Index

A
AA. See Alginic acid
Accessible volume, antiplasticization phenomenon and, 309
Acetone, dielectric constants of, 159
Acevedo, N. C., 21
Acid gels, structure of, 242
Acid-hydrolyzed cassava starch, differential scanning calorimetry data for, 265
Acrylic monomers, superabsorbent polymers based on, 386
Active ingredients, dual role of glassy carbohydrates in stabilization and delivery of, 354
Active pharmaceutical ingredient hydrates correlation of water mobility as determined by NMR, with that determined by DSC and water-sorption measurements, 31, 34–36
Ease of evaporation for hydration water as determined by DSC and water-sorption isotherm measurements, 31
Molecular mobility of hydration water, as determined by NMR, 26–30
Molecular mobility of water in, 26–36
Usefulness and limitation of water mobility by NMR and, 36
Active pharmaceutical ingredients chemical stability or instability of, in aqueous solutions or suspension formulations, 316
Moisture uptake in amorphous pharmaceutical matrices and lipid vehicles and profound effects on physical and chemical stability of, 332
Solid, apparent correlations between stability of, and molecular mobility of water, 25–26
Water's importance in, as solvent for, 315
Actomyosin, gel formation and, 241
Acyl-transfer reactions, water uptake and mobility, pharmaceutical stability in amorphous solids and, 325
Adam-Gibbs approach, enthalpy relaxation time of trehalose-glucose-lysine system and, 448
Additives, enthalpy relaxation influenced by, 420
Adhesive forces, surface tension and, 225
Adobe Photoshop 7.0, 516
Adsorption behavior, hysteresis between desorption behavior and, 238
Adsorption cycles, typical, for biopolymers and foods, 238
Adsorption isotherm, of glassy tapioca-flour-based baked sample, 594–596
Adsorption rates desorption rates vs., for starch-rich model bread crust, 169, 169–170
for starch-rich model bread crust during oscillatory sorption experiments, 172
Adya, A. K., 72, 77
Agarose, ice crystallization during rewarming observed with, 373, 381–382
Agave atrovirens Karw effects of different cut-induced microstructural and macrostructural arrays on convective drying of, 619–625
Conclusions, 625
Introduction, 619–620
Agave atrovirens Karw (continued)
materials and methods, 620–621
convective drying experiments, 620
image processing and fractal analysis
used to study shrinkage and
deformation, 620–621
results and discussion, 621, 624
drying kinetics, 621
microstructural images, 624
shrinkage-deformation kinetics, 621, 624
Agave slices
during convective drying, gallery of
binary images from superior and
lateral views of: longitudinal cut
and transverse cut, 623
dried, scanning electron microscopic
images of, longitudinal and
transverse cuts, 624, 624
drying kinetics of, at 60°C and 2 m/s for
longitudinal and transverse cuts, 622
Agave tissue, structural arrangement of, 620
Aggregation
heat gelation and, 239
relative kinetics of denaturation and, 240
Aguamiel juice, extraction of, 619
Ahromrit, A., 668
Al-Bezweni, M., 484
Albumins, heat gelation and, 239
Alginate film, describing sorption dynamics
of, 166
Alginate gel, subjected to EDTA, 392
Algic acid, paprika capsules prepared with,
681, 683
Alkali halide-saccharide-water ternary
system, physicochemical
characteristics of sodium ions and
potassium ions on, 474
Alkyl carbon atoms, in monocaprylin or
tricaprylin, radial distribution
function for water oxygen with, 331
Almond powder, plasticizing effect of
water and addition of, to soy
bread, 183
Almonds
health benefits with, 176
schematic of changes occurring in soy
bread, with and without, during
storage, 182
water state and distribution during storage
of soy bread, with and without,
175–176
Almond-soy bread
“freezable” water in, 181, 181
moisture content and specific loaf volume
of soy bread and, 179t
Alpha-lactose, protein-carbohydrated sheets
prepared with, 578
Alpha-relaxation of molecules, 161
Alpha-relaxation process, as main glass
transition, 116–117
Altoids
car interior temperature rise and effect on,
101
humidifying, review of observations,
102–104
AMBER 8, 329
Ambient food, initial freezing point of, 212
Ambient systems, water measurement and,
204
Ambient temperature systems, relative
vapor pressure as control factor
and, 212
American Association of Cereal Chemistry, 606
American Society of Testing and Materials
Standard Method D882-91, 454
American Society of Testing and Materials
Standard Method D1434-82, 454
American Society of Testing and Materials
Standard Method D3985, 642
American Society of Testing and Materials
Standard Method E96-85, 454
Amino acids
model of local reaction promoting
nonenzymatic browning reaction
progress in glassy matrix and, 574,
575
protein film-forming properties and role
of, 453
Amorphous dry foods, glass-rubber transition and affect on chemical and physical stabilities of, 445
Amorphous food matrix, distribution of microstructural domains within, 59
Amorphous food powders factors related to different behavior of crystalline food powders and, 45 stickiness and caking of, 344–345
Amorphous foods relaxation phenomena of, 339–341 enthalpy relaxations, 340 structural relaxations, 341
Amorphous glass self-association of water at higher moisture levels observed in, 332 water uptake and its implications in, 318–326 water mobility in simulated PVP glasses, 322–325 water uptake and its distribution in PVP, 318–322 water uptake and mobility on pharmaceutical stability in amorphous solids, 325–326
Amorphous glassy state, description of, 419
Amorphous growth ring, starch granule, 254
Amorphous lactose, water-sorption and time-dependent crystallization and recrystallization of, 347
Amorphous materials, dry-food products and, 571
Amorphous saccharides, different dissolution behavior of crystalline samples and, 42
Amorphous solids, implications of water uptake and mobility on pharmaceutical stability in, 325–326
Amorphous sucrose, pure, first experiments on state changes of, 95–96
Amorphous sugars, crystallization of, 346–348
Amorphous systems, antiplasticizing effect of water when polymers used for stabilization of, 401

Amoxicillin correlation between onset temperature and $T_2$ for, 34
correlation between $T_2$ and temperature dependence of $T_2$ for, 35 differential scanning calorimetric thermograms for, 32 Gaussin-type decay and Lorentzian decay exhibited by, 29

Ampicillin correlation between onset temperature and $T_2$ for, 34
correlation between $T_2$ and temperature dependence of $T_2$ for, 35 differential scanning calorimetric thermograms for, 32 Gaussin-type decay and Lorentzian decay exhibited by, 29

