

Determination and Quantification of Sodium and Potassium Levels in Brahmi (*Bacopa monnieri*) Extract by Flame Emission Spectroscopy

Preet Tyagi*, Satyam Rajput, Khushi Shrivastava, Sakshi Chaudhary, Aditya Vikram Jain, Preeti Yadav

Department of Pharmaceutical Analysis, Teerthanker Mahaveer College of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, INDIA.

ABSTRACT

Flame photometry is a sensitive technique for estimating alkali metals in pharmaceuticals and herbal extracts. It works on thermal excitation in a flame, causing desolvation, atomization, dissociation, and emission of light at characteristic wavelengths (589 nm for sodium and 766 nm for potassium). The emitted intensity is proportional to concentration. Calibration standards (200-600 µL) prepared from 1 g/L NaCl and KCl solutions showed non-linearity at higher concentrations due to self-absorption. The method effectively detected and quantified sodium and potassium in Brahmi extract. Potassium plays a key role in enhancing neuroprotective and nootropic effects by supporting neural signaling, muscle function, and electrolyte balance through Na/K ATPase activity. Sodium contributes to adaptogenic and antistress properties by maintaining fluid balance and proper nerve impulse transmission, supporting the overall pharmacological activity of Brahmi.

Keywords: Brahmi (*Bacopa monnieri*), Flame Spectrophotometer, Herbal Extract Quantification of Element.

Correspondence:

Preet Tyagi

Department of Pharmaceutical Analysis,
Teerthanker Mahaveer College of
Pharmacy, Teerthanker Mahaveer
University, Moradabad-244202,
Uttar Pradesh, INDIA.

Email: preet0903.tmu@gmail.com

ORCID: 0009-0009-7024-9438

Received: 05-06-2026;

Revised: 21-07-2026;

Accepted: 04-09-2026.

INTRODUCTION

Flame photometry is a rapid, cost-effective analytical chemistry method that uses a flame for the identification and quantification of particular metallic elements, mainly alkali and alkaline earth metals such as Na, K, Ca, and Li. The measurement of the light intensity released when a metal is added to a flame is the foundation of flame photometry (Khushal Tirele *et al.*, 2025). The colour's intensity indicates how much of the element is present, while the colour's wavelength indicates what the element is. The intensity of this light is measured by a detector and is proportional to the concentration of a specific element in that particular sample (Dadi and Yasir, 2022). It develops a distinct spectral fingerprint for both qualitative and quantitative analysis by utilizing the thermal energy of the flame to evaporate, atomise, and excite the metal atoms. These atoms subsequently release energy as light, and then they return to their stable ground state (Bhupathyaaj *et al.*, 2024; Ramírez-Muñoz, 1966).

Atoms are stimulated by the heat energy when a sample is placed in a flame; when these atoms return to their ground state, they emit radiation at various wavelengths (for example, 589 nm for Na and 766 nm for K). The concentration of the element in the sample is directly proportional to the intensity of this radiation (Garcia *et al.*, 2018). The primary cations in intracellular and extracellular fluids are potassium and sodium, respectively. Sodium is essential for blood volume, body fluids, heart function, and neural impulse transmission. Potassium is necessary for maintaining membrane potential via the Na⁺/K⁺ ATPase pump. The primary cation present in cells is potassium (K) (Udensi and Tchounwou, 2017). Normal cell function depends on the right amount of potassium. Potassium levels that are too high (hyperkalaemia) or low (hypokalaemia) can have a significant impact on the heart and neurological system and, in severe cases, be lethal. 3.5 to 5.0 millimoles/litre (mmol/l) is the typical range for blood potassium levels. The primary extracellular cation, sodium (Na), is involved in the transport of bodily fluids. The extracellular sodium ion concentration in plasma is 130-145 mmol/l. Hyponatremia and hypernatremia are terms used to describe higher and lower amounts, respectively (Fan *et al.*, 2024). The solvent evaporates, and the ions are transformed into atomic states when a solution containing sodium and potassium cations is exposed to a flame. A tiny percentage of the atoms are energized by the flame's heat, which is approximately 1800°C. Light (photons) with distinctive wavelengths (Na: 589



