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Three Simple Methods for Quantitative Estimation of Sodium and Potassium in ORS by Flame Photometry

[1]Rupali S. Joshi[*], [2]Vaishnavi U.Rajpoot, [3]Chaitali L Raccha, [4]Sejal S Renavikar
[1]Assistant Professor, [2]Student, [3]Student, [4]Student
Dr.Vithalrao Vikhe Patil Foundation's College of Pharmacy, Vilad Ghat, Ahmednagar, (MS), India, 414111.

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ABSTRACT:
Three simple, rapid, and accurate methods for the estimation of sodium and potassium in two different formulation of ORS have been developed. First method is single point standardization involves the measurement of the flame intensity of a sample solution and of a standard solution of the reference substance. Second method is Double Point Standardization involves two-point bracketing standardisation of a standard solution of the reference substance which produces the result by matrix calculations. Third method is a calibration curve involve determining the concentration of a substance in sample by comparing to a set of standard samples of known concentration. The concentration of the substance in the sample is calculated from the proportional relationship that exists between flame intensity and concentration. The linearity for sodium and potassium is in the range of 0-100 µg/ml.
The suggested methods have been effectively implemented for estimation of sodium and potassium in commercial formulations of ORS. Accurate percentage yield indicate that all three methods are simple, rapid and accurate for the estimation of sodium and potassium in two different formulations of ORS.

KEYWORDS: sodium, potassium, single point standardization, Double Point Standardization, calibration curve method.

I. INTRODUCTION:

The flame photometer is based on the measurement of the emitted light intensity when a metal is introduced into the flame. The wavelength of the color gives information about the element and the color of the flame gives information about the amount of the element present in the sample.When sodium and potassium cations are present in a solution, the solvent evaporates, converting the ions to their atomic form. A small portion of the atoms are stimulated by the heat of flame. When excited atoms relax to a lower energy level, photons with a recognizable wavelength (Na: 589 nm, K: 766 nm) are also released.(1) The concentration of specific atoms in the flame determines the intensity.

Balance of fluid and electrolytes is essential for optimal health at any age. Dehydration corresponding with diarrhea, gastroenteritis, cholera and dysentery the body is lacking of water and electrolytes. Oral rehydration therapy (ORT) is a straightforward medical procedure that entails giving a patient a salt-and-sugar solution to refill their body's electrolyte and water levels. The main cat-ion present in extracellular fluid is sodium. It regulates the water content of the body .Similarly, Potassium is the major cat-ion found inside the cells. It is required for regulation of heart beat and function of the muscles. The Sodium and Potassium concentration of ORS must be sufficient to replace their loss and correct hyponatremia/ hypokalemia but not so high as to cause or worsen hypernatremia/hyperkalemia which can itself occasionally result in death.(2)
As a result, it is needed to find out concentration of sodium and potassium in the ORS formulation. So, this work reported a simple flame photometric approach for estimating concentration of sodium and potassium in ORS formulation.

II. EXPERIMENTAL

Materials

Flame Photometer, Systronic model 130 with sensitivity 1PPM, Sodium chloride and potassium chloride are used as a standard. The commercially available sachet of ORS- Sample A ELECTRAL (Manufactured by: FDC limited) and sample- B ZUVENTUS ORS (Manufactured by Zuventus Healthcare Ltd.) were procured from the local market. Distilled water is used as a solvent.

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Preparation of standard stock and calibration curve

