INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Research Article

Green And Efficient Estimation of Ibuprofen Via Mixed Hydrotropy Approach

T. Motwani*[1], A. Mali[2]

[1]*Daly College ,1, Residency Area, Indore, Madhya Pradesh 452001 (M.P.)*
[2]*Department of Pharmacy, Shri G.S. Institute of Technology and Science, 23, Park Road Indore (M.P.) 452003.*

ARTICLE INFO

Published: 26 Nov 2025
Keywords:
Mixed Hydrotropy, Ibuprofen, Titrimetry, Solubility Enhancement
DOI:
10.5281/zenodo.17723506

ABSTRACT

In the present investigation, ibuprofen, a commonly used non-steroidal anti-inflammatory drug (NSAID), was selected as a model compound to explore solubility enhancement through the hydrotropy technique. A synergistic blend of hydrotropic agents comprising 15% sodium salicylate, 5% niacinamide, 5% sodium citrate, and 5% sodium acetate was employed for this purpose. The mixed hydrotropic system demonstrated a remarkable increase in solubility, exhibiting more than a forty-fold enhancement compared to the solubility of ibuprofen in distilled water. This significant improvement confirms the potential of hydrotropic combinations as an efficient and environmentally safer alternative to conventional solubilization methods. Furthermore, the hydrotropy assisted solubilization was effectively utilized in the titrimetric estimation of ibuprofen, eliminating the requirement for organic solvents that are often hazardous, expensive, and environmentally unfriendly. The analytical results obtained using the proposed method were in excellent agreement with those reported in the Indian Pharmacopoeia, confirming the accuracy and reliability of the developed approach. Importantly, the presence of the hydrotropic agents did not interfere with the analytical procedure, ensuring the precision of the estimation. Overall, the study demonstrates that the mixed hydrotropic system provides a simple, safe, economical, and eco-friendly method for enhancing the solubility and analytical determination of poorly water-soluble drugs like ibuprofen, potentially extending its application to other BCS Class II drugs.

INTRODUCTION

Ibuprofen is one of the most commonly used non-steroidal anti-inflammatory drugs (NSAIDs) due to its analgesic, antipyretic, and anti-inflammatory effect[1]. Despite its therapeutic benefits, ibuprofen's poor solubility,[2] in water poses challenges for both formulation development and

***Corresponding Author:** T. Motwani
Address: *Daly College ,1, Residency Area, Indore, Madhya Pradesh 452001 (M.P.).*
Email ✉: anandmali543@gmail.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

accurate analytical estimation. Traditional methods to improve solubility often rely on organic solvents such as methanol, ethanol, chloroform, or acetone However, these solvents are associated with several disadvantages, including toxicity, high cost, and environmental concerns[3]. In response to these issues, the field of green analytical chemistry has gained importance, emphasizing safer, more sustainable methods that minimize or eliminate the use of hazardous chemicals[4].

Hydrotropy[5] has emerged as a promising strategy to enhance the solubility of poorly water-soluble drugs.[6] This approach involves the use of hydrotropic agents[7], which are typically organic salts or compounds capable of increasing solubility through molecular interactions without altering the chemical structure of the drug[8]. The concept of **mixed hydrotropy** [9-11] where multiple hydrotropic agents are combined, has shown a synergistic effect[12], further improving solubility[13] while reducing the quantity of individual agents required[6].

Titrimetric analysis provides a straightforward and cost-effective method for quantitatively determining the purity and content of the active pharmaceutical ingredient Ibuprofen[14], [15, 16]. The process involves dissolving a precisely weighed sample of powdered Ibuprofen tablets in a neutral, organic solvent like ethanol or methanol, since Ibuprofen is largely insoluble in water[17].

In this study, ibuprofen was chosen as a model drug to investigate solubility enhancement and quantitative determination using a mixed hydrotropic system[11, 18, 19]. The goal is to develop a **simple, cost-effective, and environmentally friendly analytical method**[18] that avoids the use of toxic organic solvents[18], thereby aligning with green chemistry principles and promoting sustainable practices in pharmaceutical analysis[8, 20-23].

MATERIALS AND METHODS

MATERIALS

Ibuprofen drug sample and solvents employed in this analysis were taken for analysis from Schon Pharmaceutical Limited, Indore.

METHOD

Preparation Of Mixed Hydrotropic Solution

15 g of Sodium Salicylate, 5 g of Niacinamide, 5 g of Sodium Citrate and 5 g of Sodium Acetate were transferred in a 100 ml volumetric flask and about 60 ml of the distilled water was added. Flask was shaken sufficiently to get clear solution, then volume was made up to 100 ml with distilled water to get the mixed hydrotropic blend.