DOI: 10.5530/ijpi.20270180

Copyright Information :

Copyright Author (s) 2027 Distributed under
Creative Commons CC-BY 4.0

Publishing Partner : Manuscript Technomedia, [www.mstechnomedia.com]

nm, K: 766 nm) is released as the excited atoms relax to a lower energy level. The concentration of specific atoms in the flame determines the light's intensity (Contreras *et al.*, 2024). For diseases like hyponatremia, hypernatremia, and hypokalaemia, precise monitoring of these ions is an essential diagnostic tool. Determining these levels in plant tissue is important to studies on salt tolerance in agriculture Davis and Overman, 1947. The Application of Flame Photometry to Sodium and potassium Determinations in Biological Fluids. Fed Proc 1947;6:94. [https://doi.org/10.1016/S00219258\(17\)30923-7](https://doi.org/10.1016/S00219258(17)30923-7).-Google Search, n.d.). The Indian Ayurvedic medical system makes extensive use of Brahmi (*Bacopa monnieri*), which is thought to be advantageous as a health supplement and for strengthening the immune system. The significant phytochemistry, therapeutic benefits, and clinical assessment of *Bacopa monnieri* (BM) are covered in this article. Since the Brahmi herb has been used for thousands of years to treat both minor and chronic illnesses, India has become a major player in Ayurvedic, Siddha, and Unani medicine. The plant is marketed commercially in India under the name Brahmi, which is derived from Brahma, the Hindu pantheon's fabled creator. Brahmi possesses anti-epileptic, wound-healing, anti-cancer, anti-anxiety, and brain-healing properties (Sendri and Bhandari, 2023). A patient's energy and mood can be improved, and stress, anxiety, and depression can be decreased by taking Brahmi every day for two months. Southern and eastern India, Australia, Europe, Africa, Asia, North and South America, and Sri Lanka are among the regions where *Bacopa monnieri* is grown. Brahmi synonyms include Indian pennywort, thyme-leafed gracile, hyssop, Brahmi, and plant of grace. The majority of *Bacopa monnieri* trials used assessment instruments that weren't always comparable to identify healthy and unwell individuals from various diagnostic and symptom groups. The Ayurvedic system uses the medicinal plant *Bacopa monnieri* to enhance brain

growth and memory. Each brahmi extract contains five distinct compounds: bacopaside A, bacopaside B, bacopaside C isomer, and bacopa saponin C. Bacopa saponin-I was identified using the HPLC method. When given to animals, several *Bacopa monnieri* extracts have demonstrated beneficial effects on cognition in preclinical research. Research on animal behaviour has demonstrated that giving *Bacopa monnieri* to animals enhances their motor abilities (Stough *et al.*, 2001).

Brahmi (*Bacopa monnieri*), a significant Ayurvedic plant, contains minerals including Potassium (K) and Sodium (Na) that have nootropic, neuroprotective, and adaptogenic qualities. Flame photometry, which uses distinctive emissions from thermal excitation (589 nm Na, 766 nm K) to correlate intensity with concentration, is used to quantify them. Through NaK ATPase activity, Brahmi's high K (up to 45,000 µg/g) and varied Na (239-926 µg/g) support electrolyte balance, brain signalling, and enhanced cognition. Potassium aids in muscular relaxation and has anti-stress properties, whereas sodium supports neuronal transmission and fluid balance. This study validates flame photometry for standardized Brahmi extracts in pharmaceutical research, therefore connecting minerals to medicinal efficacy