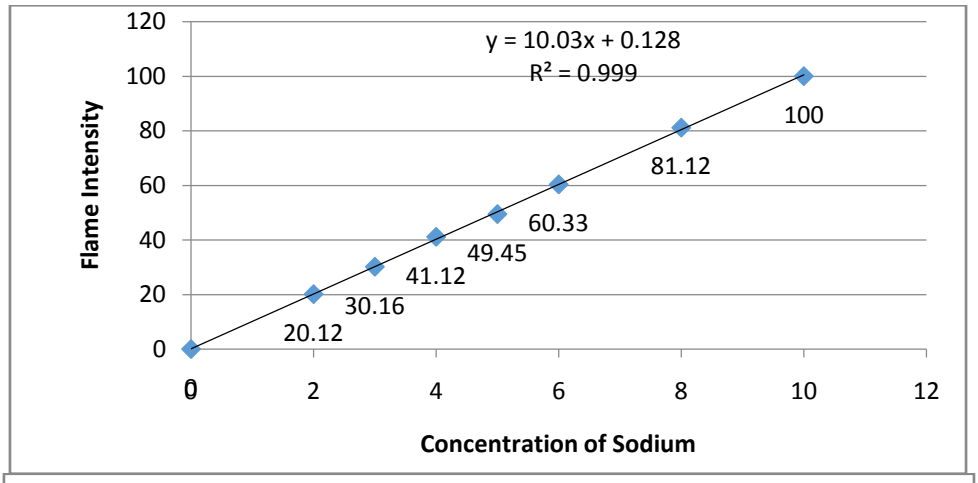
The standard stock solutions of Sodium chloride and potassium chloride were prepared by dissolving 10 mg of each powder in 100mL of distilled water in volumetric flask to get a solution containing 100 µg/mL of stock solution of each . Dilutions from stock solution were prepared in the range of 2-10 µg/ml.of each salt. Construct calibration curve graph of these aliquots.(3)

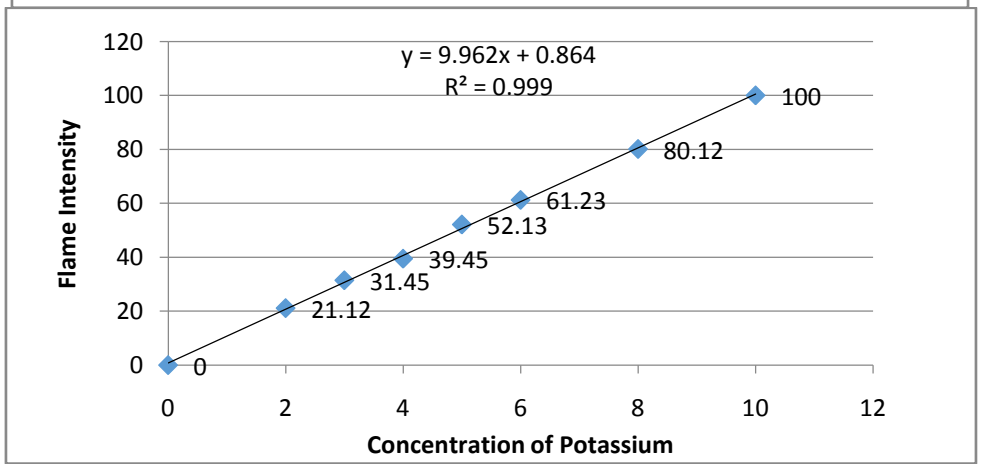
Characteristic emission color from alkali metals under the flame

Alkali metals	Characteristic wavelength	Flame color
Sodium	589 nm	Yellow color
Potassium	766 nm	Violet color

Flame intensity of standards sodium and potassium with different concentration

Sr No	Concentration µg/mL	Flame intensity	Concentration µg/mL	Flame intensity
	For sodium		For potassium	
1	2	20.12	2	21.12
2	3	30.16	3	31.45
3	4	41.12	4	39.45
4	5	49.45	5	52.13
5	6	60.33	6	61.23
6	8	80.12	8	80.12
7	10	100	10	100





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Preparation of sample solution.(4)

Powder equivalent to 10 mg of sodium of sample A and sample B were put into a 100 mL volumetric flask and dissolved in distilled water. Finally volume is adjusted with same solvent upto the 100 mL. From this sample stock solution prepared 2 and 4 µg/mL of sodium for sample A and sample B. Same procedure was repeated for potassium of sample A and sample B

Method I: Single point standardisation.(5)

The single-point procedure involves the measurement of the flame intensity of a sample solution and of a standard solution of the reference substance. The concentration of the sodium and potassium in the sample is calculated from the proportional relationship that exists between flame intensity and concentration.

$$\mathbf{C_{sap}} = \frac{\mathbf{FI_{sap}} \times \mathbf{C_{std}}}{\mathbf{FI_{std}}}$$

Where $\mathbf{FI_{sap}}$ and $\mathbf{FI_{std}}$ are the flame intensity of the sample and standard solutions respectively, and $\mathbf{C_{sap}}$ and $\mathbf{C_{std}}$ are the concentration of the sample and standard solutions respectively.