Ampoule method, sticky point by, 100

Ammoleptic improved understanding of, 252–253 retrograded, DSX-freezable water, bread characterization and, 607
Ammoleptic clusters, starch granule, 254
Ammoleptic lamellae, formation of, 253
Ammolose in cassava starch, seasonality and, 258 improved understanding of, 252–253
Ammolose content of milled rice varieties, 664 solid loss of rice grains during soaking and, 668–669
Anandaraman, S., 367
Anderson, B. D., 318
Anderson, Philip W., 111
Angel floss, 95
Angle of repose, for maltodextrin powders, evaluating, 675
Anhydrobiosis, trehalose and, 132
Annealing, 419
Annealing step, adding to freeze-drying cycle, 144, 146
Annealing treatments, time dependence of ice formation and, 348
Anomalous antiplasticization effects, of water in relation to some mechanical properties, 122
Anomalous diffusion, 166
Antibiotic hydrates
correlation between onset temperature and $T_2$ for, 34
correlation between $T_2$ and temperature
dependence of $T_2$ for, 35
ease of evaporation for, 31
time courses of spin-spin relaxation observed for, 29–30
Antimicrobials, controlled kinetics of
Maillard reaction and, 11
Antioxidants, controlled kinetics of Maillard reaction and, 11
Antiplasticization, 115
depiction of feasible explanation for
association between plasticization and, based on bulk free volume, 311, 311–312
external mechanical, by water, 116
hole-filling mechanism and, 362
MCC compaction and, 308
new perspectives on, 408
plasticization vs. polymer-diluent interactions, 116–119
polymer-plasticizer systems and, 402
polymers and, 302
various theories and models of, in synthetic polymer systems, 117–118
Antiplasticization effect of water
in raw and roasted coffee beans, 491
textural properties of raw and roasted coffee and, 494
Antiplasticization-plasticization phenomena,
factors affecting physical manifestation of, 120, 122
Antiplasticization range, compression-force-water-activity relationships
for extruded flat breads and, 120, 122
Antiplasticized modulus vs. diluent content curve, of solid polymer-diluent blends, 118
API protons, spin-spin relaxation time of water protons and, 27
APIs. See Active pharmaceutical ingredients
Apple drying methods, reaction kinetics and, 21
Apple-juice powder, onset of glass transition
temperature of food powders measured by TMCT, DSC, and TMA, 434
Aqualab 2000, 607
Aqualab dew-point hygrometer, 493
Aqueous pharmaceutical formulations,
solubility and stability of API issues, 315
Aqueous phase, 91
of dough, 50, 52, 53
Aqueous systems, quantifying fraction of water contributing to component of spectroscopic signal in, 216
Arabinose, intermolecular hydrogen bonds, NEB progress in the glassy matrix and, 576
Aroma, as major determinant of fruit quality, 657
Arrhenius equation, 111
Arrhenius plot
of alpha relaxation and beta relaxation of dielectric spectra for protein-carbohydrate sheets, 580, 580
of initial nonenzymatic browning reaction rate for samples of varying glassy matrices, 573, 573
of initial nonenzymatic browning reaction rate for samples of varying reducing sugars embedded in glassy trehalose matrix, 574
for temperature dependence of water diffusion coefficient for different carbohydrate concentration and different molecular weights, 364, 365, 366
Arrhenius relationship, 66, 98
Aspergillus flavus
combined effect of cinnamon essential oil and water activity on, 545–550
introduction, 545
materials and methods, 546–547
results and discussion, 547, 549–550
effect of cinnamon and relative humidity on growth inhibition of Rhizopus stolonifer on bread during storage at 30°C, 549
effect of cinnamon oil and water activity on inhibition of, on bread model agar, 546, 547, 548, 549
minimum inhibitory concentrations of essential oils and potassium sorbate against, 547
Aspirin matrix
average fractal dimension of edge of, within first 30s of their disintegration and diffusion, 516, 516
average fractal dimension of side face of, within first 30s of their disintegration and diffusion, 517, 517
evaluation of disintegration and diffusion of, by image processing and nonlinear dynamics, 515–520
images of, in degasified distilled water and without agitation, showing rings, halo, and vortices around, 517, 518
proposed mathematical simulation for one of the vortices during diffusion of, image at 10s; amplification of modeled vortex; digitalized vortex; iterative model; 20° clockwise-turned vortex, 519, 519–520
at 16s after being placed in degasified distilled water and without agitation, vortices arrangement in opposite-sense movement around halo formed, 518, 519
showing disintegration process comparable to opening of petals of flower, with fractures during such opening, 517, 520
Attenburrow, G. E., 123
Average mobility of water, 256
Avrami equation
analysis of release characteristics of encapsulated flavor by, in response to various influence factors, 502
moisture content modeling for crystallizing amorphous lactitol with, 273
rate of crystallization of polymers modeled with, 346–347
Azuara, E., 682, 683
Baik, M. Y., 181
Bakmix (innovative bread mixer), 607
recent design of, 605
schematic representation of, 606
Bakmix mixing process, traditional mixing process vs., 606
Barford, J. P., 53, 55
Barrier properties, of duck egg-white film made from shell eggs, 457, 458
BBSRC. See Biotechnology and Biological Sciences Research Council
Bee, cooked, change in distribution of water-proton relaxation times during compression of, 244
Benczédi, D., 126
Benzamide (single solute molecule), in molecular dynamics simulation of 60% tricaprylin-40% 1-monocaprylin lipid mixture saturated with water at 37°C, 329, 330
Benzene, dielectric constants of, 159
Berberine chloride differential scanning calorimetric thermograms for, 32
endothermic peaks for, 31
Beristain, C. I., 682, 683
Bertram, A. K., 470
Beta-carotene, encapsulated, glass transition temperatures as function of mass fraction of water for polymeric and trehalose matrices and, 19
Beta-cyclodextrin, water-sorption isotherms of beta-cyclodextrin-cinnamaldehyde and beta-cyclodextrin-thymol complexes and, 152
Beta-cyclodextrin-cinnamaldehyde system, differential scanning calorimetry thermograms of, 153–154, 154
Beta-cyclodextrins
materials and methods, 150–151
differential scanning calorimetry, 151
preparation of solid complexes, 150–151
sorption isotherms, 151
storage study, 151
Beta-cyclodextrins (continued)
release of thymol and cinnamaldehyde during storage, 154–155
results and discussion, 152–154
differential scanning calorimetry, 153–154
sorption moisture studies, 152–153
water content and structure of, 149
water-sorption properties and stability of inclusion complexes of thymol and cinnamaldehyde with, 149–155
introduction, 149–150
Beta-cyclodextrin-thymol system, differential scanning calorimetry thermograms of, 153, 153
Beta-lactoglobulin gels, 10%, light-microscopic images of, at pH 5.3, 241
Beta relaxation, 419
of molecules, 161
Beta-suppression effect, 118
BET value. See Brunauer-Emmett-Teller value
BFV. See Bulk free volume
Bhandari, B. R., 160, 195, 430
Bidwell method, mass-loss kinetics for bread dough calculated with, 629
Biexponential decay curves, for quinoa seeds equilibrated at low RHs, 650
Binary aqueous system temperature-composition phase diagram for, 213
temperature-composition state diagram for, 214
Biodegradable food-packaging, chitosan and, 459
Biological materials, water-activity theory on stability of, 158–159
Biological systems water in, 157
water’s crucial role in pressure-induced denaturation of, 80
Biologics, hypothetical states of matter of, 90
Biomaterials antiplasticizing effects of water on, 123–124
design of new, biomimetics and, 385
Biomimetics, influence and role of, 385, 395
Biomolecular dehydroprotectant agents, optimizing efficiency of, 18
Biomolecular functionality or structure, controlled kinetics of Maillard reaction and, 11
Biomolecules, encapsulation of, in amorphous matrix formed during dehydration process, 18–19
Biopolymer-based films, anomalous antiplasticization effects of water and mechanical properties in, 122
Biopolymer films prepared from aqueous solutions fracture behavior of, 291–296
introduction, 291
materials and methods, 291–292
mechanical tests, 292
preparation of specimens and conditioning, 291–292
visualization techniques, 292
results and discussion, 292–296
effect of water content on physicochemical and structural properties of biopolymer films, 292–293
post-deformation plastic zone of biopolymer films, 295
prediction of dependence of fracture characteristics on water content for: brittle-ductile transition, 295–296
in situ visualization of crack propagation, 293–294
Biopolymer gels, ice crystallization during rewarming observed with, 373
Biopolymeric matrix, fluid transport and complex flow path presented by, 232
Biopolymers edible films developed from, for over 40 years, 453
heterogeneity of, microscopically, 192
natural interaction between water and, 291
typical adsorption-desorption cycles for, 238
Biotechnology and Biological Sciences Research Council, 296
Biscuit, dry, Fickian diffusion used to describe sorption dynamics of, 166
Blanched slices, of potato chips, 526
Bligh and Dyer methodology, potato chip oil content determined by, 526
Blocklets, starch granule structure, 253, 254
Blomberg, A., 76
Blond, G., 105
Blood cholesterol levels, soy-fortified diet and lowering of, 176
Blood plasma gels, moisture loss as function of temperature and salt concentration for, 243
Boiling-point curves, on state diagram, 91
Boonyai, P., 430
Borges, A., 120
Bouchon, P., 525, 527
Bound water, 115, 127
discrete-model assumption and describing free water vs., 256
Bound water fraction, 51
Bourne, M. C., 105, 121
Bovine serum albumin effects of, on storage stability of xanthine oxidase, 599, 600, 601, 601t, 602, 602t, 603
mixtures of, in probiotic cultures, 285
Bragg 2-theta angle peaks, powder X-ray diffraction of initial dry cotton candy and, 96, 97
Branch chains, distribution of, in amylopectin molecules, 253
Bread, extruded flat, compression-force-water-activity relationships for, showing antiplastication range, 120, 122
Bread crust
  dry, crispy, water sorption and transport in, 165–173
  conclusion, 173
  introduction, 165–166
  materials and methods, 166–167
  results and discussion, 167–173
  oscillatory sorption experiment on, 170, 170–171
  starch-rich adsorption and description rates from best fits between relative change of weight, during isotherm experiment and single exponential model as function of RH, 169
  adsorption and desorption rates for, during oscillatory sorption experiments, 172
  measured relative change in weight of, and adjusted external relative humidity, 167–168, 168
Bread model agar
  combined effect of selected essential oils and water activities on inhibition of molds on, 545
effect of cinnamon oil and water activity on inhibition of *Rhizopus stolonifer* and *Aspergillus flavus* on, 546
Bread produced in innovative mixer
  bread characterization, 607–608
  DSC-freezable water and retrograded amylopectin, 607
  image analysis, 607
  loaf volume, 607
  moisture content, 607
  NMR measurements, 607–608
  statistical analysis, 608
  texture analysis, 607
  water activity, 607
  materials and methods, 606–608
  bread formulation and production, 606–607
  water properties in, 605–611
  conclusions, 611
  introduction, 605–606
  results and discussion, 608
Bread production, discontinuous ingredient mixing in, 605
Bread quality and stability, factors related to, 605
Bread shelf life
  application of cinnamon and controlled relative humidity in extension of, 546–547, 549–550
  bread preparation, 546
Bread shelf life (continued)
inoculation, incubation, and growth
measurement, 546–547
statistical analysis of data, 547
effect of cinnamon essential oil and water
activity on growth inhibition of
Rhizopus stolonifer and Aspergillus
flavus and possible extension of,
545–550
Bread spoilage, mold growth and, 545
Bread Volume Measurer BVM-L370, 177
Breakfast cereals
expanded solid foams and, 247
moisture content and loss of crispness in,
106
Breeding programs, cryopreserved gametes
used in, 551
Brittle-ductile transition, 106
determining, 107
prediction of dependence of fracture
characteristics on water content for
biopolymer films associated with,
295–296
Brittle-ductile transition temperature, 106
Brittle-ductile transition temperature plot, as
function of moisture at constant
temperature for sugar snap cookie,
108
Brittle fracture, distinguishing, 106
Brookfield model RVDV III viscometer,
viscosity of egg-white solutions
determined with, 454
Brooks and Corey model, RC described in
soil science by, 226
Broth culture, influence of glucose on
fructose uptake in, 53
Browning development, in freeze-dried
potato discs, 439
Browning index
defined, 540
of 50% wt/vol systems during storage at
70°C, 541, 542
Browning rate
as a function of temperature and mass
fraction of water, 15
Maillard reaction and, 11, 14
Browning rate constants, for lactose, milk,
and lactose-starch systems, 14
Brunauer-Emmett-Teller (BET) monolayer,
89
Brunauer-Emmett-Teller value, coffee beans,
antiplasticization effect of water
and, 492
Brunauer-Emmett-Teller water-sorption
isotherms, 478
BSA. See Bovine serum albumin
Bulk acoustic wave sensor, aroma analysis
and, 658
Bulk and tapped density, of maltodextrin
powders, evaluating, 675
Bulk free volume
accessible volume playing role of,
309
depiction of feasible explanation
for association between
antiplasticization and
plasticization, based on, 311,
311–312
Bulk water fraction, 50–51
Butter fat
effect of water and fat contents on
enthalpy of dissolution of, 42
pure, measured enthalpy of dissolution of,
43

