



Research Note

Dielectric analysis of novel bipodal and tripodal piperidin-4-ones

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KEYWORDS

Bipodal piperidin-4-ones;
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 Dielectric analysis.

Abstract. Novel bipodal, tripodal piperidin-4-ones and their corresponding piperidin-4-ols were subjected to dielectric analysis, which signifies drug delivery. The studies reveal that these compounds can exhibit better drug release in association with polymer.

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1. Introduction

Advances in organic chemistry are usually measured by the availability of simple, highly functionalized building blocks that can be used in the synthesis of larger molecules with diverse properties and applications [1]. The synthesis of *N*-substituted-4-piperidones has been a subject of continuing interest, due to its importance as a synthetic building block in medicinal chemistry, which expands its scope as a synthetic intermediate enroute to a considerable number of pharmacological agents [2,3]. Many CNS agents, such as antidepressants, anxiolytics and antipsychotics, possess 4-piperidone pharmacophore [4,5]. The piperidine ring is a ubiquitous structural feature of many natural alkaloids and drug candidates, where piperidones serves as advanced intermediates prior to their conversion to piperidines. In continuation of our interest in 4-piperidone moieties [6-11], we recently reported the synthesis of bipodal and tripodal piperidin-4-ones (**1-5**) and their corresponding piperidin-4-ols in the literature [12], which involves direct alkylation/acylation of the respective benzyl and benzoyl halides with 4-

piperidone under mild basic conditions. In continuation of our earlier work, herein, we report the dielectric analysis of those compounds which signifies drug delivery [13].

2. Experimental

2.1. Chemistry

The bipodal and tripodal piperidin-4-ones **1-5** were synthesised according to Scheme 1 using the method available in literature [12].

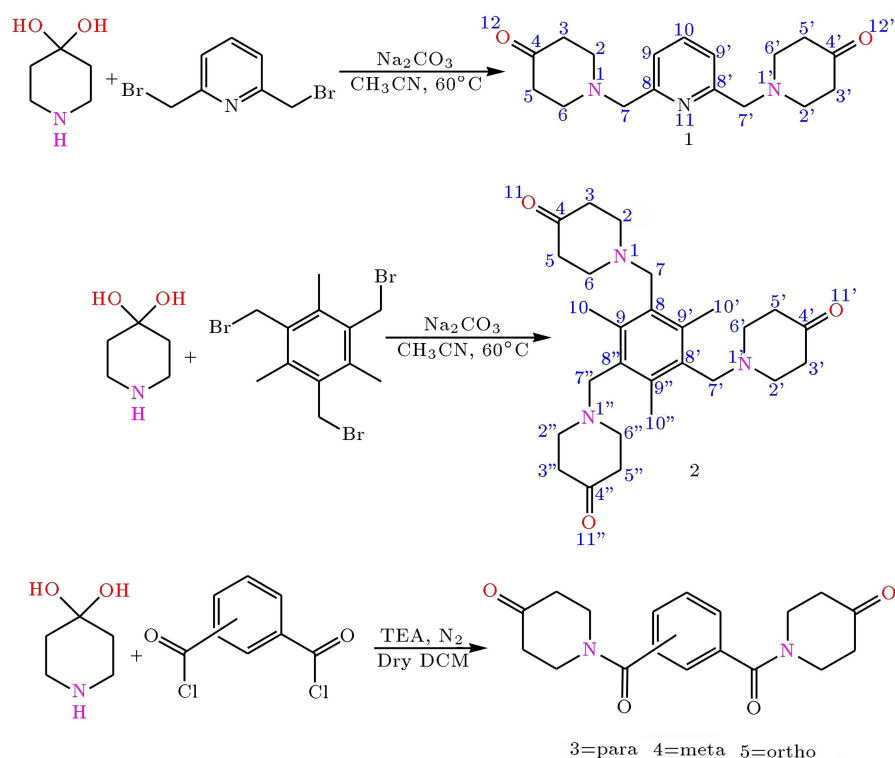
2.2. Dielectric analysis

The dielectric response of a sample is measured in a capacitance cell, conventionally consisting of two electrodes of parallel plate geometry, of plate area *A* and spacing *d*. The oscillating field is applied to the sample over a wide range of frequency and the capacitance (*C*) is monitored. The real part of susceptibility is related to the observed parameter, by Eq. (1):

$$C(\omega) = A\epsilon_0/d[\chi'(\omega) + \epsilon(\infty)] = \epsilon_0\epsilon'_r A/d, \quad (1)$$

where ϵ_0 is the permittivity of free space ($8.854 \times 10^{-12} \text{ F m}^{-1}$), and ϵ' is the real part of the relative permittivity of the sample. The relative permittivity

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Scheme 1. Synthesis of *N*-substituted bipodal, tripodal piperidin-4-ones **1-5**.

is defined as the permittivity of the sample divided by that of free space (ϵ_0).