Solubility Studies of Ibuprofen

The solubility of Ibuprofen in the hydrotropic blend was determined at 28 ± 1 °C. An excess amount of ibuprofen was added to a screw-capped 30 mL glass vial containing the mixed hydrotropic blend solution. The vial was mechanically shaken for 12 hours at 28 ± 1 °C in an orbital flask shaker (Khera Instruments Pvt. Ltd., Indore). After sealing the vial with a rubber closure and an aluminium cap to ensure an airtight fit, it was kept undisturbed for 24 hours. The solution was then centrifuged for 5 minutes at 2000 rpm (Remi, India). The supernatant liquid was filtered through Whatman filter paper No. 41, and the filtrate was analysed titrimetrically to determine the solubility[24].

Analysis Of Ibuprofen Drug Sample by Indian Pharmacopoeial Method

400 mg Ibuprofen drug was weighed accurately and transferred in a conical flask. 100 ml of ethanol (95%) was taken in another conical flask and few drops of phenolphthalein indicator were added. Clear colourless solutions was obtained. Then 0.1N NaOH solution was added one drop at a time and flak was shaken. Addition of 0.1 N NaoH was continued to get just pink colour. Now, this is phenolphthalein neutralized ethanol. Then this ethanol was transferred to conical flask containing the Ibuprofen drug and flask was shaken to get clear solution. Then titration was perform adding the 0.1 N NaOH from burette. Same procedure was repeated two times more[25].

Analysis Of Ibuprofen Drug by Proposed Method Using Mixed Hydrotropic Blend Solution.

100 ml of mixed hydrotropic blend solution was transferred in a conical flask and few drops of phenolphthalein indicator solution were added remained colourless . Drop by drop 0.1 N NaOH was added to get just pink colour. Then , 400 mg ibuprofen drug sample was transferred in the conical flask and the flask was shaken to get clear solution . Then, titration was performed adding 0.1 N NaOH from burette same procedure was repeated two more times.

RESULT AND DISCUSSION

Percent drug estimation by the proposed method was found to be 97.48 and 98.56% by Indian Pharmacopeial method. Result from the solubility studies as evident from experiment showed that enhancement in solubility by utilization of ibuprofen by more than 40-fold. And the results from the proposed analysis method are comparable with the Indian pharmacopoeia method. The validation of proposed method is further confirmed statically by low values of standard deviation percent coefficient of variation and standard error.

Table 1- Analysis Data of Ibuprofen Bulk Drug Sample

Amount Of Drug Taken (Mg)	Amount Found (Mg)		Percentage Estimated	
	IPM	PM	IPM	PM
400 mg	390.62	389.21	97.66	97.48
400 mg	393.57	399.92	98.39	99.80
400 mg	398.77	394.76	99.69	98.69

Table 2 – Statistical Evaluation of Analysis

Method	Mean Percent Estimated	Standard Deviation	% Cofficient Of Variation	Standard Error
IPM	98.56	1.0285	1.043	0.593
PM	98.66	1.1603	1.118	0.662

CONCLUSION

The present work establishes that hydrotropic agents can serve as reliable and environmentally friendly substitute for conventional methods in the titrimetric estimation of ibuprofen. By significantly improving the solubility of ibuprofen in aqueous medium and eliminating the dependence on organic solvents, the hydrotropic technique provides a straightforward, precise, and economical option for routine pharmaceutical analysis. Definitely there is further scope of hydrotropic solubilizing agent for titrimetric analysis of ibuprofen without the use of organic solvents.

