



Application Note AN-S-379

药用氟化钠片剂中的氟化物

Method qualification according to the U.S. Pharmacopeia

Fluoride has been shown to be effective at preventing tooth decay and supporting remineralization of tooth enamel [1,2]. Aside from the fluorination of drinking water, milk, or salt, fluoride can also be encountered as a topical fluoride supplement such as fluoride tablets, toothpastes, mouthwashes, or gels [2,3]. However, its efficacy highly depends on concentration and dosage, which is also crucial to avoid overdosage and fluorosis [2].

Analytical methods, including ion chromatography (IC), are used to ensure that fluoride tablets meet the quality standards as

given by the United States Pharmacopeia and National Formulary (USP-NF).

IC with suppressed conductivity detection has been approved by the USP as a validated method to quantify fluoride content in sodium fluoride tablets [4]. Using the Metrosep A Supp 16 - 250/4.0 (L91) column and applying a hydroxide eluent provides the required separation of fluoride and acetate. The qualification was performed according to USP General Chapters [5–7] and met all acceptance criteria from the USP Monograph «Sodium Fluoride Tablets» [4].

STANDARD AND SAMPLE PREPARATION

The system suitability solution and the standard solutions are prepared from a USP Sodium Fluoride RS certified standard by dilution with ultrapure water (UPW). The system suitability solution contains 2.0 µg/mL sodium fluoride (NaF) and 1.0 µg/mL of sodium acetate. The standard solutions contain 2.0 µg/mL NaF. Samples were prepared from ground sodium fluoride tablets. A 0.215 g portion of the powder was accurately weighed and transferred into a

1000 mL volumetric flask. The flask was subsequently filled up to the mark with UPW. To ensure complete dissolution, the mixture underwent ultrasonic agitation for 10 minutes. The resulting solution was then subjected to filtration using a 0.2 µm pore size membrane filter. The filtered solution was diluted 1:10 with UPW to achieve a final concentration of 2.0 µg/mL NaF.

EXPERIMENTAL

Samples and standard solutions were injected directly into the IC using an 858 Professional

Sample Processor (Figure 1).

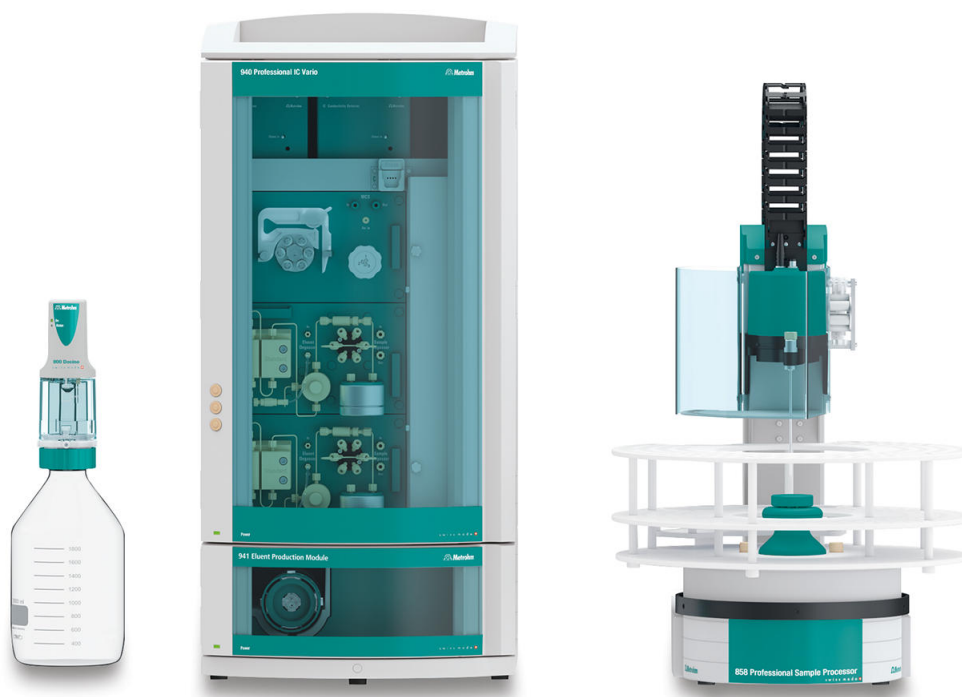


Figure 1. Instrumental setup including a 940 Professional IC Vario ONE SeS/PP/HPG, 858 Professional Sample Processor, and an 800 Dosino for Dosino regeneration of the Metrohm Suppressor Module (Metrohm Dosino Regeneration).

