COSTIN D. NENIŢESCU ROMANIAN ACADEMY AWARD for (Chemical Sciences section)

Costin D. Nenițescu AWARD of the ROMANIAN ACADEMY on Chemical Sciences section for the scientifically work of the year 2012, has been awarded for the scientifically contribution entitled: **The influence of water content of cyclodextrin-based complexes on the structural descriptors of biologically active compounds.** This award was given for two research articles on the border of chemical/bioconjugation / supramolecular interaction and the involvement to the stability / bioactivity / bioavailability of flavonoid and essential oil – cyclodextrin nanoparticles.

The authors

Daniel I. HĂDĂRUGĂ is assistant professor at the Department of Applied Chemistry, Organic and Natural Compounds Engineering, Pol;itehnica University of Timişoara.
He received the Ph.D. degree in chemistry in 2003. The main research topic includes the obtaining and analysis of new dual bioactive compounds (such as antioxidant derivatives and bioconjugates) and micro- / nanoencapsulation in cyclodextrins and liposomes. He is published many research articles and book chapters (Wiley, USA and Franche-Comté, France) in this area and is reviewer for top journals in chemical and food fields.

Nicoleta G. HĂDĂRUGĂ is full professor at the Banat's University of Agricultural Sciences and Veterinary Medicine "King Mihai I of Romania", Timişoara, Department of Food Science from the Faculty of Food Processing Technology.
She obtained the Ph.D. degree in Chemical Engineering in 2005 at the Polytechnic University of Timişoara and the Habilitated Doctor in 2013. Professor Nicoleta Hădărugă's research interests include protection / stability and controlled release of biologically active compounds from cyclodextrins. She is international journal reviewer and Editor-in-Chief of the J. Agroalim. Food Chem. and Organizing Chair of The 8th International Conference on Water in Food.

Geza N. BANDUR is associate professor at the Department of Applied Chemistry, Organic and Natural Compounds Engineering, Politehnica University of Timişoara.
He received the Ph.D. degree in 1999. Professor Geza Bandur's expertize is especially the synthesis and analysis of carbohydrate based polymers as well as advanced thermal analysis methods. He has published numerous research articles on thermogravimetry and differential scanning calorimetry analysis of oligo- and polymer based materials

Heinz-Dieter ISENGARD is Emeritus Professor at the University of Hohenheim, Stuttgart.
Professor Isengard received the Ph.D. degree in chemistry in 1972 and had numerous scientifically and administrative possitions. He is the president of Association EuroFoodWater and organized many international conferences of food chemistry.

Water content of flavonoid/cyclodextrin nanoparticles: relationship with the structural descriptors of biologically active compounds

Authors: Daniel I. Hădărugă, Nicoleta G. Hădărugă, Geza N. Bandur, Heinz-Dieter Isengard
Journal: Food Chemistry (Elsevier) 2012, 132(4), 1651-1659, doi: 10.1016/j.foodchem.2011.06.004 (ISI2012 = 3.334)

Abstract
The paper presents a study regarding the obtaining, characterization, and water evaluation of flavonoid (flavone, chrysin, naringenin, hesperetin, apigenin, fisetin, luteolin) and related compounds (cinnamic and caffeic acids, silybin etc.)/cyclodextrin complexes.
The thermogravimetric and calorimetric analyses indicate the formation of complexes, the presence of bioflavonoids and related compounds being revealed by the larger peaks from the calorimetric analysis (up to 250ºC); the dissociation of water and other volatiles (ethanol) is revealed by thermogravimetry.
The Karl Fischer titration (KFT) water content of β cyclodextrin complexes obtained by crystallization method was in the range of 8.8% (chrysin) to 12.6% (caffeic acid), and higher for ultrasonication method (9.4-13.3%).
For α-cyclodextrin complexes the water content was lower (8.2-9.8%). KFT water content correlates with the hydrophobic descriptors (i.e. octanol-water partition coefficient). This observation demonstrates the molecular encapsulation of compounds such as bioflavonoids in cyclodextrin cavity by replacing of crystallization water molecules with the more hydrophobic guest compounds.

Keywords
flavonoids; cyclodextrins; nanoparticles; Karl Fischer water titration; thermogravimetry; differential scanning calorimetry; structural descriptors.

Goal
In the present study the influence of structural characteristics of biologically active compounds from flavonoid, cinnamic acid, and flavonolignan classes on the encapsulation process in cyclodextrins by means of water content and the correlation of this water content with flavonoid structures and with the type of complexation method were investigated.

