Metrohm

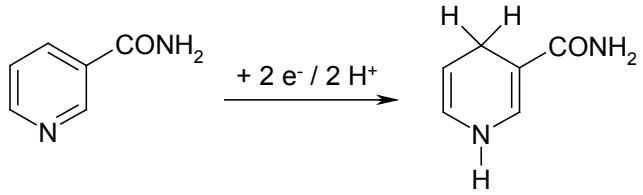
Application Bulletin 213/2 e

Determination of nicotinamide by polarography

Summary

This Application Bulletins describes the determination of nicotinamide (vitamin PP), a vitamin of the B series. Instructions for the determination in solutions (e.g. fruit juice), vitamin capsules and multivitamin tablets are given. The linearity range of the determination is also specified. The limit of detection is approximately 50 µg/L nicotinamide.

Nicotinamide is reduced at the DME according to the following mechanism:



Instruments

VA instrument capable of operating a Multi-Mode Electrode and supporting differential pulse (DP) measuring mode

Electrodes

WE	Multi-Mode Electrode pro Mercury drop capillary	6.1246.120 6.1226.030
RE	Ag/AgCl reference electrode Ag/AgCl/KCl (3 mol/L) Electrolyte vessel Filled with c(KCl) = 3 mol/L	6.0728.x20 6.1245.010
AE	Pt rod electrode	6.0343.x00

Reagents

All of the used reagents must be of purest quality possible (for analysis or for trace analysis*).

- Tetramethylammonium hydroxide, w(TMAOH) = 25%, for analysis, CAS 75-59-2
- Sodium hydroxide, for analysis, CAS 1310-73-2
- Nicotinamide, (Vitamin PP), for analysis, CAS 98-92-0
- Ultrapure water, resistivity >18 MΩ·cm (25 °C), type I grade (ASTM D1193)

Solutions

Electrolyte	Φ(TMAOH) = 1% v/v 8 mL of a 25% tetramethylammonium hydroxide solution (or 20 mL of a 10% solution) are pipetted into a 200 mL volumetric flask and filled to the mark with ultrapure water.
Extraction solution	c(NaOH) = 0.1 mol/L Dissolve 4 g/L NaOH in ultrapure water.

Standard solutions

Nicotinamide standard stock solution	β(nicotinamide) = 1 g/L Approximately 2 g nicotinamide are dried overnight in a desiccator. 250.0 mg of the dried nicotinamide are weighed into a 250 mL volumetric flask, dissolved in ultrapure water and made up to the mark.
Nicotinamide standard solution	This is prepared as needed from the stock solution by dilution with ultrapure water.

All solution (except the Extraction solution) should be freshly prepared daily.

Sample preparation

Solutions

Solutions (injection solutions, fruit juices, etc.) are adjusted to a pH of ca. 10 ... 12 with NaOH and filtered if necessary.

Vitamin capsules

The contents of 10 ... 20 capsules are weighed and mixed. The average weight is calculated and this (average capsule content) is weighed into a beaker. Extraction solution (20 mL) is added and extraction performed for 20 min on a water bath at 40 °C with stirring. After cooling, the mixture is rinsed into a 250 volumetric flask with water the flask is filled to the mark

and the contents thoroughly mixed. The flask contents are then allowed to settle for at least 20 min.

Vitamin tablets (multivitamin tablets)

10 tablets are weighed to obtain the average weight and then pulverized (grinder, mortar, etc.). The average weight of a tablet is weighed into a beaker and the procedure described for vitamin capsules then followed.

Analysis

Sample solution (1.5 ... 10 mL), which can contain 50 ... 500 µg nicotinamide, is pipetted into a polarographic vessel. 10 mL electrolyte are added and the solution made up to 20 mL with dist. water if necessary.