C
Caking
of amorphous food powders, 344–345
food storage and, 93
moisture pickup and, 95
during storage of powders containing
amorphous sugars, 100
Caking point temperature, advance, 100
Calcium, water content of, at 10% RH and
60% RH, 37t
Calcium lactate
effect of water content and, on phase-
transition characteristics of mung-
bean starch in first endotherm,
509–510, 509t
mung-bean starch and effect of, on
transition temperatures in second
endotherm at different levels of
water content, 510
mung-bean starch granules and findings
related to, 512
Calibration curves, water content determination and, 207
Calvet calorimeter, enthalpy of dissolution for model food powders quantified isothermally in, 43
Cambridge Crystallographic Data Centre, 478
Campbell, G. S., 228
Candy, glass-rubber transitions measured for, 435
Candy formulation, temperature effect on relaxation behavior of, 425
Capillarity, defined, 225
Capillarity and tension head, flow in unsaturated porous media and, 224–225
Capillary flow
mass transport in hierarchical structure and, 394
in porous media, 222–224
schematic illustration of mass transport by, 395
Capillary-flow approach to flow of liquids into dried foods, 233
for modeling temperature and anisotropic effects during rehydration of tea leaves, 231–232
Capillary imbibition theory, for modeling rehydration of foods, 231
Carbohydrate classes, effects of water on structure of, 356–357, 359
Carbohydrate hole sizes, suggested mechanisms leading to, increasing with water content in glassy state, 358
Carbohydrate matrix, varying molecular weight of, influencing membrane phase-transition temperature by, 368
Carbohydrate molecular weight, effect of, on matrix density and on glass transition temperature, 367
Carbohydrate polymers, disparate effect of water and low molecular weight sugars as plasticizers for, 362
Carbohydrates in amorphous states, 353–370
conclusions, 369–370
dynamic properties close to glass transition, 364, 366
effects of water on structure of carbohydrate glasses, 356–357, 359
glassy carbohydrates in food and pharmaceutical stability, 353–356
molecular packing in glassy carbohydrates, 359, 361–362
technological implications, 366–369
Carbohydrate-water systems
dynamic properties close to glass transition, 364, 366
outline of phase transitions and physical states of, in nonfrozen state at constant temperature, 354
snapshot from molecular dynamics simulation of, 359
Carboxymethyl cellulose, water content of, at 10% RH and 60% RH, 37
Carboxymethyl starch, water content of, at 10% RH and 60% RH, 37
Car interior temperature, hard candy exposure to, 101–102, 102, 104
Carotene degradation, 1820
magnitude of kinetic constants in, 19
Carotenoids, isochromic red fraction of, 683
Carrot fiber, T_g from DSC and corresponding DEA frequencies for, in freeze-dried amorphous fructose, 195
Carrot fiber as carrier in spray drying of fructose, 191–196
conclusion, 196
introduction, 191–193
materials and methods, 193–194
results and discussion, 194–196
carrot fiber powder size and sugar content, 194
DSC and DEA, 194–195
spray drying of fructose mixtures, 195–196
Carrot fiber-fructose, spray-dried, T_g and yield from DSC of maltodextrin-fructose and, at different ratios, 196
Carrot fiber powder size, sugar content and, 194
Carrots, volume decrease or shrinkage studied in, 613
Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence

coffee samples analyzed with, 494
evaluating NEB inhibitions or accelerations by magnesium chloride, water availability and saccharide-specific interactions with, 539, 541
gelatinization of cassava starch from drought and rainy seasons and water mobility measured by, 263
NMR experiment, microdomain distribution in food matrices, 60
starch study and $T_2$ measurement by, 258–259
water mobility measured by, acid-modified cassava starches diluted with water during heating and, 266
water mobility measured by, for cassava starches saturated with water during freezing, 264
Carr-Purcell-Meiboom-Gill echo train, hydration kinetics of cracker samples and, 414

Casein
cold gelation and, 242
unique structure of, 237

Casein films and composites
anomalous antiplasticization effects of water and mechanical properties in, 122
sorption dynamics of, 166

Case II diffusion
defined, 166
water sorption and transport in dry, crispy bread crust and, 165, 173

Cassava, as unique drought-resistant crop, 252

Cassava starch
acid-hydrolyzed, differential scanning calorimetry data for, 265
acid-modified, diluted with water during heating, water mobility measured by Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence, 266
from drought and rainy seasons, water mobility measured by Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence, 263
effect of water content on physicochemical and structural properties of, 292
five freeze-thaw cycles, $T_2$ distribution of protons in, 267, 268
gelatinized, moisture-content measurements for, 186
granular swelling upon gelatinization of, grown in drought and rainy seasons and harvested at 6 and 12 months, 260, 261
saturated with water during freezing, water mobility measured by Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence, 264
study of mechanical response to tensile loading of, 291
undergoing gelatinization, SEM and TEM micrographs of, 255
versatility and differing functionality of, 258

Cassava starch film
fracture characteristics of, brittle-ductile transition and, 296
infrared maps for, in the hydrated state, 295, 295
multicrack fracture mechanism of, 293
in situ visualization of stable crack propagation for, at 69% relative humidity by using the high-speed camera, 294, 294

Castor oil, water content of, 328

CCF. See Commercial cornflakes
CCF designs. See Composite face-centered designs
CD. See Cell density
CDs. See Cyclodextrins

Cefazidime, differential scanning calorimetric thermograms for, 32
Cefazolin sodium
correlation between onset temperature and $T_2$ for, 34
correlation between $T_2$ and temperature dependence of $T_2$ for, 35
differential scanning calorimetric thermograms for, 32
Gaussin-type decay and Lorentzian decay exhibited by, 29
water-sorption isotherms for, 33
Cefazolin sodium hydrates, water-sorption isotherms observed for, 31
Cefoxitin sodium, times for 10% degradation of, compared with measurements of structural relaxation and enthalpy relaxation times, 326

