The Determination of Sodium and Potassium in Biological Fluid

**Introduction**
The simple measurement of sodium and potassium in various biological fluids using a flame photometer is described, including dilution ratios, interferences and calibration curves.

**Materials Required**

**Equipment**
JENWAY Flame Photometer PFP7
Volumetric Glassware
Pipettes

**Reagents**
Sodium Standard Solution – 1000mg/l (1000ppm) (Jenway Part Number 025 021)
Potassium Standard Solution – 1000mg/l (1000ppm) (Jenway Part Number 025 023)
Deionised Water

**Methods**

**Calibration using a standard curve**

1. Set up the instrument as described in the instruction manual.

2. Prepare the following standard solutions: 0.2, 0.4, 0.6, 0.8 and 1.0mg Na/100ml, from the 1000mg/l sodium standard solution, using deionised water as the diluent.

3. Select the sodium filter and aspirate the 1.0mg Na/100ml standard and adjust sensitivity control to obtain a reading of 100.

4. Aspirate deionised water and adjust the zero control to obtain zero reading.

5. Aspirate 1.0mg Na/100ml standard again, re-adjust to 100.

6. Aspirate deionised water again and re-adjust if necessary to zero.

7. Repeat steps 5 and 6 if necessary to obtain 100 on the standard and zero on deionised water.

8. Aspirate the other standard solutions, note the readings and plot a calibration curve.

9. Repeat the above calibration procedure with potassium filter, using standard solutions of the following concentrations: 0.2, 0.4, 0.6, 0.8 and 1.0mg K/100ml, prepared from the 1000mg/l potassium standard solution using deionised water as the diluent.

**SERUM POTASSIUM**

**Sample preparation**
Prepare a 1:50 dilution of haemolysis-free serum in deionised water.

**Note:** The sodium present in the sample will not affect the potassium determination and no allowance need be made for sodium when preparing the standards.
Reagents
1.0mg K/100ml standard
Blank
Deionised water

Procedure
1. Set up the instrument with the K filter and adjust the flame as described in the instruction manual.

2. Adjust the instrument to obtain 100 on the 1.0mg/100ml standard and zero reading on the blank as described above in the calibration section.

3. Aspirate sample and note the reading.

4. From the calibration curve previously prepared for potassium, read off the concentration equivalent to this reading.

5. To obtain mg K/100ml of serum, multiply this concentration by the dilution factor.

6. Aspirate deionised water to remove all traces of the sample, which might otherwise block the nebuliser.

PLASMA SODIUM

Sample preparation
Prepare a 1:500 dilution of the plasma sample in deionised water.

Note: It is not necessary to remove proteins, also potassium and calcium do not interfere in the quantities present in plasma.

Reagents
1.0mg Na/100ml standard
Blank
Deionised water

Procedure
1. Set up the instrument with Na filter and adjust the flame as described in instruction manual.

2. Adjust the instrument to obtain 100 on the 1.0mg/100ml standard and zero reading on the blank as described above in the calibration section.

3. Aspirate sample and note the reading.

4. From the calibration curve previously prepared for sodium, read off the concentration equivalent to this reading.

5. To obtain mg Na/100ml of plasma, multiply this concentration by the dilution factor.

6. Aspirate deionised water to remove all traces of sample, which might otherwise block the nebuliser.

URINE POTASSIUM

Sample preparation
Prepare a 1:500 dilution of fresh urine in deionised water.

Note: Urine does not contain a sufficient concentration of any substance likely to interfere with potassium determination made with the Flame Photometer and true values may be obtained using fresh urine diluted only with deionised water.
Reagents
1.0mg K/100ml standard
Blank
Deionised water

Procedure
1. Set up the instrument with the K filter and adjust the flame as described in the instruction manual.

2. Adjust the instrument to obtain 100 on the 1.0mg/100ml standard and zero reading on the blank as described above in the calibration section.

3. Aspirate sample and note the reading.

4. From the calibration curve previously prepared for potassium, read off the concentration equivalent to this reading.

5. To obtain mg K/100ml of urine, multiply this concentration by the dilution factor.

6. Aspirate deionised water to remove all traces of the sample, which might otherwise block the nebuliser.

URINE SODIUM

Sample preparation
Prepare a 1:1000 dilution of fresh urine in deionised water.

Reagents
1.0mg K/100ml standard
Blank
Deionised water

Procedure
1. Set up the instrument with Na filter and adjust the flame as described in instruction manual.

2. Adjust the instrument to obtain 100 on the 1.0mg/100ml standard and zero reading on the blank as described above in the calibration section.

3. Aspirate sample and note the reading.

4. From the calibration curve previously prepared for sodium, read off the concentration equivalent to this reading.

5. To obtain mg Na/100ml of urine, multiply this concentration by the dilution factor.

6. Aspirate deionised water to remove all traces of sample, which might otherwise block the nebuliser.

PROCEDURE FOR USING HIGH AND LOW STANDARDS
As an alternative to using a calibration curve, it may be preferred to use two standards representing the upper and lower limits of normal concentration of the sample. For this technique it is necessary to prepare standards of suitable concentration to suit these normal limits, making allowance for the dilution factors employed on the sample.

When using these standards, the sensitivity may be adjusted to obtain any convenient reading on the high standard, whilst the zero reading is obtained on deionised water. The readings given by the low standard and by the sample are noted. It may be assumed that over the limited range represented by these two standards, the calibration curve will be linear. The concentration present in the sample may be worked out.
assuming such linearity between the standards. If we take $X$ as the sample, $L$ as the low standard and $H$ as the high standard, then:

$$\text{Conc } X = \text{Conc } L + \frac{(\text{Reading } X - \text{Reading } L) \times (\text{Conc } H - \text{Conc } L)}{(\text{Reading } H - \text{Reading } L)}$$

**MILLI-EQUIVALENTS**

Clinically it may be convenient to express the quantities of sodium and potassium in body fluids in terms of 'Milli-equivalents per litre' of sample.

Solutions containing 1 milli-equivalent sodium per litre would contain the atomic weight of sodium in milligrams (i.e. 23mg) per litre of solution.

Similarly for potassium, (atomic weight 39.1), 1 milli-equivalent per litre would contain 39.1mgK/litre solution.

Results obtained in terms of mg/100ml can, of course, be converted to milli-equivalent per litre, but by the use of standards of suitable concentration, the Flame Photometer may be arranged to read directly in milli-equivalent units.

Thus, if a potassium standard containing 9.8mg K/litre is used to read 100, the instrument will read over the range 0 - 0.25 milli-equivalent K/litre.

Similarly, a sodium solution containing 11.5mg Na/litre enables the instrument to be set to cover the range 0 – 0.5 milli-equivalents Na/litre.

In each case, of course, a calibration curve should be obtained using suitably diluted standards.

**REAGENTS**

In these methods, reagents are not mentioned, since it is not generally required to treat the samples in any way for these particular determinations.

If at any time, reagents are used in the preparation of samples, for example, if ashed material is taken up in acid and diluted, the same acid should be added to the standard solution and blank so that it is present in the same final concentration in the standard and blank as in the sample solution aspirated. This automatically allows for any variation in reading, which might otherwise result from the presence of the acid.