Measuring solution

10 mL (diluted) sample

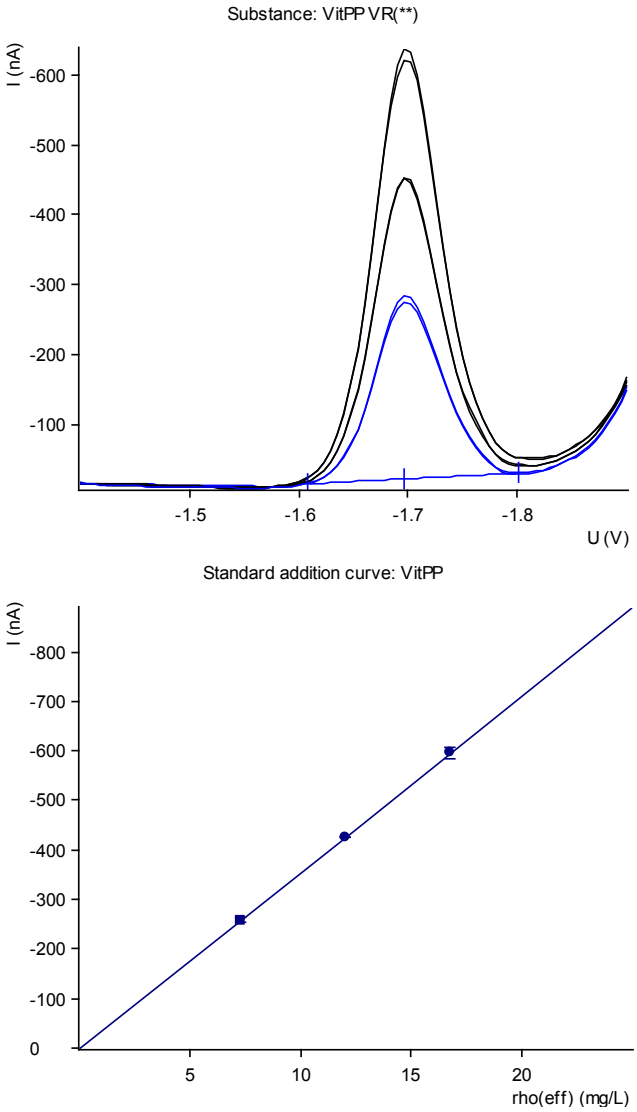
10 mL electrolyte

The concentration is determined by standard addition.

Parameters

Voltammetric	
Electrode operating mode	DME
Measuring mode	DP – Differential pulse
Stirring rate	2000 min^{-1}
Equilibration time	5 s
Sweep	
Start potential	-1.4 V
End potential	-1.9 V
Potential step	0.006 V
Potential step time	0.6 s
Sweep rate	0.01 V/s
Pulse amplitude	0.04 V
Substance	
Name	Nicotinamide
Characteristic potential	-1.7 V

Example



Result

Sample	Vitamin PP tablet
Sample size	4.78 g (1 tablet)
β(Nicotinamide)	3.2 mg/g (15.2 mg/tablet)

Comments

- Optimum values are obtained when 2.5 ... 25 mg/L nicotinamide are present in the polarographic vessel (can be adjusted using the sample size).
- It is essential to use the DME as working electrode. With the SMDE lower sensitivities are obtained. The SMDE is also more susceptible to disturbances in the alkaline electrolytes (pH ca. 12.8) used.

References

- Dewjatnin, W. A., Kuznetzowa, L. A., Polarographic determination of vitamins B-1, B-2 and nicotinamide in mono- and polyvitamin preparations, Med. Prom. USSR 58. (1964) 58-60 (Russian)
- Göbbeler, K. H., Breinlich, J., Quantitative wechselstrompolarographische Simultanbestimmung von Vitaminen der B-Gruppe, Pharm. Ztg. 48, (1972) 1859-1862
- Jacobsen, E., Thorgersen, K. B., Electroreduction and pulse-polarographic determination of nicotinamide in multivitamin tablets, Anal. Cim. Acta 71, (1974) 175-184
- Moore, J. M., Polarographische Schnellanalyse von Nikotinamid in pharmazeutischen Präparaten, J. Pharm. Sci. 58, (1969) 1117-1120 (English)
- Söderhjelm, P., Lindquist, J., Electrochemical assay of thiamine, riboflavine, pyridoxine, nicotinamide and ascorbic acid in pharmaceutical preparations, Acta Parm. Suec. 13, (1976) 201-212
- Taira, A. Y., Polarographic determination of niacinamide in multivitamin preparations, J. Assoc. Off. Anal. Chem. 57/4, (1974) 910-913