Ceftazidime
  correlation between onset temperature and \( T_2 \) for, 34
  correlation between \( T_2 \) and temperature dependence of \( T_2 \) for, 35
Gaussin-type decay and Lorentzian decay exhibited by, 29
Ceftazidime hydrates, temperature dependence of \( T_2 \) for, 34

Cell density
  image processing of bread dough and, 632, 633

Cell mortality, changes in fluidity of plasma membrane and, 76

Cells
effect of combined physical stresses on:
  role of water, 71–83
  example 1: effects of combined hyperosmotic and temperature perturbation, 72–77
  example 2: effects of combined high hydrostatic pressure, low temperature, and hyperosmotic perturbations, 77–82

Cellular wall collapse, shrinkage-deformation behavior during drying of potato slabs and, 613, 616, 617

Cellulose, in fibers, 192
Cellulose extraction, *Agave atrovirens* Karw, convection drying and, 619

Center of Excellence on Supramolecular Biomaterials: Structure Dynamics and Properties, 385

Center temperature, changes in dough/bread-crumble structure and, 631, 631

Cephalothin, hydrolysis rate of, in freeze-dried formulations, molecular mobility of water and, 26

Cereal cracker sample, water-sorption isotherms for, 416
Cereals, Fick’s laws of diffusion and water absorption of, 663
Cereal snacks, dry, perception of crispness of, 105

*Chadmo* quinoa seeds
  amplitude of signal of lipid component of, with different water activities, 652
  genotype description of, 648
  high viability and germination values for, 650
  percent germination of, during storage at 32°C and 43% or 75% relative humidity, 650, 650
  percent viability of, assessed by tetrazolium test, 651
  relaxation times of lipid component of, with different water activities, 652
  sorption isotherms of, 651t
  storage behavior of, 654

Chang, Y. P., 120, 121t, 122, 131
Charge-coupled device (CCD) digital cameras, shrinkage and deformation of agave slices evaluated during convective drying with, 619, 620

Charmathy, S. P., 126
Charoenrein, S., 642
Chatakanonda, P., 258, 440
Chemical titration, quantification of water by, 207

Chen, P. L., 259
Cheng, L. H., 125, 132

*Chenopodium quinoa*
  adaptability of, to extreme environmental conditions, 648
  materials and methods, 648–649
  seed material, 648
  molecular mobility and seed longevity in, 647–654
  discussion, 654
  introduction, 647–648
  results, 650–651


**Chenopodium quinoa (continued)**

NMR relaxation measurements, 649
seed conditioning, 649
spin-spin relaxation time measurement, 649
seed storage behavior, 648–649
germination assessment, 648–649
seed storage, 648
viability test, 649
sorption isotherms, 649–650
Chevallier, S., 628
Chiang rice, hydrothermal analysis of high-amylose rice starch from, 635
Chinachoti, P., 181
Chirife, J., 14, 439
Chitosan, uses and applications with, 459
Chitosan film

describing sorption dynamics of, 166
advantages with, 459
Fickian diffusion for, 166
Fourier transform spectroscopy spectra of, 461, 461
improving water-resistant properties of, 459
scanning electron micrographs of surfaces and fracture surfaces of, 462, 462
Chitosan/MPEG-Beta-PCL blend

homogeneous films

materials and methods, 460–461
blend films preparation, 460
chitosan and blend films characterization, 460–461
materials, 460
results and discussion, 461–463
FTIR analysis, 461–462
morphology, 462
water-vapor permeability, 462–463
water-vapor permeability of, 459–463
conclusions, 463
introduction, 459–460
Chitosan/MPEG-Beta-PCL blend ratio, rate of water-vapor permeability, 462–463, 463
Chocolate wafers, moisture content and transition temperatures of, 110
Chromatographic techniques, water content estimating with, 207
Chuy, L., 100
Cicerone, M. T., 132
Cinnamaldehyde

in cinnamon essential oil, 150
release of, during storage, 154–155, 155
sorption characteristics of beta-cyclodextrins formed with, and their release, 149
storage study on, 151
water sorption and stability of beta-cyclodextrin complexes with, 155
Cinnamon, ground, application of, and controlled relative humidity in extending bread’s shelf life, 546, 549–550
Cinnamon bark oil, minimum inhibitory concentrations of and potassium sorbate against *Rhizopus stolonifer* and *Aspergillus flavus*, 547
Cinnamon essential oil, combined effect of water activity and, on growth inhibition of *Rhizopus stolonifer* and *Aspergillus flavus* and possible application in extending bread’s shelf life, 545–550
Cinnamon oil

antifungal activity of, 547
effect of water activity and, on inhibition of *Rhizopus stolonifer* and *Aspergillus flavus*, on bread model agar, 547, 548, 549
preliminary examination of, for antifungal activities by an agar dilution method, 545
Citrus juice, studies of spray drying of, with maltodextrin as a carrier, 196
Citrus oils

antifungal activity of, 547
carbohydrate-encapsulated, oxygen uptake by, 367–368, 368
Clathrate, comparison of orientation about oxygen-oxygen hydrogen bond for, 206
Clathrate cage lattice, schematic of, 205
Clathrate hydrates, 204
Clathrate lattice, ice lattice vs., 204
*Clostridium botulinum*, 89
Cloudberry ellagitannins
microencapsulation and improving storage
stability of, 563–568
conclusions, 568
introduction, 563–564
materials and methods, 564–565
results and discussion, 565–568
storage stability, 566–568
water sorption and glass transition
temperature, 565–566
Cloudberry extract, encapsulated and
nonencapsulated, storage stability
of, at different relative humidities
evaluated as retention of
ellagitannins, content of ellagic
acid, and antioxidative activity, 567, 567t
Cloudberry phenolics
antioxidative and antimicrobial activity of, 563
extraction of, 564
CLSM. See Confocal laser scanning
microscopy
Coarcervates, formation of, 242
Coffea arabica, 492
Coffea canephora, 492
Coffee
raw
normalized differential scanning calorimetry thermograms of,
rehydrated at water activity 0.11
and 0.94, 495, 495–496
uniform-penalty inversion $T_2$
relaxograms of, rehydrated at
different water contents, 496,
496–497
raw and roasted, Guggenheim-
Anderson-de Boer parameters
computed by fitting of sorption
isotherms of, 494t
rehydrated green and roasted, normalized
fracture force of, as a function of
water activity, 495, 495
Coffee beans
materials and methods, 492–494
DSC measurements, 493
materials, 492
NMR relaxation measurements, 494
textural properties, 493
water-sorption isotherm, 492–493
results and discussion, 494–497
DSC results, 495–496
NMR results, 496–497
textural properties, 494–495
water-sorption discussions, 494
water state and mobility affecting
mechanical properties of, 491–497
conclusions, 497
introduction, 491–494
Cohesive forces, surface tension and, 225
Cojazzi, G., 381
Cold gelation, 242
Cold inflection point, for bread dough, 630
Collagen, protein films developed from, 453
Collapse
defined, 341–342
in freeze drying, 343
Collapse phenomena in food systems,
341–345
collapse temperatures, 345
effect of thermal and water plasticization
on mechanical, flow and, on
relaxation times and time-
dependent changes in food solids,
340
equilibrium and nonequilibrium states and,
337
importance of, 335
reasons for occurrence of, 342
stickiness and caking, 344–345
time dependence and, 336
Collapse properties, of amorphous food
solids in dehydration at various
water contents and, 343
Collapse temperatures, of freeze-dried
materials, 345
Collisions, between reactant molecules,
158
Colloidal phase separation, in dough, 50
Colorants, cyclodextrins and solubility,
stability, and bioavailability of,
150
Color changes
nonenzymatic browning and, 445
in potato slices during frying, 525, 529,
530
Color evolutions, of blanched potato slices fried at 180°C, 529, 530
Color function calculations, in freeze-dried potato disc study, 439
Color values
  of duck egg-white film made from shell eggs, 456t
  of duck egg-white films, 455
Commercial cornflakes
differential scanning calorimetry thermograms of, at 7.5% and 5.2% water content, 585, 585
Hahn spin-echo transverse relaxation time values vs. water content for, 586–587, 587
maximum force of compression and onset of glass transition temperature at different water contents for, 587, 588
relationship between relaxation time constant determined by free-induction decay analysis and temperature for, 586, 586
water content for, 583, 584
Compaction, balance of factors related to, 308
Compaction pressure
plots of porosity vs., compressibility of microcrystalline cellulose under different conditions of relative humidity and, 306, 306
relationship between tensile strength and, in microcrystalline cellulose, 309
Compartmentalized water concept, for water in polymer gels vs. from water in pores, 373
Compartmentalized water in polymer gels factors influencing ice crystallization of, 377
freezing scheme for, 379–380
scheme for ice crystallization of, 380t
Composite face-centered designs, 143–144
Compression-force-water activity relationships, for extruded flat breads showing wide antiplasticization range, 122
Compression pressure, effect of, on mechanical strength of MCC compacts, 308–309
Concentrated solution, liquid state of water and, 205, 206
Conducting polymer sensor, aroma analysis and, 658
Confectionary product changes
availability of water, lactitol crystallization and, 271–281
conclusions, 281
glass transition temperature and, 278, 280–281
introduction, 271–272
materials and methods, 272–275
determination of moisture content, 273
determining melting enthalpy, melting temperature, and glass transition temperature, 274
modeling glass transition temperature, 274–275
modeling of moisture content of crystallizing amorphous lactitol, 273–274
preparation of amorphous lactitol, 272
preparation of saturated salt solutions, 272–273
sample preparation for differential scanning calorimetry, 274
results and discussion, 275–278
melting temperatures of lactitol crystallites, 275–276
rate and extent of crystallization, 276–278
Confectionary products
sugar as major component of, 271
water activity level and maintaining quality of, 271–272
Confined water
relaxation time of, 408–409
restricted mobility of, 409
Confocal laser scanning micrographs, of mung-bean starch gel containing 60% water content (wt/wt) prepared by autoclaving at 121°C, 511, 511
Confocal laser scanning microscope
jellyfish images taken with, 389, 390
microstructure of jellyfish characterized
by, 385
Confocal laser scanning microscopic images
of cells and fibers in mesoglea, 391
showing area of mesoglea consisting of
open network structure composed of
polysaccharides and proteins, 392, 392
Conoidial suspension, *A. flavus* and *R.
stolonifer*, fungal strains and
preparation of, 546
CONTIN computer program, continuum-
model approach pursued with, 258
Continuous models
application of, to NMR relaxometry, 259
of proton relaxation, in interpretation of
exponential decay curve, 257
Continuum models, for water mobility
(proton spin-spin relaxation time, $T_2$), 62–64
Convective drying
evaluating deformation and shrinking of
potato slabs during, 613–617
experiments on *Agave atrovirens* Karw, 620
image processing and fractal analysis used
to study shrinkage and deformation of
agave slices during, 620–621
Convenience foods, continued demand for,
219
Cookies
dynamic mechanical thermal analysis of, 106
moisture content and loss of crispness in, 106
sugar snap
brittle-ductile transition study on, 107
brittle-ductile transition temperature
plot as function of moisture at
constant temperature for, 108
wafer, stress/strain plot for, at 0.05%
relative humidity and 23°C, 109
Cool, dry storage, for hard candies, 105
Cooling rate, free volume of molecules
within amorphous matrix and, 338