3. Results and discussion

Dielectric spectroscopy is an analytical technique which involves the application of an oscillating electric field to a sample and the measurement of the corresponding response over a range of frequencies, from which, information on sample structure and behavior may be extrapolated [14-17]. This method has recently been applied to a number of pharmaceutical systems [18-20]. Recently, dielectric analysis shows considerably promising results in the absorption of drugs onto polymeric pharmaceutical carriers, both ionized and non-ionized [21,22]. In general, to obtain controlled release, the polymer material interaction between itself should be higher, thereby, reducing interaction of the surrounding matter. So, in pharmaceutical preparations, polymers are used as a drug delivery system. By obtaining the relation between log frequency vs dielectric constant, it was proved that the nanocomposite (core-shell) can function better as a drug delivery system than the polymer [22]. Here the dielectric constant decreases with increasing frequency for the polymer, whereas the dielectric constant almost remains the same in the case of nanocomposites.

Figures 1-3 show the variation in dielectric constant for our samples, with respect to the various frequencies, in the range of 1-3000 kHz at 300 K,

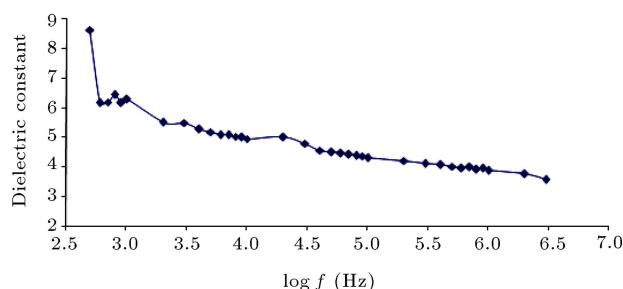


Figure 1. Log frequency vs dielectric constant for **1**.

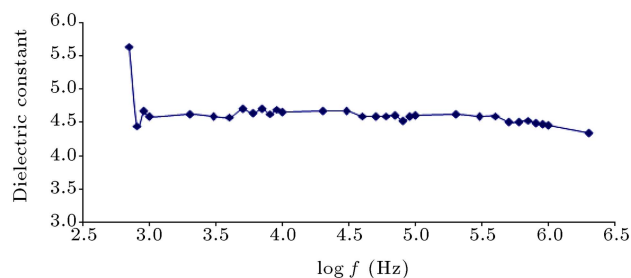


Figure 2. Log frequency vs dielectric constant for **2**.

using a Hioki 3532-50 LCR meter. The dielectric constant of **1-5** is almost constant, even after the change in frequency. Particularly, amide compounds (**3-5**) exhibit more consistent dielectric constants at different frequencies than the amine compounds (**1-2**). So, it is clearly comparable with the results of the nanocomposite discussed earlier, which can show better drug release in association with polymer.

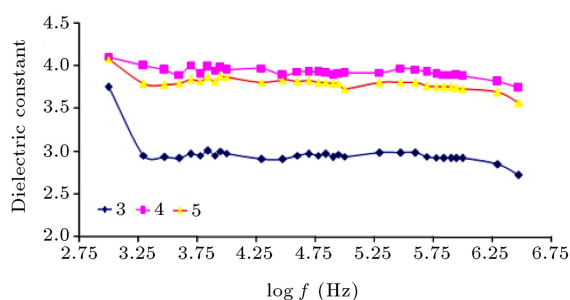


Figure 3. Log frequency vs dielectric constant for 3-5.

4. Conclusion

Novel bipodal, tripodalpiperidin-4-ones and their corresponding piperidin-4-ols were subjected to dielectric analysis, which shows coruscating results. Thus, these compounds can exhibit better drug release in association with polymer.

