

WATER PROPERTIES IN FOOD, HEALTH, PHARMACEUTICAL AND BIOLOGICAL SYSTEMS: ISOPOW 10

Editors DAVID S. REID TANABOON SAJJAANANTAKUL PETER J. LILLFORD SANGUANSRI CHAROENREIN

WILEY-BLACKWELL

Table of Contents

<u>Cover</u>

Table of Contents

Half title page

<u>Title page</u>

<u>Copyright page</u>

<u>Preface</u>

Editorial Note

Acknowledgments

Contributors

Part 1: Invited Speakers and Oral Presentations

<u>1 Complementary Aspects of</u> <u>Thermodynamics, Nonequilibrium</u> <u>Criteria, and Water Dynamics in the</u> <u>Development of Foods and</u> <u>Ingredients</u> Introduction Reactions, Materials, and Methods Maillard Reaction Enzyme Stability Degradation of Carotenes Structural Effects Concluding Remarks Acknowledgments

2 Water Mobility in Solid Pharmaceuticals as Determined by Nuclear Magnetic Resonance, Isothermal Sorption, and Dielectric Relaxation Measurements

Introduction Apparent Correlations Between the Stability of Solid APIs and the Molecular Mobility of Water Molecular Mobility of Water in API Hydrates Molecular Mobility of Water Coexisting with Various Pharmaceutical Excipients Concluding Remarks

<u>3 The Effect of Water and Fat</u> <u>Contents on the Enthalpy of</u> <u>Dissolution of Model Food Powders: A</u> <u>Thermodynamic Insight</u> Introduction <u>Experimental Methods</u> <u>Results and Discussion</u> <u>Conclusions</u>

<u>4 "Solvent Water" Concept Simplifies</u> <u>Mathematical Modeling in Fermenting</u> <u>Dough, a Multiphase Semisolid Food</u>

Introduction Dough Structure Solvent-Water Concept Solvent Water in Dough Materials and Methods Results and Discussion Conclusions

<u>5 Microdomain Distribution in Food</u> <u>Matrices: Glass Transition</u> <u>Temperature, Water Mobility, and</u> <u>Reaction Kinetics Evidence in Model</u> <u>Dough Systems</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusions</u>

<u>6 Effect of Combined Physical</u> <u>Stresses on Cells: The Role of Water</u> <u>Introduction</u> **Example 1: Effects of Combined** <u>Hyperosmotic and Temperature</u> <u>Perturbation</u> <u>Example 2: Effects of Combined High</u> <u>Hydrostatic Pressure, Low Temperature,</u> <u>and Hyperosmotic Perturbations</u> <u>Conclusions</u>

<u>7 Soft Condensed Matter: A</u> <u>Perspective on the Physics of Food</u> <u>States and Stability</u>

<u>Introduction</u> <u>Physical State Changes in Foods in Storage</u> <u>Examples of Use of the State Diagram and</u> <u>Glass Transition Curve</u> <u>Conclusions</u>

<u>8 Antiplasticization of Food Polymer</u> <u>Systems by Low Molecular Mass</u> <u>Diluents</u>

<u>Introduction</u> <u>Polymer-Diluent Interactions: Plasticization</u> <u>versus Antiplasticization</u> <u>Water, the Ubiquitous Diluent, as</u> <u>Antiplasticizer at T < T_g</u> <u>Conclusion</u>

<u>9 Freeze Drying of Lactobacillus</u> <u>coryniformis Si3: Focus on Water</u> Introduction Materials and Methods Results and Discussion Acknowledgments

<u>10 Water-Sorption Properties and</u> <u>Stability of Inclusion Complexes of</u> <u>Thymol and Cinnamaldehyde with β-</u> <u>Cyclodextrins</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Release of Thymol and Cinnamaldehyde</u> <u>During Storage</u>

<u>11 Beyond Water: Waterlike</u> <u>Functions of Other Biological</u> <u>Compounds in a Waterless System</u>

Introduction Understanding Molecular Mobility Water-Activity Theory on the Stability of Biological Materials Waterlike Solvation Property of Polyols Glass Transition, Molecular Mobility, and Sub-T_g Relaxation Molecular Mobility and the Maillard Reaction Concluding Remarks

<u>12 Water Sorption and Transport in</u> <u>Dry, Crispy Bread Crust</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Models</u> <u>Results and Discussion</u> <u>Conclusion</u>

<u>13 Water State and Distribution</u> <u>During Storage of Soy Bread with and</u> <u>without Almond</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u>

<u>14 Phase Separation of Ice Crystals in</u> <u>Starch-Based Systems During</u> <u>Freezing and Effects on Moisture</u> <u>Content and Starch Glass Transition</u>

Introduction Materials and Methods Results and Discussion Conclusion Acknowledgments