Events occur in Flame Emission Spectroscopy

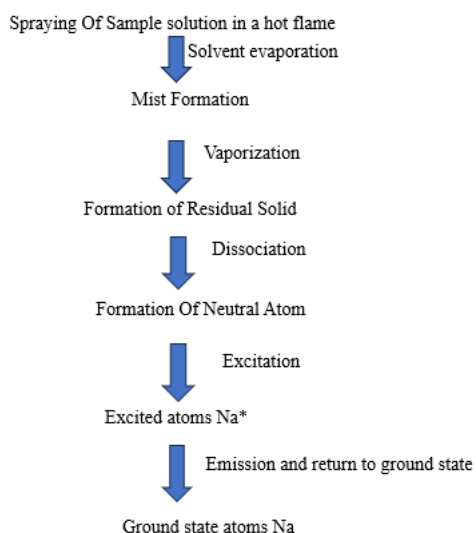


Figure 1: Principle of Flame spectrophotometer.



Figure 2: Flame Photometer.



Figure 3: Determination of the extraction process of Brahmi.

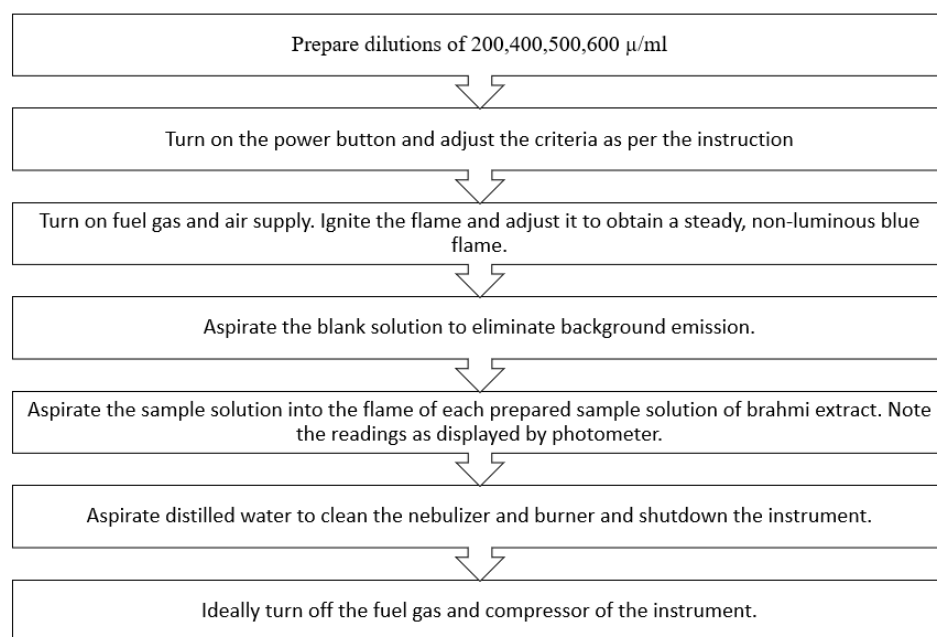


Figure 4: Process of Experiment.

(Ayilara and Owoyele, 2025; Lopresti and Smith, 2025; Mishra *et al.*, 2018).

Instrumentation

The instrument used in the study was a set of flame spectrophotometer models: 672, serial no. 2024-12-561 [Labtronic microcontroller flame photometer] shown in Figure 2, and an air compressor. The instrument consists of the following: Nebulizer and Mixing Chamber (converts the liquid sample into a fine spray aerosol and mixes it with fuel and oxidant for steady introduction into the flame); Flame Atomizer/Burner (provides a constant temperature flame to desolvate, vaporize, and atomize the sample); Optical system (isolates the specific wavelength of light emitted by the target element while eliminating background radiation); Photodetector (detects the emitted light and converts the intensity into an electrical signal); Readout Device/Amplifier (amplifies the electrical signal and displays the result, often on a digital display) Figures 1 and 2 (Fernández-Sánchez *et al.*, 2019; MacIntyre, 1961).

Fundamentals of Flame Photometry

The fundamental idea behind flame photometry is the use of thermal energy to excite atoms. A number of intricate physical and chemical processes take place when a solution containing metallic salts is inhaled into a burner.

Desolvation and volatilization

Solid salt particles are left behind when the solvent evaporates and transforms into a gaseous state.