Conclusions

- The study regarding the obtaining, characterization, and water content evaluation of flavonoid and related compounds/ α- and β-cyclodextrin complexes revealed that the formation of the complex depends of the hydrophobicity of the guest compound (expressed by different descriptors), but only in the case of obtaining of complexes by crystallization method.
- Thus, the water content of cyclodextrin complexes, determined even by classical Karl Fischer titration or evaluated by thermogravimetry, depend on the hydrophobic (or related) descriptors of guest compound, especially for β-cyclodextrin complexes, the best correlation being obtained for logP (logarithm of octanol-water partition coefficient) and Nnp (total number of non-polar atoms); good correlations were obtained also for the water solubility descriptor (LogS), which are correlated (inverse correlation) with the hydrophobicity descriptors.
- These correlations were obtained only for the case of obtaining of cyclodextrin complexes by crystallization method and can be explained by the possibility to touch the association/dissociation equilibrium between guest (flavonoid and related compounds) and host (cyclodextrin) by very slow crystallization, when some of the water molecules from cyclodextrin are replaced by the guest molecule; if the guest molecule are more hydrophobic the van der Waals interaction with the inner cavity of cyclodextrin is better and the water content of the final complex is reduced. Furthermore, the obtaining of cyclodextrin complexes by ultrasonication method is inappropriate due to the facility of dissociation of guest-cyclodextrin complex in this process, as is revealed by the higher water content of these complexes.
- The water content determined by classical Karl Fischer method seems to be the better method for water evaluation in cyclodextrin micro/nanoparticles; thermogravimetry conduct to similar results, but little bit lower than the above mentioned method, due to the analysis technique: the TG analysis starts after obtaining the inert atmosphere (nitrogen) in the balance space and in this period a small quantity of water is already lost
- Moreover, the KFT allow evaluating only the water content and TG analysis indicate the mass loss by increasing temperature and do not differentiate between water and other volatile compounds,

Water content of natural cyclodextrins and their essential oil complexes: A comparative study between Karl Fischer titration and thermal methods

Authors: Nicoleta G. Hădărugă, Daniel I. Hădărugă, Heinz-Dieter Isengard

Journal: Food Chemistry (Elsevier) 2012, 132(4), 1741-1748, doi: 10.1016/j.foodchem.2011.11.003 (ISI2012 = 3.334)

Abstract

The paper presents a comparative study regarding the water determination in natural cyclodextrins and in their essential oil complexes (Apiaceae, Liliaceae, and Cupressaceae families) by using Karl Fischer titration (KFT) and thermal methods.

For the natural cyclodextrins the influence of the solvent hydrophobicity and the preheating temperature on the water extraction process were evaluated. The water contents, estimated by KFT in both methanol and methanol-octanol solvent systems, were 10.6% and 14.4% for α and β-cyclodextrin, respectively.

The water content, estimated by KFT in a more hydrophilic solvent system, methanol-formamide, was 0.4-0.6% higher.

Thermogravimetric evaluation of water conducts to lower values. For the essential oil/cyclodextrin complexes, the KFT water content were in the range of 6.4-8.1%, higher values being obtained in the case of Juniperus essential oil/β cyclodextrin complexes (7.5-8.1%). With some exceptions, thermal analyses of complexes are in good agreement with the KFT results.

Keywords

Karl Fischer water titration; microparticles and nanoparticles; cyclodextrins; thermogravimetry; differential scanning calorimetry; scanning electron microscopy.

Goal

In this study the influence of the hydrophobicity of solvent mixture and the preheating temperature on the water extraction process for α- and β-cyclodextrin as well as for their complexes with various essential oils were evaluated by using classical Karl Fischer titration method and the results were compared with those from the thermogravimetric analysis.

Conclusion

- Classical Karl Fischer water titration is a good tool for evaluation of water concentration in cyclodextrins and their micro/nanoparticles used in food industry and KFT results are in good agreement with the thermogravimetric results; the KFT chemical method is more accurate than TG due to the fact that it evaluate only water concentration and furthermore the "surface" and "strong-bonded" water molecules can be determined.
- Karl Fischer water titration values for natural cyclodextrins depend on the hydrophobicity of solvent mixture: lower values were obtained in the case of more hydrophobic solvent addition to the methanol used as the base solvent. The differences between KFT water content values for natural cyclodextrins and their essential oils complexes is still small from the solvent hydrophobicity point of view and further investigations must be performed in order to elucidate all aspects of cyclodextrin Karl Fischer titration.