REFERENCES

1. Singh S, Dash UN, Talukdar M. Solubility enhancement and study of molecular interactions of poorly soluble ibuprofen in presence of urea, a hydrotropic agent. Materials Today: Proceedings. 2020;30:246–53.
2. Janus E, Ossowicz P, Klebeko J, Nowak A, Duchnik W, Kucharski Ł, et al. Enhancement of ibuprofen solubility and skin permeation by conjugation with l-valine alkyl esters. RSC advances. 2020;10(13):7570–84.
3. Jouyban A, Soltanpour S, Acree Jr WE. Solubility of acetaminophen and ibuprofen in the mixtures of polyethylene glycol 200 or 400 with ethanol and water and the density of solute-free mixed solvents at 298.2 K. Journal of Chemical & Engineering Data. 2010;55(11):5252–7.
4. Doumtsi A, Manousi N, Karavasili C, Fatouros DG, Tzanavaras PD, Zacharis CK. A simple and green liquid chromatography method for the determination of ibuprofen in milk-containing simulated gastrointestinal media for monitoring the dissolution studies of three-dimensional-printed formulations. J Sep Sci. 2022;45(21):3955–65.
5. Namdev B, Venkatachalam S, Jawahar N, Chorsiya A. A brief review on solubility enhancement technique: hydrotropy. Indian J Pharm Educ Res. 2022;56(2):347–55.
6. Shukla RS, Patel A, Soni M, Modi V, Jaliwala Y. Quantitative spectrophotometric estimation of cefadroxil using hydrotropic solubilization technique. Asian Journal of Pharmaceutics (AJP). 2008;2(3).
7. Kunz W, Holmberg K, Zemb T. Hydrotropes. Current Opinion in Colloid & Interface Science. 2016;22:99–107.
8. Maheshwari R, Wanare G, Chahar N, Joshi P, Nayak N. Quantitative estimation of naproxen in tablets using ibuprofen sodium as hydrotropic agent. Indian journal of pharmaceutical sciences. 2009;71(3):335.
9. Madan JR, Pawar KT, Dua K. Solubility enhancement studies on lurasidone hydrochloride using mixed hydrotropy. International journal of pharmaceutical investigation. 2015;5(2):114.
10. Abdullah Ali H, Kamal Omer H. Solubility Enhancement of a Poorly Water‐Soluble Drug Using Hydrotropy and Mixed Hydrotropy‐Based Solid Dispersion Techniques. Advances in Pharmacological and Pharmaceutical Sciences. 2022;2022(1):7161660.
11. Nair V, Rajput MS. A simple spectrophotometric estimation of Ketoprofen in tablets using mixed hydrotropy. Der Pharma Chemica. 2010;2(2):267–71.
12. Maheshwari R, Chaturvedi S, Jain N. Novel application of hydrotropic solubilization in the analysis of some NSAIDs and their solid dosage forms. Indian journal of pharmaceutical sciences. 2007;69(1):101–6.
13. El Hamd MA, El-Maghrabey MH, Almawash S, El-Shaheny RN. Green Hydrotropic Technology as a Convenient Tool for the Handling of Poor Water-Soluble Candidates Proceeding Their Economic Analytical Measurements. In: El-Maghrabey MH, Sivasankar V, El-Shaheny RN, editors. Green Chemical Analysis and Sample Preparations: Procedures, Instrumentation, Data Metrics, and Sustainability. Cham: Springer International Publishing; 2022. p. 265–309.
14. Caffrey AR, Borrelli EP. The art and science of drug titration. Therapeutic advances in drug safety. 2020;11:2042098620958910.
15. Skoog DA, West, D. M., Holler, F. J., & Crouch, S. R. (2014). Fundamentals of Analytical Chemistry (9th ed.). Cengage.

16. Maheshwari R, Saxena M, Gahlot M, Chaki R, Kinariwala M, Jagwani Y. Novel application of hydrotropic solubilizing additives in the estimation of aspirin in tablets. Indian journal of Pharmaceutical sciences. 2010;72(5):649.
17. Dwivedi S, Sattari S, Jamali F, Mitchell A. Ibuprofen racemate and enantiomers: phase diagram, solubility and thermodynamic studies. International journal of pharmaceutics. 1992;87(1-3):95–104.
18. Sharma S, Sharma R, Koka SS, Darwhekar G. A Review:"Hydrotropy" Techniques to increase the solubility of Drug. J Pharm Negat Results. 2023;14:1611–8.
19. Kitak T, Dumičić A, Planinšek O, Šibanc R, Srčič S. Determination of solubility parameters of ibuprofen and ibuprofen lysinate. Molecules. 2015;20(12):21549–68.
20. Kuldeep J, Patel A, Patel S, Dwivedi NK. FORMULATION OF LIQUISOLID SYSTEM OF A POORLY SOLUBLE DRUG. 2019.
21. Soni S. Novel Application of Solubilizing Properties of Solids (Mixed Solvency Concept) for Extraction of Active Constituents from Herbal Drug Powder and Formulation and Evaluation of Topical Oily Solution of Curcumin Extract. Asian Journal of Pharmaceutics (AJP). 2022;16(4).
22. Sen A, Patel A, Patel S, Dwivedi N. Formulation And Evaluation Of Dry Suspension Of Ornidazole As Parenterals. 2019.
23. Joshi DR, Adhikari N. An overview on common organic solvents and their toxicity. J Pharm Res Int. 2019;28(3):1–18.
24. Hansen CM. Solubility parameters. Hansen Solubility Parameters: A User's Handbook. 2012.
25. commision Ip. Indian pharmacopoeia 8th ed. Gazhiabad: Indian pharmacopoeia commission; 2018.

HOW TO CITE: T. Motwani*, A. Mali, Green and Efficient Estimation of Ibuprofen Via Mixed Hydrotropy Approach, Int. J. of Pharm. Sci., 2025, Vol 3, Issue 11, 4186-4190 https://doi.org/10.5281/zenodo.17723506