Cooperative alpha relaxation, 419
Copolymeric food packaging, anomalous
antiplasticization effects of water
in relation to some mechanical
properties demonstrated in, 122
Copovidone, water content of, at 10% RH
and 60% RH, 371
Corn, leveling of melting enthalpies for,
277
Corn curls, extruded, loss of crispness in,
105
Corn flakes
thermal transitions, mechanical properties
and molecular mobility in, as
affected by water content, 583–588
introduction, 583–584
materials and methods, 584–585
results and discussion, 585–588
Corn powder
hydration experiments on, 414
water-sorption isotherms and dependence
of relative mobile tdNMR signal
on hydration for, 417
Cornstarch, native, glass-rubber transitions
measured for, 435
Corn-syrup solids
representative calorimetric thermograms
of, 422
representative differential scanning
calorimetric thermograms of,
indicating increased enthalpy
relaxation overshoot at higher
water activity, 424, 424
Corn syrup-sucrose mixture
enthalpy relaxation
as function of corn syrup-sucrose ratio, 426
as function of temperature, 427
as function of water activity, 424–425
glass transition temperature value of,
421f
analysis of enthalpy relaxation data,
421–423
kinetics of enthalpy relaxation in, 419–427
conclusion, 427
introduction, 419
Kohlrausch-Williams-Watts parameters
for, 423f
materials and methods, 420–421
determination of enthalpy relaxation
kinetics, 420–421
sample preparation in glassy state at
various water activities, 420
observed and predicted (Kohlrausch-
Williams-Watts model) enthalpy
relaxation values for, at aging
temperature of 22°C, 426
representative differential scanning
calorimetric thermograms of, at
various proportions, 425
results and discussion, 421–427
temperature effect on relaxation behavior
of, 425
Corn syrup-sucrose mixture, representative
calorimetric thermograms of, 422
Corn syrup-sucrose ratio, enthalpy
relaxation as function of, 426
Corn zein, protein films developed from,
453
Cosmetic industry, cyclodextrins used in,
150
Cotton candy, 88, 111
fresh, X-ray diffraction (XRD) pattern
for, 96, 97
history behind, 95
initial dry, powder X-ray diffraction of,
97
sugar recrystallization in storage of foods:
sucrose and, 95–100
X-ray diffraction powder pattern of, stored
for 2 hours at 45% relative
humidity and 23°C, 97
Covalent bonds, 158
CPAs. See Cryoprotective agents
CPMG pulse sequence. See Carr-Purcell-
Meiboom-Gill pulse sequence
Crackers
dynamic mechanical thermal analysis of, 106
moisture content and loss of crispness in,
106
Cracker sample, porous, water-sorption
isotherms for, 415
Crack propagation
in situ visualization of, 293–294
stable, in situ visualization of, for
hydroxypropyl cellulose film and
cassava starch film at 69% relative
humidity by using high-speed
camera, 294, 294
Crank, J., 167
Crispness
consumer appreciation for, 165
do, dry, crisp products, control of,
592
of glassy tapioca-flour-based baked
samples, sensory approach to,
595–596
loss of
food storage and, 105–108, 111
moisture pickup and, 95
potato chips processing and, 526
in tapioca-flour-based baked products,
591–592
rating for, 593
Crisp snacks, 88
Crispy Cracks: Creating and Retaining the
Crispness of Food
Symposium (University of Wageningen,
Netherlands), 105
Cross-linked dextrans
containing small amount of water, glass
transition of, 381
ice crystallization exotherm during
rewarming observed with, 374–
375, 377
Crowe, J. H., 16, 368
Cryogenic ethanol, at −40°C and −80°C,
adsorption surface changes as
function of water activity of
sucrose-calcium powders at 25°C
by, 686
Cryomicroscopy, freeze-thaw behavior of
aqueous glucose solutions within
concentration range of 10%-60%
wt/wt studied by, 466
Cryopreservation
description of process, 551–552
ice and freeze injury of cells during,
551
improving cell survival during, 552
Index

Cryoprotective agents
  nonpermeable, types of, 551
  permeable, types of, 551
Crystal hydrates, 204
Crystal lattice, 204
Crystalline food powders, factors related to
different behavior of amorphous
food powders and, 45
Crystalline samples, different dissolution
behavior of amorphous saccharides
and, 42
Crystallinity
  amyllopectin lamellae, 253
  polymer-diluent interactions and, 119
Crystallinity index, 126
Crystallization
  of polyols, more research needed for,
  272
  in pure-water ice, generally observed in
  the hexagonal dendrite, 466
  short-range mobility and, 94
  of sugars, food properties and, 271
  time-dependent, of amorphous lactose,
  347
Crystallization phenomena, 345–348
  crystallization of amorphous sugars and,
  346–348
  as glass transition-related time-
dependent change in low-water
  and frozen foods, 336
  ice formation, recrystallization and,
  348
Cutins, in fibers, 192
Cyclodextrins
  composition of, 149
  uses for, 149–150
Cysteine
  effect of water content and, on phase-
  transition characteristics of mung-
  bean starch in first endotherm,
  509–510, 509r
  influence of, on starch network
  architecture at intermediate water
  content, 511–512
  mung-bean starch and effect of, on
  transition temperatures in second
  endotherm at different levels of
  water content, 510