Fluoride was separated from acetate by applying a binary potassium hydroxide gradient (**Tables 1 and 2**) and using the Metrosep A Supp 16

column (L91) followed by chemically suppressed conductivity detection.

Table 1. Requirements for the IC method as per USP Monograph «Sodium Fluoride Tablets» [4].

Column with L91 packing	Metrosep A Supp 16 - 250/4.0
Flow rate	1.0 mL/min
Eluent	A: 100 mmol/L Potassium hydroxide B: Ultrapure water
Temperature	40 ° C
Injection volume	20 µL
Detection	Suppressed conductivity

Table 2. Binary gradient program for USP Monograph «Sodium Fluoride Tablets» [4].

Time (minutes)	Eluent A (%)	Eluent B (%)
0.0	15	85
7.0	15	85
8.0	80	20
15.0	80	20
15.1	15	85
25.0	15	85

RESULTS

The IC method presented for fluoride determination in sodium fluoride tablets was qualified according to the general requirements of USP and the USP Monograph «Sodium Fluoride Tablets» [4–7].

The appropriate separation of fluoride and acetate on the A Supp 16 column was achieved by applying a hydroxide gradient (**Table 3**). The chromatogram is shown in **Figure 2**.

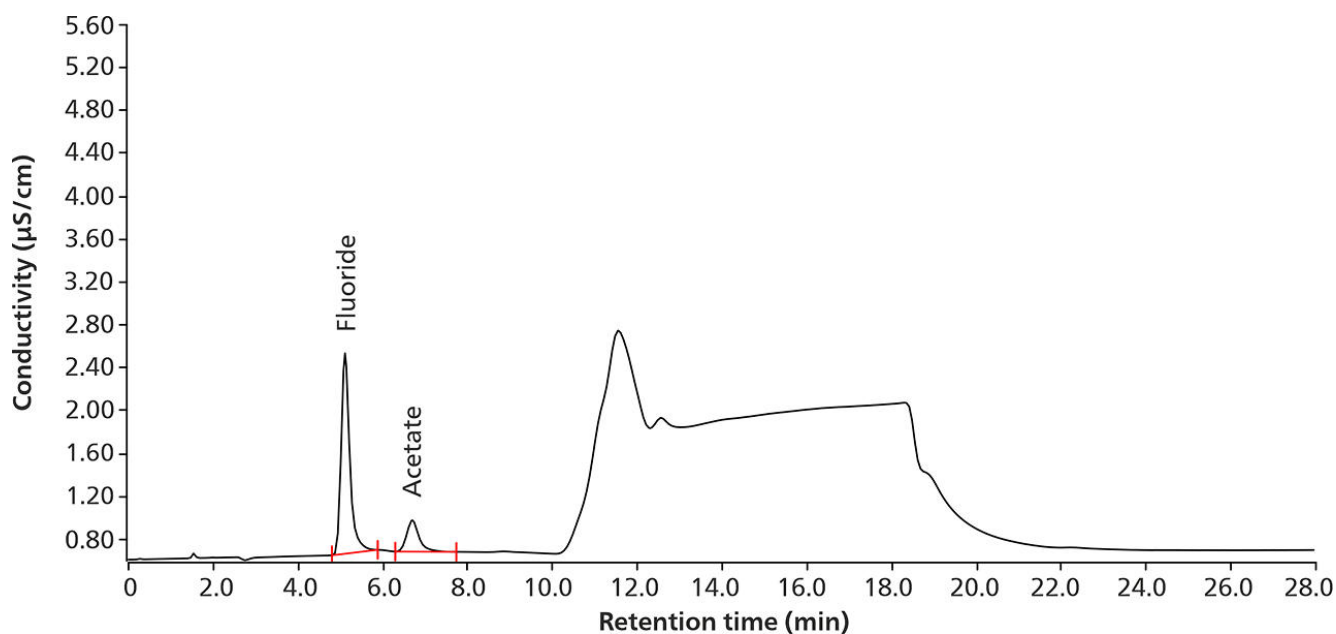


Figure 2. Chromatogram of the system suitability solution. The concentration of sodium fluoride was 2.0 µg/mL. Acetate was not quantified (nominal concentration 1.0 µg/mL).