Acknowledgments

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References

- Szmant, H.H., *Organic Building Blocks of the Chemical Industry*, Wiley, New York (1989).
- Dyakov, M.Y., Sokolova, T.D., Peretokin, A.S., Moskovkin, A.S. and Unkovskii, B.V. "Synthesis of substituted 2-phenyl-4-piperidinones from styryl B-dimethylamino ethyl ketones and their steric structure", *Chem. Heterocycl. Comp.*, **27**, pp. 183-186 (1991).
- Scherer, T., Hielkema, W., Krijnen, B., Hermant, R.M., Eijkelhoff, C., Kerkhof, F., Ng, A.K.F., Verleg, R., van der Tol, E.B., Brouwer, A.M. and Verhoeven, J.W. "Synthesis and exploratory photophysical investigation of donor-bridge-acceptor systems derived from N-substituted 4-piperidones", *Recl. Trav. Chim. Pays-Bas*, **112**, pp. 535-548 (1993).
- Maryanoff, C.A., Reitz, A.B., Scott, M.A., Villani Jr, F.J. "Cyclic benzylamino, benzylamido, and benzylimido antipsychotic agents", U.S. Pat. 5,314,885 A.
- Katritzky, A.R. and W. Fan. "The chemistry of benzotriazole: A novel and versatile synthesis of 1-alkyl-, 1-aryl-, 1-(alkylamino)-, or 1-amido-substituted and of 1,2,6-trisubstituted piperidines from glutaraldehyde and primary amines or monosubstituted hydrazines", *J. Org. Chem.*, **55**(10), pp. 3205-3209 (1990); and the references cited therein.
- Vijayakumar, V., Rajesh, K., Suresh, J., Narasimhamurthy, T. and Nilantha Lakshman, P.L. "1, 10-(p-Phenylenedimethylene)-dipiperidin-4-one", *Acta Cryst.*, **E66**, p. o170 (2010).
- Vijayakumar, V., Sundaravadevelu, M., Perumal, S. and Hewlines, M.J.E. "NMR study of the stereochemistry of 2,4,6,8-tetraaryl-3,7-diazabicyclo [3.3.1]nonan-9-ones", *Mag. Reson. Chem.*, **38**, pp. 883-885 (2000).
- Vijayakumar, V., Sundaravadevelu, M. and Perumal, S. "An NMR and IR spectroscopic study of mono, bi and tricyclic piperidone systems", *Mag. Reson. Chem.*, **39**, p. 101 (2001).
- Subha Nandhini, M., Vijayakumar, V., Mostad, A., Sundaravadevelu, M. and Natarajan, S. "Ethyl-4-oxo-2,6-diphenyl-4-piperidine-3-carboxylate", *Acta Cryst.*, **E59**, pp. o1672-1674 (2003).
- Rajesh, K., Vijayakumar, V., Sarveswari, S., Narasimhamurthy, T. and Tiekink, E.R.T. "1-3-[(4-Oxopiperidin-1-yl)carbonyl]-benzoylpiperidin-4-one", *Acta Cryst.*, **E66**, p. o1988 (2010).
- Balaji, G.L., Vijayakumar, V. and Rajesh, K. "Microwave assisted synthesis of 2,6-Diaryl-4-piperidones and 2,4,6,8-tetraaryl-3,7-diazabicyclo [3.3.1]nonan-9-on es", *Arabian Journal of Chemistry*, **4**, 10.1016/j.arabjc.2011.12.011 (2011).
- Rajesh, K., Palakshi Reddy, B. and Vijayakumar, V. "Ultrasound-promoted synthesis of novel bipodal and tripodalpiperidin-4-ones and silica chloride mediated conversion to its piperidin-4-ols: Synthesis and structural confinements", *Ultrasonics Sonochemistry*, **19**, p. 522 (2012).
- Reshmi, G., Mohan Kumar, P. and Malathi, M. "Preparation, characterization and dielectric studies on carbonyl iron/cellulose acetate hydrogen phthalate core/shell nanoparticles for drug delivery applications", *Int. J. Pharm.*, **365**, pp. 131-135 (2009).
- Marzec, E., Wierzbicki, K., Olszewski, J., Samborski, W., Skorupska, E., Bahloul, K., Krzywicka, A. and Krauss, H. "Dielectric phenomena associated with the keratin-glucose interactions of nail plate", *Colloids and Surfaces B: Biointerfaces*, **109**, pp. 143-146 (2013).
- Mohan Kumar, P. and Malathi, M. "Study of temperature effect on binary mixtures of polyamide with phenol derivatives using TDR", *Der Pharma Chemica*, **5**(1), pp. 320-326 (2013).
- Mohan Kumar, P. and Malathi, M. "Solvent effect dielectric relaxation studies of polystyrene using TDR", *Der Pharma Chemica*, **4**(2), pp. 800-807 (2012).
- Mohan Kumar, P. and Malathi, M. "Study of fluid structure of polyamide-6 with polar/apolar solvents using dielectric parameters", *Der Pharma Chemica*, **4**(1), pp. 76-84 (2012).
- Sutananta, W., Craig, D.Q.M., Hill, R.M. and Newton, J.M. "The use of low frequency dielectric spectroscopy as a novel means of investigating the structure of pharmaceutical glyceride bases", *Int. J. Pharm.*, **125**, pp. 123-132 (1995).
- Craig, D.Q.M. and Slobodanka, T. "Dielectric analysis of bioadhesive gel systems", *Eur. J. Pharm. Biopharm.*, **44**, pp. 61-70 (1997).

20. McLoughlin, C.M., McMin, W.A.M. and Magee, T.R.A. "Physical and dielectric properties of pharmaceutical powders", *Powder Technol.*, **134**, pp. 40-51 (2003).
21. Benoit, E., Prot, O., Maincent, P. and Bessiere, J. "Applicability of dielectric measurements in the field of pharmaceutical formulation", *Bioelectrochem. Bioenergetics*, **40**, pp. 175-179 (1996).
22. Nilsson, M. and Alderborn, G. "Water-induced charge transport in tablets of microcrystalline cellulose of varying density: Dielectric spectroscopy and transient current measurements", *Chem. Phys.*, **295**, pp. 159-165 (2003).

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