Analysis data of ORS formulation of sample A and sample B for method I

	Conc. µg/mL	**Flame intensity**	Conc.obtained **µg/mL**	% Obtained
For Sodium				
Sample A	2	20.46	2.33	101.68
	4	40.84	3.97	99.31
Sample B	2	20.30	2.17	100.89
	4	40.42	3.93	98.29
For Potassium				
Sample A	2	20.97	1.98	99.28
	4	40.03	4.05	101.47
Sample B	2	21.11	1.99	99.95
	4	40.27	4.08	102.07

Method II: Double point standardisation.

A two-point bracketing standardisation is used to determine the concentration of the sample solution. The concentration of the sodium and potassium in the sample solution is given by the equation

$$\mathbf{C_{sap}} = \frac{(\mathbf{FI_{sap}} - \mathbf{FI_{std1}})(\mathbf{C_{std1}} - \mathbf{C_{std2}}) + \mathbf{C_{std1}}(\mathbf{FI_{std1}} - \mathbf{FI_{std2}})}{\mathbf{FI_{std1}} - \mathbf{FI_{std2}}}$$

Where $\mathbf{FI_{sap}}$ and $\mathbf{FI_{std}}$ are the flame intensity of the sample and standard solutions respectively, and $\mathbf{C_{sap}}$ and $\mathbf{C_{std}}$ are the concentration of the sample and standard solutions respectively.

Analysis data of ORS formulation of sample A and sample B for method II

	Conc. µg/mL	**Flame intensity**	**Conc.obtained µg/mL**	**% Obtained**
For Sodium				
Sample A	4	40.84	4.06	101.52
Sample B	4	40.42	4.03	100.97
For Potassium				
Sample A	4	40.03	3.88	97.14
Sample B	4	40.27	3.90	97.74

Method III: Calibration Curve Method

A calibration curve is a method for determining the concentration of a sodium and potassium in sample by comparing the to a set of standard solutions of known concentration. The calibration curve is a plot of how the instrumental response, the so-called analytical signal, changes with the concentration of the analyte (the substance to be measured). For analyses a plot of flame intensity vs. concentration will show a linear

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relationship. Measure the response of the sample and, using the calibration curve, can interpolate to find the concentration of analyte. The data - the concentrations of the analyte and the instrument response for each standard - can be fit to a straight line, using linear regression analysis. This yields the equation $Y = mx + c$ where Y is the instrument response, m represents the sensitivity, and c is a constant that describes the background. The analyte concentration x of samples calculated from regression equation.(6)

Analysis data of ORS formulation of sample A and sample B for method III

	Conc. µg/mL	Flame intensity	Conc.obtained µg/mL	% Obtained
For Sodium				
Sample A	4	40.84	4.05	101.47
Sample B	4	40.42	4.01	100.42
For Potassium				
Sample A	4	40.03	3.93	98.30
Sample B	4	40.27	3.95	98.91

III. RESULTS AND DISCUSSION

The linearity range was found to be 0-10 µg/mL for sodium and potassium and coefficient of correlation was found 0.999 for both standards. Both standards showed good regression values at their respective concentration so that concentration of sodium and potassium in ORS formulation could be accurately determined by the proposed methods. Percentage estimation of sodium and potassium found in ORS formulation are ranges from 98.00 to and 102.00.in all three methods.

IV. CONCLUSION

The Flame photometric method is almost free of interferences from other elements as specific element filter is utilized. Therefore these are simple, rapid, and accurate methods for quantification of sodium and potassium in ORS formulation which can be used for routine analysis of ORS formulation.

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