D
  Dairy foods, dehydrated, lactose glass
  transition in, 336
  Dairy powders, sticking or caking, during
  storage of, 100
  Darcy equation, fluid flow in porous media
  and, 233
  Darcy flow of gases, due to pressure, 233
  Darcy flow of liquid, due to gas and
  capillary pressures, 233
  Darcy law, flow equation in saturated media
  and, 227
  Davies, R. J., 51
  DEA. See Dielectric analysis
  Decagon, 90
  Decoupling of mobility of water, from
  mobility of carbohydrate molecules
  in approach to glass transition,
  technological implications of,
  366–369
  Deep-fat-fried potato chips, loss of crispness
  in, 105
  Defects, in glassy structure, 419
  D_{eff}-moisture-content curve, form of,
  resembling that of modulus-
  moisture-content curve of
  antiplasticized system, 129
Dehydrated foods
  Arrhenius relationship and reactions
  limiting storage stability of, 98
  stability of, main requirements for,
  342–343
Dehydration
  manipulating food composition to control
  collapse phenomena in, 335
  membrane structure and fluidity and, 71
  sequence of hyperosmotic perturbation of
  yeast cells and, 72
  understanding plasma membrane changes
  occurring during, 77
Dehydration characteristics, importance of
  collapse phenomena in food
  systems and, 335
Dehydration process
  encapsulation of biomolecules, in
  amorphous matrix formed during,
  18–19
  freezing process vs., 338
Dehydration step, interdependence of changes occurring in rehydration step and, 74
De la Fuente, G., 55
Del Nobile, M. A., 166
Denaturation
heat gelation and, 239
relative kinetics of aggregation and, 240
Dense glass, endotherm around glass transition and, 340
DENT specimens. See Double-edged notched tension specimens
de Pablo, J. J., 543
Desiccated oils, lower solubility for estradiol and testosterone in, vs. in hydrated oils, 330, 332
Desiccators, saturated salt solutions used to maintain fixed relative humidity levels in, 303
Desorption behavior, hysteresis between adsorption behavior and, 238
Desorption cycles, typical, for biopolymers and foods, 238
Desorption rates
adsorption rates vs., for starch-rich model bread crust, 169, 169–170
for starch-rich model bread crust during oscillatory sorption experiments, 172
Deteriorative reactions, analyzing kinetics of, 21
Deterministic chaos, solid matrix diffusion studied in frame of, 520
Deuterium
$T_1$ of, correlation between, and crystallization rate of amorphous nifedipine in solid dispersion formulations, 26, 27
$T_1$ of, correlation between and hydrolysis rate of cephalothin in freeze-dried formulations, 26, 26
Devitrification, 348
Dextran gels, cross-linked, ice crystallization exotherm during rewarming observed with, 374–375, 377
Dextrans
cross-linked
glass transition of, containing small amount of water, 381
ice crystallization during rewarming of, 373
effects of, on storage stability of xanthine oxidase, 599, 600, 601, 601r, 602, 602r, 603
Dickenson, E., 245
Dielectric analysis, 192
finding glass transition temperature from freeze-dried mixtures of carrot fiber plus fructose with use of, 191, 194–195
physical state of protein-carbohydrate sheets verified by, 579
Dielectric constants, of various compounds, 159
Dielectric disturbance, time-dependent response of amorphous materials to, 341
Dielectric relaxation, in amorphous materials below and around glass transition, 342
Dielectric relaxation spectroscopy, 25
probing properties of carbohydrates in glassy state with, 355
Differential scanning calorimetric thermograms
for active pharmaceutical ingredient hydrates, 32
of corn-syrup solids, indicating increased enthalpy relaxation overshoot at higher water activity, 424, 424
of corn syrup-sucrose mixture at various proportions, 425
Differential scanning calorimetry, 10, 14, 25, 192
amorphous lactitol sample preparation for, 274
denaturation measured by, 239
determining heat needed to melt thymol or cinnamaldehyde in complexes with use of, 151
ease of evaporation for hydration as determined by, and water-sorption isotherm measurements, 31
fibrous and dense protein composites inspected by, 247
finding glass transition temperature from freeze-dried mixtures of carrot fiber plus fructose with use of, 191, 194–195
findings related to characterization of water fraction of soy bread with, 175
freezeable water in soy bread and almond-soy bread obtained from, 181, 181
freeze-thaw behavior of aqueous glucose solutions within concentration range of 10%–60% wt/wt studied by, 466
glass transitions for potato discs determined with, 438
measuring distribution of water in bread with, 176
onset of glass transition temperature of food powders measured by, 434
physical state of protein-carbohydrate sheets verified by, 579
solvent water in dough and, 51
state diagram generation and use of, 214
thermal properties of food-grade starches determined with, 508
Differential scanning calorimetry data, for acid-hydrolyzed cassava starch, 265
Differential scanning calorimetry rewarming traces obtained with gelatinized potato-starch gels, 382
obtained with Sephadex gels dependent on prior freezing, 376
obtained with Sephadex G25 gels containing small amount of water, 381
Differential scanning calorimetry studies of amorphous sugars, 346
on freezing behavior of polymer gels, 373
Differential scanning calorimetry thermograms for cinnamaldehyde and beta-cyclodextrin-cinnamaldehyde complex, 153–154, 154
of commercial cornflakes and sugar-frosted cornflakes, at 7.5% and 5.2% water content, 585, 585
for cornflakes study, 584
enthalpy relaxation kinetics in corn syrup-sucrose mixtures and, 420, 421
for thymol and beta-cyclodextrin-thymol complex, 153, 153
Differential thermal analysis, of solvent water in dough, 51–52
Diffusion, schematic illustration of mass transport by, 395
Diffusion model, rehydration studies and, 221–222
Diffusion rates, size of diffusing molecule and affect on, 94
Dilatometry, probing properties of carbohydrates in glassy state with, 355
Dilute solution, liquid state of water and, 205–206
Dilution of the glass, 42
Dimethyl sulfoxide addition of, to freezing solutions, 551, 552
dielectric constants of, 159
Dimethyl sulfoxide salt solution, composition of ethylene glycol salt solution and, with constant weight ratios of 4.54 and 18.17, 553
Dimethyl sulfoxide-salt-water, partial phase diagram of, with constant weight ratio values of 4.54 and 18.17, 558
Dimethyl sulfoxide solution, leakage from large unilamellar vesicles with various concentrations of, after cooling and heating of mixture, 560
Dipole-dipole force, solvent-water concept and, 50
Disaccharides as effective stabilizers, 600
intermolecular hydrogen bonds, NEB progress in the glassy matrix and, 576
mixtures of, in probiotic cultures, 285
retention of LGG viability during freezing, freeze drying, and storage with, 289
survival during drying and, 141
Discrete models of proton relaxation, in interpretation of exponential decay curve, 257

Dispersability of maltodextrin powders, determining, 675
maltodextrin powders evaluation, at different feed concentrations and drying temperatures in production of powders, 677
quality of food powder properties obtained by spray drying and, 674

Dispersive model, dough sample and use of, 61

Disposable baby diapers, superabsorbent polymers used in, 386

Dissolution, use of term, relative to food powders, 42
Dissolution of soluble food powders, coupling between heat and mass transfer during process of, 46
Dissolution process, complexity of, 47
Distilled water, iso-inactivation of Escherichia coli, vs. pressure and temperature in, 81

D-limonene encapsulated, 499
effect of water activity on and n values for release of from spray-dried powder at 50°C storage, 503
effect of water activity on release-rate of, at 50°C, 503
release time courses in spray-dried powders stored at various relative humidities, 501
encapsulated flavor powder preparation, 500

DMA. See Dynamic mechanical analysis
DMSO. See Dimethyl sulfoxide
DMTA. See Dynamic mechanical thermal analysis

Double-edged notched tension specimens, 291

Dough aqueous phase of, 52
pasta, heated at 5°C, 246
solvent water in, 51–52
transforming to bread, steps in, 627
Dough/bred-crumb evolution, center temperature and, during baking, 631, 631
Dough foam structure, transformation of, into elastic crumb sponge, 627–628
Dough manufacture, 52
Dough structure, 50
Downton, G. E., 344

DPPC. See 1,2-dipalmitoyl-rac-glycero-3-phosphocholine

DPPC large unilamellar vesicles, phase volume of ice and unfrozen matrix at −40°C and leakage of, at −40°C, 557, 557

Dried foods new approaches with, and other advances in rehydration of, 232–234
rehydration of, as fundamental unit operation in food industry, 219
Dried solid matrix, empirical or semiempirical models and liquid transport into, 233
Drink mixes, sticking or caking, during storage of, 100
Drought-resistant crops, 252

DRS. See Dielectric relaxation spectroscopy

Drugs, hypothetical states of matter of, 90
Drug solubility in lipid vehicles, water uptake, distribution, and effects on those composed of triglycerides and monoglycerides, 326–330, 332

