

Application Note AN-I-035

Sodium content in food using an ion-selective electrode

Fast, accurate, and selective determination in table salt, potato chips, and baby food according to AOAC 976.25

World Health Organization (WHO) guidelines recommend a maximum daily sodium intake of 2 g for adults, which is equivalent to 5 g of dietary salt (sodium chloride, NaCl). Diets high in sodium can have negative health consequences as the risk of developing high blood pressure (hypertension) increases. High blood pressure is one of the main risk factors for cardiovascular disease. Therefore, increased sodium intake indirectly increases this risk.

Sodium in our food is mainly present in the form of sodium chloride salt and should be measured accordingly. Ion-selective electrodes (ISEs) are an accurate, selective, and rapid way to measure sodium in food. Compared to chromatographic or spectroscopic methods, ISEs are cost effective, space saving, and easy to use. This Application Note describes sodium analysis in different matrices like table salt, potato chips, and baby formula (milk powder) using the separate sodium-selective electrode (Na-ISE).

Both direct measurement and standard addition are demonstrated. The method is based on the standard AOAC 976.25.

INTRODUCTION

This application utilizes a Na-ISE. The ion-selective polymer membrane of the electrode is made of polyvinyl chloride (PVC), plasticizer, and ionophore including additive. It is not necessary to condition the PVC membrane – the polymeric membrane is immediately ready for use. The ionophore within the polymer membrane is responsible for the selectivity, i.e., it is able to selectively take up Na^+ ions.

Direct measurement is recommended for unproblematic samples and in the case of low-level sodium measurements (mg/L or µg/L range). The ion activity in the sample is interpolated from a calibration curve. Plot the calibration curve using standard solutions. The expected ion activity in the sample should be in the middle of the concentration range of the standard solutions.

Standard addition (STDADD) is recommended for undefined or complex sample matrices. In the standard addition method, a defined amount of the ion of interest is added to a known volume of sample (in several steps). The unknown concentration can be calculated from the resulting potential differences between the sample and the sample with added standard solution. This calculation is performed automatically by modern ion meters or software such as OMNIS.

SAMPLE AND SAMPLE PREPARATION

The analysis is demonstrated on table salt (NaCl), potato chips, and baby food (milk powder).

For all samples, solutions were prepared in advance by dissolving an appropriate amount of sample in deionized water.

EXPERIMENTAL

This analysis is performed on an OMNIS Advanced Titrator and an OMNIS Dosing Module equipped with a separate sodium-selective electrode (Figure 1).

To a reasonable amount of sample, either ISA solution consisting of $c(CaCl_2)$ = 1 mol/L is automatically added and the potential is measured, or the standard addition is carried out with the sodium standard solution $\beta(Na^+)$ = 2000 mg/L.

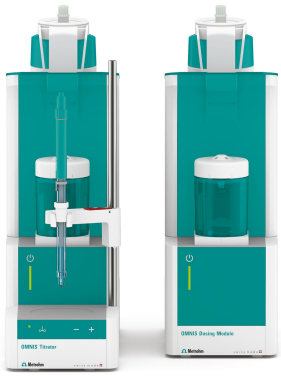


Figure 1. OMNIS Advanced Titrator and OMNIS Dosing Module equipped with Na-ISE for the determination of sodium.

RESULTS

Both direct measurement and standard addition provide accurate and reproducible results for different sodium levels with SD(rel) < 2.0% as shown in Table 1 and Table 2.

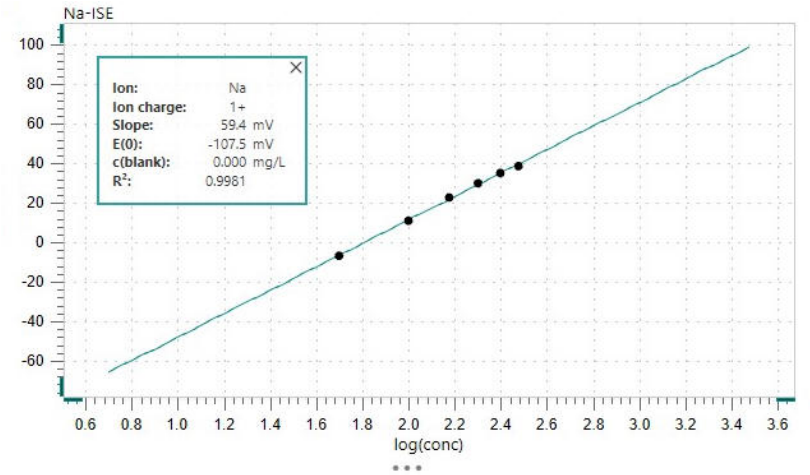
The calibration for direct measurement is shown in Figure 2 and an example of standard addition is shown in Figure 3.

Table 1. Results for sodium in table salt (NaCl) by direct measurement.