Appendix

Report for the example determination of nicotinamide in vitamin PP tablets

```
================== METROHM 746 VA TRACE ANALYZER (5.746.0100) ==================
 Determ.     :  05291623           User:                      Date:  96-05-29
 Modified    :  96-06-05 10:08:17   Run :  0                   Time:  16:23:00
 Sample table:  -
--------------------------------------------------------------------------------
  Pos.  Ident.1/S1    Ident.2/S2    Ident.3/S3    Method.call   Sample size/S0
        VitPP Tabl           1.0                                       4.78 g
--------------------------------------------------------------------------------
 Method  :  VitPP
 Title   :  VitPP polarographisch
 Remark1 :  10 ml Grundloesung + 10 ml Milli Q-H2O + 1 ml Probeloesung
 Remark2 :
--------------------------------------------------------------------------------

  Substance : VitPP                                          Comments
  Mass conc.:    152.0 mg/L          Mass     :   152 ug   ------------------
  MC.dev.   :     5.52 mg/L (3.63%)  Add.mass :   100 ug
  Cal.dev.  :    -                   V0.sample:     1 mL

              VR   U/mV    I/nA   I.mean  Std.dev. I.delta   Comments
              ---  -----  ------  ------  -------  -------   ------------------
              00   -1696  -261.4  -257.8    5.095
              01   -1696  -254.2
              10   -1697  -422.1  -422.3   0.2654   -164.6
              11   -1696  -422.5
              20   -1697  -582.6  -590.3    10.83   -168.0
              21   -1697  -598.0

 Substance    Techn.     Y.reg/offset   Slope        Nonlin.      Mean deviat.
 ---------    --------   ------------   ----------   ----------   ------------
 VitPP        std.add.     -2.569e-07   -3.550e-05                 6.186e-09


Final results                        +/- Res.dev.    %      Comments
 ---------------------------------     -----------------     ------------------
      VitPP =   3.1792 mg/g              0.115    3.63
      VitPP =   15.197 mg/Tab.           0.552    3.63
```

Method print for the determination of nicotinamide

```
================== METROHM 746 VA TRACE ANALYZER (5.746.0100) ==================
 Method: VitPP   .mth         OPERATION SEQUENCE
 Title : VitPP polarographisch
--------------------------------------------------------------------------------

      Instructions   t/s   Main parameters            Auxiliary parameters
      ------------ -----   ------------------------  ------------------------
 1    SMPL/M               V.fraction    1.000 mL    V.total          0.1 L
 2    DOS/M                V.added      20.000 mL
 3    PURGE
 4    STIR          300.0  Rot.speed      2000 /min
 5    (ADD
 6      NOP         10.0
 7      SEGMENT             Segm.name   pol
 8      ADD>M               Soln.name   VitPPstd     V.add         0.100 mL
 9    ADD)2
10    END

 Method: VitPP                SEGMENT
                                   pol
--------------------------------------------------------------------------------

      Instructions   t/s   Main parameters            Auxiliary parameters
      ------------ -----   ------------------------  ------------------------
 1    0PURGE
 2    0STIR
 3    (REP
 4      DME
 5      DPMODE            U.ampl          -50 mV     t.meas         20.0 ms
                          t.step         0.30 s      t.pulse        40.0 ms
 6      SWEEP       26.1  U.start       -1400 mV     U.step            6 mV
                          U.end         -1900 mV     Sweep rate       20 mV/s
 7    REP)1
 8    PURGE
 9    STIR                Rot.speed      2000 /min
10    0MEAS               U.standby           mV
11    END
```