Dry foods importance of prediction and control of NEB in, 571
stored, nonenzymatic browning and stability of, 445
Drying, effects of various perturbations on, 72
Drying conditions, influence of, on shrinkage and deformation of potato slabs, 615–616
Drying kinetics agave samples and, 621
of agave slices, at 60°C and 2 m/s for longitudinal and transverse cuts, 622
Dry pasta systems, Maillard reaction in, 162
DSC. See Differential scanning calorimetry
DTA. See Differential thermal analysis
Dubinin-Radushkevitch relationship, 681, 682
Duck egg white
description of, 453
film-forming ability of, and its water-vapor barrier property, 453–458
conclusion, 457–458
introduction, 453
Haugh unit, viscosity, and pH of, stored at room temperature for 18 days, 455, 455
materials and methods, 454
barrier properties, 454
egg freshness, 454
film preparation, 454
physical properties, 454
statistical analysis, 454
viscosity, 454
results and discussion, 455–457
barrier properties, 457
color properties, 455
egg freshness, 455
film formation, 455
mechanical properties, 456–457
separated from shell eggs, viscosity and film-forming ability of, 456
Duck egg-white film
made from shell eggs, barrier properties of, 457, 458
made from shell eggs, mechanical properties of, 457
Ductile materials, brittle materials vs., 106
Duncan’s new multiple range test, pineapple sample statistical analysis and use of, 659
DVS. See Dynamic vapor sorption
Dye, W. B., 95, 96, 97, 346
Dynamic differential scanning calorimetry, tapioca-flour-based baked products study and determining glass transition temperature with, 593
Dynamic mechanical analysis
distribution of water in bread measured with, 176
physical state of protein-carbohydrate sheets verified by, 579
Dynamic mechanical thermal analysis, 106, 124, 427, 429
Dynamic vapor sorption, sorption behavior followed by, 484
E
Edible films, starch-based, 642
influence of glass transition on oxygen permeability of, 641–644
conclusion, 644
introduction, 641
materials, 642
methods
glass transition temperature, 642
oxygen permeability, 642
preparation of starch films, 642
preparation of starch with various chain lengths, 642
results and discussion, 642–644
glass transition temperature, 643–644
oxygen permeability, 642–643
Edible films and coatings
chitosan and, 459
for future food packaging, 453
Ediger, M. D., 18
EDTA, fresh and dialyzed jellyfish as well as alginate gel subjected to, 392
Effective diffusion coefficient, 221
for milled rice grains at different temperatures, 669
EG. See Ethylene glycol
Egg-albumen films, water-vapor permeability values for, 453
Egg-white solutions, viscosities of, after addition of sorbitol, 455
Elbing, K., 55
Electrical conductivity, enzyme stability and measurements of, 17–18
Electronic nose (e-nose)
data on sensitivity of, to pineapple aroma during freezing and thawing, 659–661
measurements of frozen-thawed pineapple samples, 659
off-aroma scores from sensory evaluation of freeze-thaw pineapple corresponding to data from, 661
Electronic nose (e-nose) (continued)
principal component analysis plot for
fresh and freeze-thaw Smooth Cayenne and Queen pineapple cultivars determined by, 659, 660
Electronic nose (e-nose) technique,
analyzing effect of freeze-thaw cycle on pineapple off-aroma with, 657–661
Electron paramagnetic resonance
in combination with PALS, for insight
into structure of carbohydrate-water system, 359
investigating dynamic properties close to
glass transition and, 364
Electron spin resonance
probing properties of carbohydrates in
glassy state with, 355
TEMPO dissolved in dough matrix and
monitored with, 64–66
Electron spin resonance spectrometer,
microdomain distribution in food matrices and measured values in
experiment with, 60–61
Elizalde, B. E., 20
Ellagitannins, 563
encapsulated and nonencapsulated, storage
stability of, 566–567
at low RH, increased storage stability of,
via encapsulation by maltodextrin
DE5-8 vs. maltodextrin DE18.5,
563, 567, 568
Elongation, softening of a polymer and, 402
Empirical models
liquid transport into dried solid matrix
and, 233
rehydration studies and, 220
Emulsifiers
controlled kinetics of Maillard reaction
and, 11
water interactions and, 157
Emulsification, proteins and, 245
Endocytic vesicles, deep plasma membrane
invaginations and formation of, 74
Endothermic enthalpy relaxations, changes
in volume associated with around
glass transition, 341
Endothermic trend, origin of, observed prior
to exotherm during rewarming,
377–379
Enthalpy relaxation, 419
as function of corn syrup-sucrose ratio,
426
as function of water activity, 424–425
physical changes caused by, 445
time and temperature dependence of, 420
Enthalpy relaxation kinetics, determination
of, in corn syrup-sucrose mixtures,
420–421
Enthalpy relaxations, of amorphous materials
and, 340
Enthalpy relaxation time, macroscopic
molecular mobility of glass and, 446
Environmental moisture, tablet making and,
302
Environmental scanning electron
microscopy, appearance of freeze-dried Sephadex beads detected
through, 380
Enzyme stability, 16–18
EPNOE. See European Polysaccharide
Network of Excellence
EPR. See Electron paramagnetic resonance
Equilibrium freezing-point curves, on state
diagram, 91
Equilibrium relative humidity (ERH), 88
modeling approach to predict sorption
behavior of nonelectrolytic
mixtures and, 483
thermodynamic approach and, 208
Erythorbic acid
NMR and EXR experiments with wheat
flour dough and, 60–61
reaction kinetics and monitoring of, in
dough matrices at different
moisture contents and
temperatures, 64
Escherichia coli baroresistance, effect of low
temperature and hyperosmotic
perturbation on, 79–80
Escherichia coli inactivation
pressure and temperature in a binary
medium at a water activity of 0.85
vs., 80
pressure and temperature in binary medium at a water activity of 0.99 vs., 79
pressure and temperature in distilled water vs., 81
*Escherichia coli* K12TG1 cells, unusual pattern of survival of, after combined high-pressure and subzero-temperature treatments, 78
*Escherichia coli* survival, combined high hydrostatic pressure and low temperature on, 77–79
Essential oils
  antifungal activity of, 546
cyclodextrins and solubility, stability, and bioavailability of, 150
Estradiol, water content and solubility of, 330
ET. See Ellagitannins
Ethanol, dielectric constants of, 159
Ethylene glycol, addition of, to freezing solutions, 551, 552
Ethylene glycol salt solution, composition of dimethyl sulfoxide salt solution and, with constant weight ratios of 4.54 and 18.17, 553
Ethylene glycol solution, leakage from large unilamellar vesicles with various concentrations of, after cooling and heating of mixture, 560
Ethylene vinyl alcohol, anomalous antiplasticization effects of water and relation to mechanical properties in, 122
Eudragit E100
  components in, 402
  effect of low concentrations of water on, 404
  effect of low concentrations of water on glass transition temperature of, 405
  permeability of water in, as function of relative humidity, 406
Eudragit E100-indomethacin mixture, effect of low concentrations of water on glass transition temperature of, 408
Eukaryotic cells, physical or physicochemical environment changes and stress on, 71
European Polysaccharide Network of Excellence, 296
Excipients
  effects of, on storage stability of freeze-dried xanthine oxidase, 599–603
  mechanisms of stabilization of freeze-dried protein by, during dehydration, 600
  in pharmaceutical formulations, 302
Exothermic enthalpy relaxations, changes in volume associated with, around glass transition, 341
Expanded solid foams, 247–249
Exponential decay curve, discrete and continuous models of proton relaxation in interpretation of, 257
Exponential model, 165
  adsorption and desorption curves from oscillatory experiments on model bread crust described by, 165, 168–171
  adsorption and desorption curves from oscillatory experiments with dry, crispy bread crust described by, 165, 167
  bread crust experiments and summary of fitted diffusional coefficient and goodness of fits of diffusion model and, 171
  curve fitting of rehydration data and, 221
  oscillatory adsorption and desorption curves for bread crust best described by, 173
  predicting moisture rate of rice grains with, 664
  rehydration studies and, 220
  rice varieties and, regression coefficient and percentage of root mean square error obtained from model fitting with, 667
External mechanical antiplasticization, by water, 116
Extruded flat breads, compression-force-water-activity relationships for, 120, 122
Extruded snacks, proteins and, 237
Extruded wheat flour, light micrograph of, showing starch as continuous structure with protein particles included, 249

Extrusion
cost-effectiveness of, in food industry, 578
structuring proteins by, 246–249
expanded solid foams, 247–249
fibrous and dense composites, 246–247
intermediate to high water content, 246