Sample (n = 6)	Mean value in %	SD(abs) in %	SD(rel) in %
Table salt	39.34	0.00	0.0

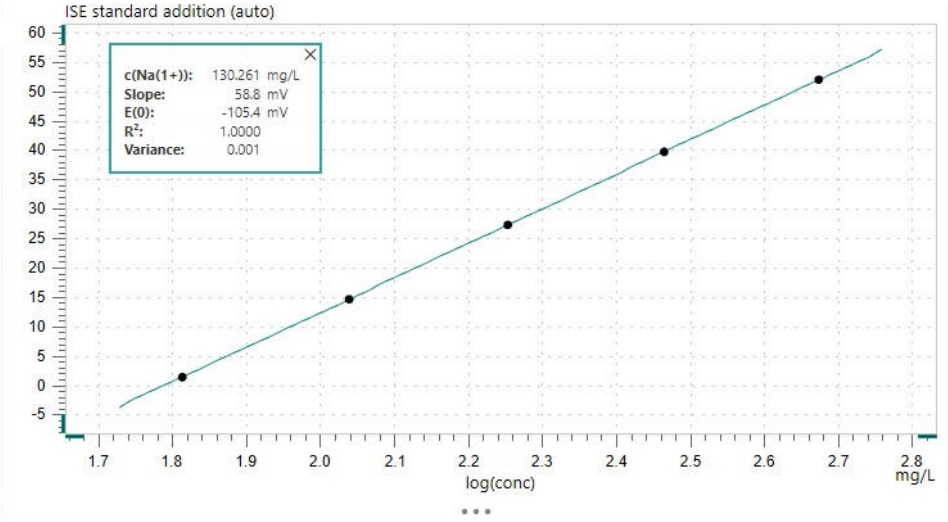
Table 2. Results for sodium in potato chips and baby food (milk powder) by standard addition.

Sample (n = 6)	Mean value	SD(abs)	SD(rel) in %
Potato chips	3912 mg/kg	42.6 mg/kg	1.1
Baby food	2606 mg/kg	3.58 mg/kg	0.1



Subsample name	Concentration / mg/L	Potential – End value / mV	Temperature / °C
Sodium standard solution	50.000	-6.8	25.9
Sodium standard solution	100.000	10.9	26.0
Sodium standard solution	150.000	22.7	25.9
Sodium standard solution	200.000	29.9	26.0
Sodium standard solution	250.000	35.1	26.0
Sodium standard solution	300.000	38.6	26.0

Figure 2. Calibration of six standard solutions with 50 mg/L, 100 mg/L, 150 mg/L, 200 mg/L, 250 mg/L, and 300 mg/L sodium.



	Volume increment / mL	Potential / mV	Potential difference /...	Temperature / °C
Sample		1.4		24.8
Increment 1	0.938	14.6	13.2	24.8
Increment 2	1.572	27.3	12.7	24.9
Increment 3	2.794	39.7	12.4	25.1
Increment 4	5.346	51.9	12.3	25.3

Figure 3. Standard addition of baby food (milk powder) with four increments made with 2000 mg/L sodium.

CONCLUSION

Ion-selective electrodes can determine sodium content in food with fast, reproducible, and accurate results.

Handling the Na-ISE is user-friendly. There is no need to condition the electrode, which means it is immediately ready for use. Furthermore, this method conforms to AOAC 976.25.

The system used in this Application Note offers users flexibility combined with high-end software. The measuring range of the separate polymer Na-ISE lies between 5×10^{-6} mol/L and 1 mol/L Na^+ (corresponds to approximately 0.11 mg/L Na^+) and is suitable for a wide range of different samples, from foodstuffs like fast food or table salt with reduced sodium content to pharmaceutical products and cosmetics.

Metrohm helps you to measure sodium content in food with confidence. As well as improving the precision and speed of measurements, OMNIS delivers results that are equal to or better than other established titration systems.

CONTACT

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CONFIGURATION



OMNIS Advanced Titrator with magnetic stirrer

Innovative, modular potentiometric OMNIS Titrator for stand-alone operation or as the core of an OMNIS titration system for endpoint titration and equivalence point titration (monotonic/dynamic). Thanks to 3S Liquid Adapter technology, handling chemicals is more secure than ever before. The titrator can be freely configured with measuring modules and cylinder units and can have a rod stirrer added as needed. If required, the OMNIS Advanced Titrator can be equipped for parallel titration via a corresponding software function license.

- Control via PC or local network
- Connection option for up to four additional titration or dosing modules for additional applications or auxiliary solutions
- Connection option for one rod stirrer
- Various cylinder sizes available: 5, 10, 20 or 50 mL
- Liquid Adapter with 3S technology: Secure handling of chemicals, automatic transfer of the original reagent data from the manufacturer

Measuring modes and software options:

- Endpoint titration: "Basic" function license
- Endpoint and equivalence point titration (monotonic/dynamic): "Advanced" function license
- Endpoint and equivalence point titration (monotonic/dynamic) with parallel titration: "Professional" function license



OMNIS Dosing Module without stirrer

Dosing module for connection to an OMNIS Titrator for extending the system to include an additional buret for titration/dosing. Can be supplemented with one magnetic stirrer or rod stirrer for use as separate titration stand. Freely selectable cylinder unit with 5, 10, 20 or 50 mL.



Separate polymer membrane electrode, Na

Sodium-selective electrode with polymer membrane. This ISE has to be used in combination with a reference electrode and is suitable for:

- ion measurements of Na+ in aqueous solutions
- ion measurements in small sample volumes (minimum immersion depth 1 mm)
- titrations in aqueous solutions

Thanks to a robust/break-proof plastic shaft made of PVC, this sensor is mechanically very resistant.