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Analysis of zinc in toothpaste using the Thermo Scientific iCE 3000 Series AAS

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Introduction

Typically our day starts with a mixture of chemicals, toothpaste, a paste or gel dentifrice used with a toothbrush as an accessory to clean and maintain the aesthetics and health of teeth. Toothpaste is used to promote oral hygiene: it serves as an abrasive that aids in removing the dental plaque and food from the teeth, assists in suppressing halitosis (bad breath), and delivers active ingredients such as fluoride or xylitol which help to prevent tooth and gum disease (gingivitis).[1]

Although toothpaste was used as long ago as 500 BC in ancient Egypt, China and India, it was not until the19th century that toothpastes came into general use. Ancient tooth powders used abrasive ingredients such as crushed bone, burned and crushed egg, snail or oyster shells, which were used to clean debris from teeth. First ‘modern’ toothpastes in the 1800s were homemade, with chalk, soap and salt as common ingredients and were sold in jars either as a powder or paste. A dentist in the US first introduced tooth paste in a tube, in 1892. The most important breakthrough in the history of toothpaste was the addition of fluoride in toothpaste in 1914. The use of fluoride in toothpastes became widespread much later in the 1950’s.

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Modern toothpaste is a complex formulation that has many more added ingredients since it was first introduced. Extensive work has been carried out to introduce an ingredient which can provide effective protection against various dental conditions.

Triclosan is reported as one of the commonly used important antimicrobial agents used in toothpaste that fight the bacteria which contribute to dental plaque. However, Triclosan induces damage and lesions to the cell wall of bacteria resulting in bacteriolysis (death of the cell) and hence its use is restricted or banned in many countries.[2]

As an alternative to Triclosan many leading manufacturers prefer to use bacteriostatic agents such as zinc (zinc chloride or zinc citrate) which stop the growth of dental plaque bacteria by inhibiting their metabolism. The combination of bacteriostatic and bactericidal agents as toothpaste ingredients is the most effective one way to fight dental plaque and gum disease.

This application note presents a simple, rugged flame atomic absorption spectrometry method for the analysis of zinc in toothpaste. Random samples of known international and local brands in the market were used for this work.

Sample preparation

Reagents

1. Concentrated nitric acid (65%)
2. Hydrofluoric acid
3. Deionized water

Procedure

Around 2-3 g of toothpaste sample was weighed out and 15 ml of concentrated nitric acid added in a 250 ml glass beaker. It was stirred well with a glass rod to break up the sample, covered with watch glass and placed on a hot plate. It was then heated for around 25-30 min with intermittent shaking.

On cooling to room temperature, it was transferred to a 50 ml polypropylene tube. About 1ml of hydrofluoric acid was added drop wise with continuous shaking to dissolve the bulk of the residue. The sample was then made up to a volume of 50 ml with deionized water. The resulting solution was turbid, which maybe because of insoluble substances like silica or mica in the toothpaste samples. It was therefore filtered to get a clear solution. A blank was also prepared similarly but without sample.

The clear solution was analyzed by aspirating into the flame of a Thermo Scientific™ iCE™ 3500 AAS using the instrument parameters in Table 1. To check the repeatability/reproducibility, samples were prepared in triplicate and 3 replicates were taken every time. Recovery studies were carried out by spiking the samples with zinc standard of suitable concentrations. As the zinc content in different samples varied the spike quantity was adjusted accordingly. Results are given in Tables 2 and 3.

Instrumentation

Instrument method

Table 1. Parameter setting.

Parameter	Value
Element	Zinc (Zn)
Wavelength	213.9 nm
Measurement mode	Absorbance
Band pass	0.2 nm
Lamp current	75%
Background correction	D_2
Measurement time	4 Seconds
Number of replicates	3
Flame type	Air - Acetylene
Fuel flow	1.2 L/min
Burner height	7.0 mm

Calibration

The calibration curve was generated using NIST traceable zinc standards in the range of 0.25 to 1 ppm.

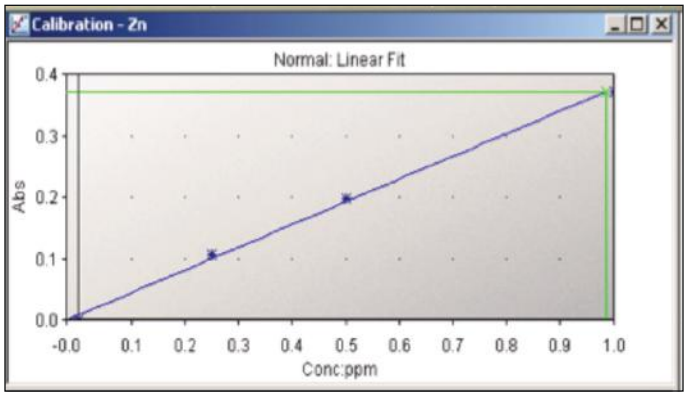

Figure 1. Calibration curve and data for zinc.

Results

Table 2.

Sr. No.	Sample name	Zn in sample (ppm)	Mean value (ppm)	% RSD between samples
1	Sample 1	6.33	6.28	2.94
		6.44		
		6.08		
2	Sample 2	6652.72	6432.94	3.11
		6260.49		
		63.85.59		
3	Sample 3	471.09	452.09	3.64
		443.18		
		442.01		
4	Sample 4	22.17	22.17	4.70
		23.94		
		22.02		
5	Sample 5	7.57	7.52	3.43
		7.75		
		7.24		
6	Sample 6	8.38	8.16	3.32
		8.24		
		7.86		

Table 3.

Sr. No.	Sample name	% Recovery
1	Sample 1	94.1
2	Sample 2	98.9
3	Sample 3	102.2
4	Sample 4	96.9
5	Sample 5	93.2
6	Sample 6	105.2

Conclusion

The Thermo Scientific iCE 3500 AAS is a suitable instrument for the analysis of zinc in toothpaste and other similar types of matrix. The optimization wizards within the Thermo Scientific SOLAAR™ software make method development simple and ensure optimum analytical conditions.

The data obtained demonstrates that repeatability/ reproducibility is excellent for 3 repeat sample preparations of the toothpaste samples with RSD < 5 %. Recovery is also well within generally acceptable limits of 93 to 105 %.

References

1. American Dental Association Description of Toothpaste
2. History of toothpaste (web dental office)

Disclaimer: Samples analyzed are obtained from public domain and the intent of the analysis is only to show the capability/suitability of Thermo Scientific AAS: iCE 3000 series.

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