<u>15 Carrot Fiber as a Carrier in Spray</u> <u>Drying of Fructose</u> <u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusion</u>

<u>16 Taking the Measure of Water</u>

<u>Introduction</u> <u>States of Water</u> <u>Metrics for Water</u> <u>Conclusion</u>

<u>17 Rehydration Modeling of Food</u> <u>Particulates by Using Principles of</u> <u>Water Transport in Porous Media</u>

Introduction <u>Mathematical Modeling</u> <u>Paradigm Shift</u> <u>Flow in Unsaturated Porous Media</u> <u>New Approaches and Other Advances</u> <u>Research Needs</u> <u>Conclusions</u>

<u>18 Protein Hydration in Structure</u> <u>Creation</u>

<u>Introduction</u> <u>Hydration Studies</u> <u>Gelation</u>

<u>19 Water Partitioning in Colloidal</u> <u>Systems as Determined by Nuclear</u> <u>Magnetic Resonance</u>

Introduction Starch Amylose, Amylopectin, and More Hydration Nondiscriminating Properties Water Distribution **Discriminating NMR T₂ Distribution** Cassava Starch **NMR** The Gelatinization Behavior of Water-Saturated Starch Granules Starch-Chain Mobility During Gelatinization The Freezing Behavior of Water-Saturated **Starch Granules** Acid Hydrolysis Syneresis and Freeze-Thaw Stability **Conclusions**

20 Physical Changes in Confectionery Products Caused by the Availability of Water, with a Special Focus on Lactitol Crystallization

Introduction Materials and Methods Results and Discussion Glass Transition Temperature Conclusions <u>21 Entrapment of Probiotic Bacteria</u> <u>in Frozen Cryoprotectants and</u> <u>Viability in Freeze Drying</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u>

22 Fracture Behavior of Biopolymer Films Prepared from Aqueous Solutions

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Acknowledgments</u>

<u>23 The Plasticization-</u> <u>Antiplasticization Threshold of Water</u> <u>in Microcrystalline Cellulose: A</u> <u>Perspective Based on Bulk Free</u> <u>Volume</u>

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgments

<u>24 Understanding the Role of Water</u> <u>in Nonaqueous Pharmaceutical</u> <u>Systems</u> <u>Introduction</u> <u>Conclusions</u>

<u>25 Crystallization, Collapse, and</u> <u>Glass Transition in Low-Water Food</u> <u>Systems</u>

Introduction Flow in Glassy and Liquid States Collapse Phenomena Crystallization Phenomena State Diagrams Conclusions

<u>26 Carbohydrates in Amorphous</u> <u>States: Molecular Packing,</u> <u>Nanostructure, and Interaction with</u> <u>Water</u>

<u>Glassy Carbohydrates in Food and</u> <u>Pharmaceutical Stability</u> <u>Effects of Water on the Structure of</u> <u>Carbohydrate Glasses</u> <u>Molecular Packing in Glassy Carbohydrates</u> <u>Dynamic Properties Close to the Glass</u> <u>Transition</u> <u>Technological Implications</u> <u>Concluding Remarks</u> <u>Acknowledgments</u>

<u>27 Ice Crystallization in Gels and</u> <u>Foods Manipulated by the Polymer</u> <u>Network</u>

Introduction The Ice Crystallization Exotherm During Rewarming Observed with Cross-Linked Dextran Gels Origin of an Endothermic Trend Observed Prior to the Exotherm During Rewarming Vitrified Water in a Frozen G25 Gel Freezing Scheme for Compartmentalized Water in Polymer Gels Glass Transition of Cross-Linked Dextrans Containing a Small Amount of Water Ice Crystallization During Rewarming Observed with Various Food Biopolymer Gels Conclusions

<u>28 Marine-Inspired Water-Structured</u> <u>Biomaterials</u>

Introduction Jellyfish (Aurelia aurita) Life Cycle and Accessibility Water-Holding and Textural Properties of Jellyfish Jellyfish Microstructure Gel Structures, Hierarchy, and Mass Transport

Part 2: Poster Presentations

29 Another Unusual Property of Water: It Increases the Glass Transition Temperature of a Glassy Polymer

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgment

<u>30 Molecular Mobility Interpretation</u> of Water-Sorption Isotherms of Food <u>Materials by Means of Gravimetric</u> <u>Nuclear Magnetic Resonance</u>

Introduction <u>Theory</u> <u>Methods</u> <u>Results</u> <u>Discussion</u> <u>Conclusions</u> <u>Acknowledgments</u>

<u>31 Kinetics of Enthalpy Relaxation in</u> <u>Corn Syrup-Sucrose Mixtures</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusion</u>

<u>32 Development of a Novel Phase</u> <u>Transition Measurement Device for</u> <u>Solid Food Materials: Thermal</u> <u>Mechanical Compression Test (TMCT)</u>