The relative retention times (r_G , unadjusted) for fluoride and acetate are 1.0 and 1.3, respectively. These unitless values are automatically

calculated with the MagIC Net software by applying the following formula:

$$r_G = \frac{t_{Ri}}{t_{Rst}}$$

r_G = relative retention time, unadjusted t_{Ri} = retention time peak of interest t_{Rst} = retention time peak of reference peak (peak corresponding to the substance to be examined, sodium fluoride)

Table 3 shows that the system suitability criteria are met, including resolution, tailing factor, and relative standard error (RSD) of multiple standard injections [4].

Table 3. System suitability test requirements and results from the study.

Parameter	Actual	USP requirement	Status
Resolution fluoride/acetate	3.7	NLT 1.5	Pass
Tailing factor for fluoride	1.4	NMT 2.0	Pass
RSD fluoride (% , n=5)	0.4	NMT 2.0	Pass

The calibration for the sample analysis was performed using a single standard at 2.0 µg/mL NaF injected six times. The sample was analyzed

in duplicate and fulfilled the respective USP validation criteria as shown in **Table 4**.

Table 4. Sample test showing the calculated percentage of the labeled amount of sodium fluoride (NaF) in the used tablets reached in the analysis.

Parameter	Actual	USP requirement	Status
Fluoride sample [%]	99.4	90–110	Pass

CONCLUSION

Ion chromatography (IC) has successfully passed the qualification tests for quantifying the fluoride content in pharmaceutical tablets, in full compliance with the USP Monograph «Sodium Fluoride Tablets». The qualification was conducted in accordance with the guidelines set by the USP.
Regarding system suitability and sample analysis, the IC method passed all predefined acceptance

criteria including resolution, tailing factor, and the relative standard deviation for repeated standard injections as well as for the sample result. Consequently, ion chromatography has qualified as a reliable and highly automated method for fluoride quantification in pharmaceutical compounds, offering both user-friendliness and accurate results.

REFERENCES

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CONFIGURATION



Metrosep A Supp 16 - 250/4.0

Metrosep A Supp 16 适用于高容量分离问题,即使在复杂的分离问题中也能保持优良的分辨率。Metrosep A Supp 16 分离柱基于表面作用的聚苯乙烯/二乙烯基苯共聚物。官能组均为共价键合。该特征以及表面结构使阴离子交换剂具有独特的选择性。高容量 Metrosep A Supp 16 适用于复杂的分离问题。

Metrosep A Supp 16 - 250/4.0 拥有优良的分辨率,可解决复杂的分离问题。该柱非常适用于监控电镀浴。可测定浓酸中的阴离子痕量。可在食品分析中用于测定麦芽糖衍生物,这只是高容量 Metrosep A Supp 16 - 250/4.0 的众多应用中的一种。



Metrosep A Supp 16 Guard/4.0

Metrosep A Supp 16 Guard/4.0 保护柱可有效保护分析用分离柱 Metrosep A Supp 16,使其免受污染。该保护柱采用 «On Column Guard System» 技术,其特征是操作简便。只要将其拧到分析柱上即可。不需要任何工具。

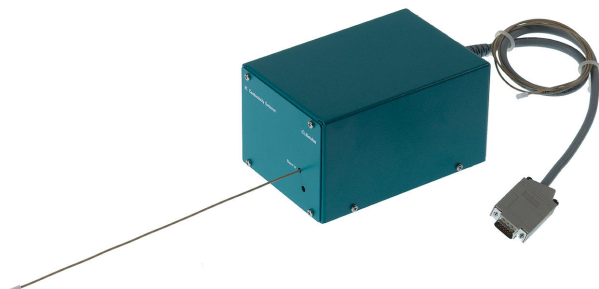


940 Professional IC Vario ONE/SeS/PP/HPG

940 Professional IC Vario ONE/SeS/PP/HPG 是智能型离子色谱仪器,带有序列抑制、蠕动泵用于抑制器再生,以及二元高压梯度。可使用 942 Extension Modul 将其扩展至四元梯度系统。该仪器可使用各种分离和检测方法。

典型的应用范围:

- 用于阴离子或阳离子测定的梯度应用,序列抑制法



IC Conductivity Detector

用于智能型离子色谱仪的紧凑智能型高性能电导检测器。不凡的温度稳定性,受保护的检测器端子板内的整个信号处理过程以及新一代的 DSP(数字式信号处理)均能确保测量的准确性。归功于动态工作范围,无需进行范围变更(也不是自动进行)。



858 Professional Sample Processor – Pump

858 Professional Sample Processor – Pump 可处理体积在 500 µL 至 500 mL 之间的样品。进行样品转移时,既可以使用内置的双向双通道蠕动泵、也可通过 800 Dosino 来进行。