample in mg.

Fluoride content by ppm = Fluoride content (%by mass) x 10,000.

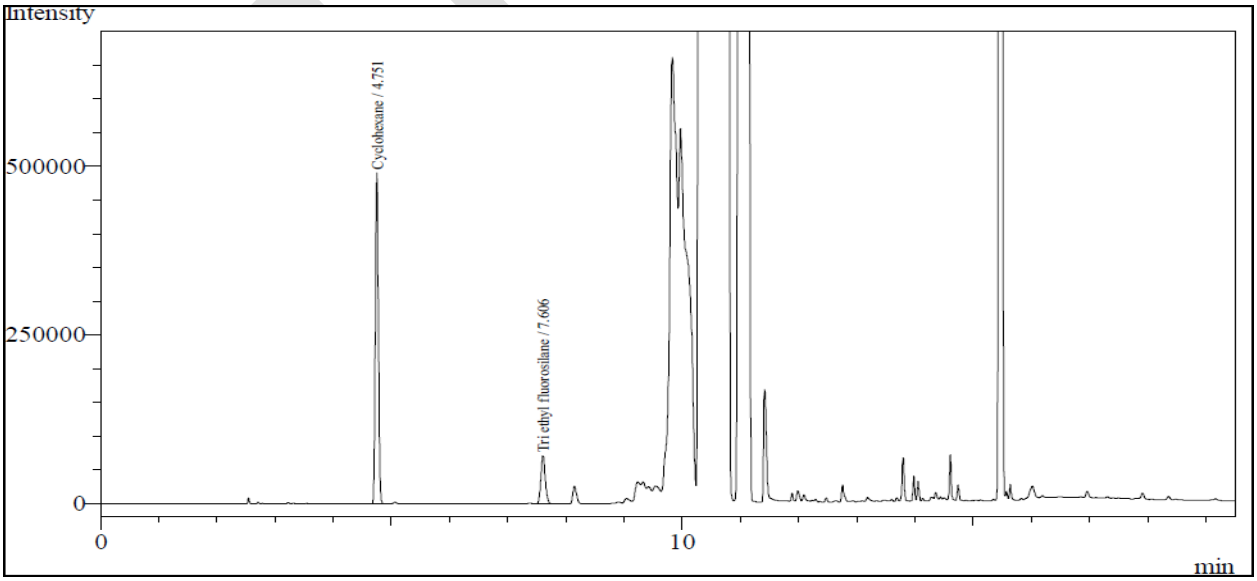

Figure 1: Chromatogram of fluoride analysis by GC.

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IV.METHOD VALIDATION

Specificity and Selectivity: The specificity of the method was checked by injecting blank solution and sample solution. There was no interference from blank and excipients at the retention time of analyte peak.

Linearity: The method showed linear in the concentration range of 250ppm to 2000ppm. The correlation coefficient was 0.9966.The results are shown in table1.

Accuracy: The accuracy of the method was determined by adding known amount of fluoride content corresponding to three concentration levels of 50%, 100%, and 200% of target analyte concentration along with the excipients in triplicate. The accuracy was calculated by the percentage of analyte recovered by the assay method. Based on our results that the method is highly accurate. The accuracy results are shown in table2.

Precision: The method precession and system precession were calculated. The results were within the limits**.** The results of the method precision were shown in table3.

Robustness of the method: Changing with the flow rate (±0.2mL/min), and temperature program, no change in area of fluoride and RSD was within limits. It indicates robustness of the method.

Ruggedness of the method: Changing with different column (ZB-624 and DB-624), different analyst and different instruments (Shimadzu and Agilent systems) the results are within limits.

LOD and LOQ: Method limit of detection is 2.6ppm and limit of quantification is 8.0ppm.

V.EXPERIMENTAL RESULTS

The method was optimized based on using ZB-624 capillary column in gas chromatography. The deravatization process was simplified with optimization of deravatizating reagent. This method was validated as per ICH guidelines for specificity, linearity, accuracy, precession, robustness and ruggedness. The results were within limits.

Table 1: Linearity

Parameter	**Value**
Concentration range(ppm)	250-2000ppm
Slope of regression	0.0001
Intercept	0.0042
Correlation coefficient	0.9966

Table 2: Accuracy

Levels (%)	**Amount taken(ppm)**	**Recovery (%)**
50	225	96.00
100	450	104.80
200	900	107.00

Table 3: Method Precession

Parameter	**Fluoride content**
Average(ppm)	432.7
Standard deviation	7.08
%RSD	1.64

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VI.CONCLUSION

This developed and validated gas chromatographic method was very good efficient for the analysis of fluoride content in given samples. This method was specific, selective, linear, precessie, acuurate, robust and ruggedness. This method was having less run time with low cost. As per best of my knowledge this method was simple with good reproducible results compare with other methods. So, this method suitable for analysis of fluoride content in toothpaste.

REFERENCES

[1] Wejnerowska G, Karczmarek, Gaca J, "Determination of fluoride in tooth paste using headspace solid-phase micro extraction andgas chromatography-flame ionization detection", Journal of Chromatography, A1150; 173-177, 2007.

[2] Mariusz Koc,Magdalena Anna Donten,Jacek Musijowski,Xinghua GUO, Alexander Fauland,Ernst Lankmayr ,and Marek Trojanowicz, **"**Application of Gas Chromatography to Determination of Total Organic Fluorine after Defluorination of Perfluorooctanoic Acid as a Model Compound", Croat. Chem., Acta84 (3); 399-406.CCA-3488, 2011.

[3] MacLeod, Kathryn E., and Howard L. Crist, "Comparison of the SPADNS-Zirconium Lake and Specific Ion Electrode Methods of Fluoride Determination in Stack Emission Samples", Analytical Chemistry, 45; 1272–1273, 1973.

[4] J.H.Glerum, A.Van Dijk, and S.W.Klein, "A general system for the automation of a backflush equipped gas chromatograph and its application in the determination of fluoride in plasma and faeces",Pharam.Weekblad Sci.Ed.6.75-79, 1984.

[5] J.Belisle and D.F.Hagen,"A method for the determination of perfluorooctanoic acid in blood and other biological samples",Anal. Biochem. 101, 369-376, 1980.

[6] R. Bock , H.J.Semmler,"Gas chromatographic determination of traces of fluoride with several alkylsilane extractants",Z.Anal.Chem.*230*, 161-184, 1967.

[7] Cropper.E, Puttman.N.A "The gas chromatographic determination of fluoride in dental creams", J.Soc.Cosmet.Chem.21, 533-540, 1970.