<u>Introduction</u> <u>Methodology</u> <u>Applications</u> <u>Conclusion</u>

<u>33 Proton Nuclear Magnetic</u> <u>Resonance Studies of Molecular</u> <u>Mobility in Potato Systems in</u> <u>Relation to Nonenzymatic Browning</u>

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgments

<u>34 Nonenzymatic Browning Reaction</u> and Enthalpy Relaxation of Glassy <u>Foods</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results</u>

Discussion

<u>35 Film-Forming Ability of Duck Egg</u> <u>White and Its Water-Vapor Barrier</u> <u>Property</u>

Introduction Materials and Methods Results and Discussion Conclusion Acknowledgment

<u>36 Water-Vapor Permeability of</u> <u>Chitosan and Methoxy Poly(ethylene</u> <u>glycol)-b-poly(ε-caprolactone) Blend</u> <u>Homogeneous Films</u>

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgment

<u>37 Ice Formation in Concentrated</u> <u>Aqueous Glucose Solutions</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>38 Effects of Sodium and Potassium</u> <u>Ions on the Viscosities in the</u> <u>Sodium/Potassium-Glucose-Water</u> <u>Ternary System</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u>

<u>39 Comparison of Water Sorption and</u> <u>Crystallization Behaviors of Freeze-</u> <u>Dried Lactose, Lactitol, Maltose, and</u> <u>Maltitol</u>

Introduction Materials and Methods Results and Discussion Conclusions

<u>40 Sorption Behavior of Extruded</u> <u>Rice Starch in the Presence of</u> <u>Glycerol</u>

Introduction Materials and Methods Results and Discussion Conclusions

<u>41 Water State and Mobility Affect</u> the Mechanical Properties of Coffee

<u>Beans</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusions</u>

<u>42 Effect of Water Activity on the</u> <u>Release Characteristics of</u> <u>Encapsulated Flavor</u>

Introduction Materials and Methods Results and Discussion Conclusion Acknowledgments

<u>43 Water and Protein Modifier Effects</u> <u>on the Phase Transitions and</u> <u>Microstructure of Mung-Bean Starch</u> <u>Granules</u>

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgment

<u>44 Evaluation of the Disintegration</u> and Diffusion of Pharmaceutical Solid

<u>Matrices by Image Processing and</u> <u>Nonlinear Dynamics</u>

Introduction Methods Results and Discussion Conclusions Acknowledgments

<u>45 Effect of Water Content on</u> <u>Physical Properties of Potato Chips</u>

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgment

<u>46 Predicting Water Migration in</u> <u>Starchy Food During Cooking</u>

Introduction Method Results and Discussion Conclusion Nomenclature

<u>47 Nonenzymatic Browning May Be</u> <u>Inhibited or Accelerated by</u> <u>Magnesium Chloride According to the</u> <u>Level of Water Availability and</u> <u>Saccharide-Specific Interactions</u>

Introduction Materials and Methods Results and Discussion Conclusion Acknowledgments

<u>48 Combined Effect of Cinnamon</u> <u>Essential Oil and Water Activity on</u> <u>Growth Inhibition of Rhizopus</u> <u>stolonifer and Aspergillus flavus and</u> <u>Possible Application in Extending the</u> <u>Shelf Life of Bread</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u>

<u>49 From Water to Ice: Investigation of</u> <u>the Effect of Ice Crystal Reduction on</u> <u>the Stability of Frozen Large</u> <u>Unilamellar Vesicles</u>

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgments <u>50 Does Microencapsulation Improve</u> <u>Storage Stability of Cloudberry</u> <u>(Rubus chamaemorus) Ellagitannins?</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusions</u>

51 Nonenzymatic Browning Reaction of Glassy Foods: Characterization of Local Reactions Independent of the Glassy Matrix

<u>Introduction</u> <u>Materials and Methods</u> <u>Results</u> <u>Discussion</u> <u>Conclusion</u>

<u>52 Physical Properties of Protein-</u> <u>Carbohydrate Sheets Produced by a</u> <u>Twin-Screw Extruder</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusions</u> <u>Acknowledgment</u> <u>53 Thermal Transitions, Mechanical</u> <u>Properties, and Molecular Mobility in</u> <u>Cornflakes as Affected by Water</u> <u>Content</u>

Introduction Materials and Methods Results and Discussion Acknowledgments

54 Texture of Glassy Tapioca-Flour-Based Baked Products as a Function of Moisture Content

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u>

<u>55 Effects of Excipients on the</u> <u>Storage Stability of Freeze-Dried</u> <u>Xanthine Oxidase</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results</u> <u>Discussion</u>

<u>56 Water Properties in Bread</u> <u>Produced with an Innovative Mixer</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusions</u>