Atomization and dissociation

The gaseous molecules split into free ground-state atoms (Khushal Tirele *et al.*, 2025).

Excitation

Electrons in these atoms move to higher energy levels due to thermal energy from the flame, which is created when gases like natural gas or acetylene are burned with air or oxygen.

The energy collected by these unstable excited atoms is released as electromagnetic radiation, or light, as they settle down to their lower-energy ground state (Garcia *et al.*, 2018).

MATERIALS AND METHODS

Methods

Extraction Process

Soak powdered plant material (such as 100-200 g) in 0.01-0.05 M NaOH (1:4-1:10 w/v). For 15 to 90 min at room temperature (Eubank and Bogue, 1949).

After neutralizing with HCl, centrifuge to remove the supernatant, resuspend the sediment in water, and separate the starch granules using a sieve or filter.

Dry the starch at a low temperature; higher temperatures and lower alkali concentrations result in higher yields Shown in Figure 3 (Liu and Kuo, 2016).

Sample preparation

For analysis, accurately weigh 1 g of brahmi extract and transfer it into a 1-L (stock solution) volumetric flask with water. From

Table 1: Observation of Na/K in ppm.

Volume of Extract (µg/ mL)	Flame Intensity	
	Na	K
200 µg	60 ppm	57.7 ppm
400 µg	91.5 ppm	63.1 ppm
500 µg	177 ppm	135 ppm
600 µg	163 ppm	172 ppm

Table 2: Observation table of Na/K in mg.

Volume of Extract (µ/ mL)	Flame Intensity	
	Na	K
200 µg	0.06 mg	0.0577 mg
400 µg	0.0915 mg	0.0631 mg
500 µg	0.177 mg	0.135 mg
600 µg	0.163 mg	0.172 mg

Conversion Rule: mg/g = ppm/1000.

a 1 mg/mL stock solution of brahmi extract, pipette out 2 mL, 4 mL, 5 mL, and 6 mL of extract into a 10 mL volumetric flask consecutively and make up the volume with distilled water. A series of sample solutions ranging from 200 to 600 µ/mL was prepared (Asch *et al.*, 2022; Nayak *et al.*, 2022; Sharma and Tejinder, 2014).

Chemicals

The materials used in the study were procured: Brahmi (*Bacopa monnieri*) from Shantikunj, Haridwar; NaOH (Sodium Hydroxide) from CDH (Central Drug House P. Ltd.), HCl (Hydrochloric Acid) Rankem.

RESULTS

Using a Labtronics LT-672 flame photometer, the experiment assessed the flame intensities for sodium (Na) and potassium (K) standards at concentrations of 200, 400, 500, and 600 µg/mL. Both elements showed non-linear increases in flame intensities with concentration: Na measurements were 60 ppm (0.06 mg), 91.5 ppm (0.09156 mg), 177 ppm (0.177 mg), and 163 ppm (0.163 mg), while K readings were 57.7 ppm (0.0577 mg), 63.1 ppm (0.0631 mg), 135 ppm (0.135 mg), and 172 ppm (0.172 mg) in brahmi extract shown in Tables 1 and 2.

DISCUSSION

The study demonstrates the efficacy of flame emission spectroscopy in quantifying Na and K in Brahmi (*Bacopa monnieri*) extract: Na (60, 91.5, 177, and 163 ppm) and K (57.7, 63.1, 135, and 172 ppm) via Labtronics LT-672 Shown in Figure 4 at 589 nm (Na) and 766 nm (K). Sensitivity is made possible by thermal processes like atomization and desolvation, yet self-absorption results in high concentration aberrations like Na's fall. A strong method for reliable herbal analysis includes blanks,

flame stabilization, NaCl/KCl standards, and precise dilutions. Pharmacologically, K increases nootropic effects through Na-K ATPase, neural signaling, and muscular function, whereas Na promotes adaptogenic advantages through fluid balance and nerve transmission. Despite the validation of Ayurvedic standards, there are still issues such as non-linearity, redundant needs, and missing Brahmi-specific ppm; better calibration can boost pharmaceutical accuracy.

CONCLUSION

Flame emission spectroscopy is a rapid and cost-effective method for quantifying sodium and potassium in Brahmi extract. The observed elemental levels support the plant's pharmacological relevance and potential neurological benefits.

ACKNOWLEDGEMENT

The author(s) thank to their institution for providing necessary facilities and support for this research work.

ABBREVIATIONS

BM: *Bacopa monnieri*; **HCl:** Hydrochloric Acid; **K:** Potassium; **Na:** Sodium; **NaOH:** Sodium Hydroxide; **PPM:** Parts per million.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

FUNDING DETAILS

The author(s) reported that there is no funding associated with the work featured in this article.

AUTHORS CONTRIBUTION

PT, SR, KS and SC: Conducted experiments and data collection. **PT:** Drafted the manuscript. **AVJ and PY:** Supervised the work and reviewed the manuscript. All authors approved the final version.

REFERENCES

- Asch, J., Johnson, K., Mondal, S., & Asch, F. (2022). Comprehensive assessment of extraction methods for plant tissue samples for determining sodium and potassium via flame photometer and chloride via automated flow analysis. *Journal of Plant Nutrition and Soil Science*, 185(2), 308-316. <https://doi.org/10.1002/jpln.202100344>
- Ayilara, G. O., & Owoyele, B. V. (2025). Effectiveness of *Bacopa monnieri* (Brahmi) in the management of schizophrenia: a systematic review. *Nutritional Neuroscience*, 28(7), 788-795. <https://doi.org/10.1080/1028415X.2024.2421782>
- Bhupathyaaraj, M., Salty, S. S. R. Al, Al-Ghazali, M., & Halligudi, N. (2024). Analysis of Sodium Levels in Different Brands of Edible Salts by Flame Photometer. *International Journal of Nutrition, Pharmacology, Neurological Diseases*, 14(1), 72-79. https://doi.org/10.4103/ijnpnd.ijnpnd_67_23
- Contreras, R. G., Torres-Carrillo, A., Flores-Maldonado, C., Shoshani, L., & Ponce, A. (2024). Na⁺/K⁺-ATPase: More than an Electrogenic Pump. *International Journal of Molecular Sciences*, 25(11), 6122. <https://doi.org/10.3390/ijms25116122>
- Dadi, M., & Yasir, M. (2022). Spectroscopy and Spectrophotometry: Principles and Applications for Colorimetric and Related Other Analysis. *Colorimetry*. <https://doi.org/10.5772/INTECHOPEN.101106>
- Davis AK, Overman RR. (1947). The application of flame photometry to sodium and potassium determinations in biological fluids. *Federal Proceeding*, 6, 94. [https://doi.org/10.1016/s00219258\(17\)30923-7](https://doi.org/10.1016/s00219258(17)30923-7).