<u>57 Evaluation of Deformation and</u> <u>Shrinking of Potato Slabs During</u> <u>Convective Drying</u>

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgments

<u>58 Effects of Different Cut-Induced</u> <u>Microstructural and Macrostructural</u> <u>Arrays on Convective Drying of Agave</u> <u>atrovirens Karw</u>

Introduction Materials and Methods Results and Discussion Conclusions Acknowledgments

<u>59 Study of White-Bread Structural</u> <u>Evolution by Means of Image Analysis</u> <u>and Associated Thermal History and</u> <u>Water-Loss Kinetics</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusions</u> <u>Acknowledgments</u>

<u>60 Effect of Hydrothermal Treatment</u> <u>on the Rheological Properties of</u> <u>High-Amylose Rice Starch</u>

Introduction Materials and Methods Results and Discussion Conclusion Acknowledgments

<u>61 Influence of Glass Transition on</u> <u>Oxygen Permeability of Starch-Based</u> <u>Edible Films</u>

Introduction Materials and Methods Results and Discussions Conclusion

<u>62 Molecular Mobility and Seed</u> <u>Longevity in Chenopodium quinoa</u>

Introduction Materials and Methods NMR Relaxation Measurements Results Discussion <u>63 Analyzing the Effect of Freeze-</u> <u>Thaw Cycle on the Off-Aroma of</u> <u>Pineapple by Using an Electronic</u> <u>Nose Technique</u>

Introduction Materials and Methods Results and Discussion Conclusion Acknowledgments

<u>64 Water Uptake and Solid Loss</u> <u>During Soaking of Milled Rice Grains</u>

Introduction Materials and Methods Results and Discussion Conclusion

<u>65 Microstructural, Physical, and</u> <u>Rehydration Properties of</u> <u>Maltodextrin Powders Obtained by</u> <u>Spray Drying</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusion</u> <u>Acknowledgments</u>

<u>66 Nanostructures and Minimum</u> <u>Integral Entropy as Related to Food</u> <u>Stability</u>

<u>Introduction</u> <u>Materials and Methods</u> <u>Results and Discussion</u> <u>Conclusions</u> <u>Acknowledgments</u>

<u>Index</u>

WATER PROPERTIES

IN FOOD, HEALTH, PHARMACEUTICAL AND BIOLOGICAL SYSTEMS: ISOPOW 10

WATER PROPERTIES

IN FOOD, HEALTH, Pharmaceutical and Biological systems: Isopow 10

Edited by DAVID S. REID TANABOON SAJJAANANTAKUL PETER J. LILLFORD SANGUANSRI CHAROENREIN





A John Wiley & Sons, Inc., Publication

Edition first published 2010

© 2010 Blackwell Publishing

Chapter 18 and 28 copyrights held by Anne-Marie Hermansson.

Blackwell Publishing was acquired by John Wiley & Sons in February 2007. Blackwell's publishing program has been merged with Wiley's global Scientific, Technical, and Medical business to form Wiley-Blackwell.

Editorial Office

2121 State Avenue, Ames, Iowa 50014-8300, USA

For details of our global editorial offices, for customer services, and for information about how to apply for permission to reuse the copyright material in this book, please see our website at <u>www.wiley.com/wiley-blackwell.</u>

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by Blackwell Publishing, provided that the base fee is paid directly to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For those organizations that have been granted a photocopy license by CCC, a separate system of payments has been arranged. The fee codes for users of the Transactional Reporting Service are ISBN-13: 978-0-8138-1273-1/2010.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book. This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold on the understanding that the publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought. Library of Congress Cataloguing-in-Publication Data

International Symposium on the Properties of Water (10th : 2007 : Bangkok, Thailand)

Water properties in food, health, pharmaceutical and biological systems : ISOPOW 10 edited by David Reid, Tanaboon Sajjaanantakul, et al.

p. cm.

Includes bibliographical references and index.

ISBN-13: 978-0-8138-1273-1 (alk. paper)

ISBN-10: 0-8138-1273-9 (alk. paper)

ISBN: 978-0-4709-5956-5 (ebk)

1. Food-Water activity-Congresses.2. Food-Moisture-
Congresses.Congresses.3.Pharmaceutical
Congresses.chemistry-
Congresses.Congresses.I.Reid,
David.David.II.Tanaboon.III.Title.

TX553.W3I57 2007

664-dc22

2008054012

A catalog record for this book is available from the U.S. Library of Congress.

Set in 10/12 pt Times by Toppan Best-set Premedia Limited Printed in Singapore

Disclaimer

The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation warranties of fitness for a particular purpose. No warranty may be created or extended by sales or promotional materials. The advice and strategies contained herein may not be suitable for every situation. This work is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional services. If professional assistance is required, the services of a competent professional person