- Eubank, W. R., & Bogue, R. H. (1949). Studies on the flame photometer for the determination of Na₂O and K₂O in portland cement. *Journal of Research of the National Bureau of Standards*, 43(2), 173. <https://doi.org/10.6028/jres.043.020>
- Fan, Y., Wu, M., Li, X., Zhao, J., Shi, J., Ding, L., *et al.* (2024). Potassium levels and the risk of all-cause and cardiovascular mortality among patients with cardiovascular diseases: a meta-analysis of cohort studies. *Nutrition Journal*, 23(1), 8. <https://doi.org/10.1186/S12937-023-00888-Z>
- Fernández-Sánchez, M. L., Fernández-Arguelles, M. T., & Costa-Fernández, J. M. (2019). Atomic emission spectrometry | flame photometry. *Encyclopedia of Analytical Science*, 160-168. <https://doi.org/10.1016/B978-0-12-409547-2.14533-0>
- García, R. A., Vanelli, C. P., Pereira Junior, O. dos S., & Corrêa, J. O. do A. (2018). Comparative analysis for strength serum sodium and potassium in three different methods: Flame photometry, ion-selective electrode (ISE) and colorimetric enzymatic. *Journal of Clinical Laboratory Analysis*, 32(9), e22594. <https://doi.org/10.1002/jcla.22594>
- Khushal Tirele, R. B. T. N., Tirele, K., Bhagat, R., & Nimbekar, T. (2025). Application of Flame Photometry in the Detection of Main Group Metals (Na, K, Li & Ca) in Pharmaceutical Industry. *International Journal of Pharmaceutical Sciences*, 03(12), 2667-2680. <https://doi.org/10.5281/ZENODO.17959128>
- Liu, H. H., & Kuo, M. I. (2016). Ultra high pressure homogenization effect on the proteins in soy flour. *Food Hydrocolloids*, 52, 741-748. <https://doi.org/10.1016/j.foodhyd.2015.08.018>
- Lopresti, A. L., & Smith, S. J. (2025). The Effects of a *Bacopa monnieri* Extract (Bacumen®) on Cognition, Stress, and Fatigue in Healthy Adults: A Randomized, Double-Blind, Placebo-Controlled Trial. *Clinical Drug Investigation*, 45(12), 967-982. <https://doi.org/10.1007/s40261-025-01492-1>
- MacIntyre, I. (1961). Flame Photometry. *Advances in Clinical Chemistry*, 4(C), 1-28. [https://doi.org/10.1016/S0065-2423\(08\)60033-5](https://doi.org/10.1016/S0065-2423(08)60033-5)
- Mishra, A., Mishra, A. K., & Jha, S. (2018). Effect of traditional medicine brahmi vati and bacoside A-rich fraction of *Bacopa monnieri* on acute pentylentetrazole-induced seizures, amphetamine-induced model of schizophrenia, and scopolamine-induced memory loss in laboratory animals. *Epilepsy and Behavior*, 80, 144-151. <https://doi.org/10.1016/j.yebeh.2017.12.040>
- Nayak, P., Rayaguru, K., Brahma, S., Routray, W., & Dash, S. K. (2022). Standardization of process protocol for isolation of starch from mango kernel and its characterization. *Journal of the Science of Food and Agriculture*, 102(7), 2813-2825. <https://doi.org/10.1002/jsfa.11622>
- Ramírez-Muñoz, J. (1966). Qualitative and quantitative sensitivity in flame photometry. *Talanta*, 13(1), 87-101. [https://doi.org/10.1016/0039-9140\(66\)80129-7](https://doi.org/10.1016/0039-9140(66)80129-7)
- Sendri, N., & Bhandari, P. (2023). *Bacopa monnieri*. Herbs, Spices and Their Roles in Nutraceuticals and Functional Foods, 111-131. <https://doi.org/10.1016/B978-0-323-90794-1.00005-3>
- Sharma, P., & Tejinder, S. (2014). Extraction of starch from hulled and hull-less barley with papain and aqueous sodium hydroxide. *Journal of Food Science and Technology*, 51(12), 3870-3877. <https://doi.org/10.1007/s13197-013-0924-z>
- Stough, C., Lloyd, J., Clarke, J., Downey, L., Hutchison, C., Rodgers, T., & Nathan, P. J. (2001). The chronic effects of an extract of *Bacopa monnieri* (Brahmi) on cognitive function in healthy human subjects. *Psychopharmacology*, 156(4), 481-484. <https://doi.org/10.1007/s002130100815>
- Udensi, U. K., & Tchounwou, P. B. (2017). Potassium Homeostasis, Oxidative Stress, and Human Disease. *International Journal of Clinical and Experimental Physiology*, 4(3), 111. https://doi.org/10.4103/IJCEP.IJCEP_43_17

Cite this article: Tyagi P, Rajput S, Shrivastava K, Chaudhary S, Jain AV, Yadav P. Determination and Quantification of Sodium and Potassium Levels in Brahmi (*Bacopa monnieri*) Extract by Flame Emission Spectroscopy. *Int. J. Pharm. Investigation*. 2027;17(1):150-4.