F
Fairy floss, 95
Fat content
enthalpy of dissolution measurements for, in model food powders, 43
enthalpy of dissolution for food powder samples tested as function of water activity and, 44
enthalpy of dissolution of all food powder samples tested as function of water contents and, 46
enthalpy of food powder dissolution and effects of, 41, 42, 43, 44, 45, 46
Fat crystallization, glass transitions overlapping with, at some levels of water plasticization, 337
FDA. See Food and Drug Administration
FDC. See Fractal dimension of the slice contour
Feret diameter, image analysis and qualifying parameters related to, 613
Fermi model, relaxation times above glass transition modeled with, 339
Fibers, composition of, and use in spray drying, 192–193
Fibrous structures, formation of, from proteins, 246
Fickian diffusion model, 165, 167
defined, 166
Isotherm and oscillatory simulation of in sphere, summary of fitted diffusional coefficient and goodness of fit of diffusion model and exponential model for, 171

Fick’s laws of diffusion, 166, 232
first law, diffusion model and, 221–222
liquid transport into dried solid matrix and application of, 233
second law, 220, 533
diffusion model and, 221–222
permeability of water through polymer obtained with, 404–405
water absorption of cereals and legumes described by, 663
transport phenomena in foods and drawbacks with, 222
Fick’s second law solution for a sphere, water-diffusion process in rice grains during soaking determined with, 665
FID. See Free-induction decay
Finney, J. L., 238
First-order kinetics model
curve fitting of rehydration data and, 221
rehydration studies and, 220
Fish, testing freshness of, 599
Flake extrudate, aligned, 246, 247

Flavor encapsulation
definition of and advantages with, 499
effect of water activity on release characteristics, 499–505
conclusion, 504–505
introduction, 499–500
materials and methods, 500–501
encapsulated flavor powder preparation, 500
materials, 500
release of encapsulated flavor from spray-dried powder, 501
results and discussion, 501–504
analysis of release rate and release mechanism by Avrami equation, 502–504
effect of relative humidity on release of D-limonene from the powder, 501
effect of relative humidity on release of L-menthol from the powder, 502
Flavor in food
  cyclodextrins and solubility, stability, and
  bioavailability of, 150
  main components of overall sensation of, 657
  nonenzymatic browning and changes in, 445
Flink, J. M., 345
Flomoxel in gelatin gel, with kanamycin, hydrolysis rate of, 26
Flour, water interacting with polymers in, 51
Flour suspensions, that have undergone five freeze-thaw cycles, $T_2$ distribution of protons in, 268
Flowability, water of hydration, API hydrate and, 26
Flow behavior, of high-amylose rice-starch samples, 636
Flow in porous media theory, 233
Flow properties of particles in dehydration, collapse phenomena in food systems and, 335
Fluidity, hydraulic conductivity of saturated porous medium and, 227
Fluorescence emission spectra, of 50% wt/vol sugar systems at 70°C for 168h/240h, glucose and trehalose systems respectively, 541, 542
Fontanet, S., 121
Food and Drug Administration, 176
Food biopolymer gels, ice crystallization during rewarming observed with, 381–382
Food colloids, composition of, 251
Food dehydration, main requirements for, 342–343
Food drying process, complexity of, 673
Food gels, 119
Food industry, decoupling of mobility of water from mobility of carbohydrate molecules in approach to glass transition and implications for, 366–369
Food matrix, stability of, factors related to, 59
Food packaging, future, edible films and coatings for, 453
Food polymer science, basic premise behind, 116
Food polymer-water blend
  properties of, 119–120, 122–126
  gas transport, 126
  mechanical, 119–120, 122–124
  thermal, 124–126
Food powders
  dissolution kinetics of, critical importance of, 41
  effect of water and fat contents on enthalpy of dissolution of, 41–47
  conclusions, 46–47
  experimental methods, 42–43
  introduction, 41–42
  results and discussion, 43, 45–46
  enthalpy of dissolution for all samples, tested as function of their water and fat contents, 46
  enthalpy of dissolution of all samples tested as a function of water activity, 44
  exothermic responses from dissolution of, at all conditions tested, 43
  less exothermic responses related to slower dissolution rate in, 46
  model, characterization of, 42
  thermodynamics and predicting dissolution of, 46
Food processing, quality and safety characteristics in, 673
Foods
  as complex examples of soft condensed matter, 87
  hypothetical states of matter of, 90
Food safety, quality and stability, distribution of microstructural domains and assessment of, 66
Food sciences
  carbohydrate polymers and role in, 301
  water as most common plasticizer in, 401
Foods in storage, physical state changes in, 93–94
Food solids, effect of thermal and water plasticization on mechanical, flow, and collapse phenomena on relaxation times and time-dependent changes in, 340
Food stability
- general rules with respect to measured $a_w$ and, 89–90
- nanostructures and minimum integral entropy as related to, 681–687
- relative vapor pressure and, 212

Food systems
- heterogeneity of, 61
- proteins in, 237
- Forssell, P. M., 643

Fourier transform infrared spectroscopy, 126
- apparent crystallinity index of microcrystalline cellulose, obtained from, 310, 310
- chitosan and blend films characterization with, 460–461
- in combination with PALS, for insight into structure of carbohydrate-water system, 359
- post-deformation plastic zones used with, in monitoring fracture behavior of biopolymer films prepared from aqueous solutions, 292
- water-replacement hypothesis partially corroborated by use of, 355

Fourier transform spectroscopy spectra, of chitosan film, 90:10 blend film, 80:20 blend film, 70:30 blend film, and MPEG-Beta-PCL powder, 461

Fractal analysis
- macroscopic shrinking and deformation in potatoes studied with, 613
- shrinkage and deformation of agave slices evaluated during convective drying with, 620, 625

Fractal dimension, image analysis and qualifying parameters related to, 613

Fractal dimension of the slice contour, agave slices during convective drying and, 621

Fractal geometry
- evaluating complexity of biological systems with, 515
- studying interfaces and their roles as transfer-controlling barriers with, 613

Fracture response of food material, determining, 107

Fracture stress and fracture strain, changes in, for gluten and starch, as function of moisture content, 124

Free-induction decay, 15, 60, 251
- for ceftazidime and cefazolin sodium hydrates, 29
- hydration kinetics of cracker samples and, 414
- for Na$_2$HPO$_4$·12H$_2$O and Na$_2$HPO$_4$·2H$_2$O, 28
- for quinidine sulfate and scopolamine hydrobromide hydrates, 30
- water mobility in model dough system and, 62

Free-induction decay analysis
- molecular mobility in cornflakes evaluated with, 584
- relationship between relaxation time constant determined by, and temperature for commercial cornflakes and sugar-frosted cornflakes, 586, 586
- Free-induction decay curve, non-monoexponential, evaluating, 257

Free volume
- defined, 94
- gas transport properties and, 126
- plasticization-antiplasticization threshold of water in microcrystalline cellulose based on, 301, 309–312
- water and increase in low molecular weight materials and polymers, 407

Free-volume reduction, 118

Free water, 115, 128
- discrete-model assumption and describing bound water vs., 256
- “Freezable” water, in soy bread and almond-soy bread, 181

Freeze-concentrated glass formation, 599
Freeze-concentrated systems, ice formation in, 348

Freeze concentration, starch fraction and effect of initial water content and freezing temperature on rate of, 188
Freeze-dried amorphous food powder samples
large exothermic responses observed for, 43, 45
typical dissolution calorimetry curves of, containing different amounts of fat, 44
Freeze-dried enzymes, analyzing stability of, over range of temperature and water-content conditions, 16
Freeze-dried food powder samples, hydration of hydrophilic groups in, and highly exothermic values for, 45
Freeze-dried formulations, mannitol in, 20
Freeze-dried products, appearance of, factors related to, 142
Freeze drying
bacterial preservation and, for food and pharmaceutical applications, 285
collapse in, 343
collapse phenomena in food systems and, 335
entrapment of probiotic bacteria in frozen cryoprotectants and viability in, 285–289
stresses generated by, 599
successful, requirements for, 343–344
uses for, 141
water activity of sucrose-cell formulations after, 144, 145
Freeze drying of Lactobacillus coryniformis Si3
focus on water, 141–147
introduction, 141–142
materials and methods, 142–144
cell survival, 143
fermentation and sample preparation, 142
freeze-drying protocol, 143
statistical analysis, 143–144
thermal analysis, 142–143
water activity, 143
results and discussion, 144, 146
important factors for freeze-drying survival, 144
water and solute properties, 144, 146
Freeze-drying survival
effects plot with error bars showing 95 confidence level relative to, 144, 146
important factors for, 144
Freezing
effect of initial water content and freezing temperature on starch-fraction moisture content after, 187–188
effects of various perturbations on, 72
understanding effects of, in starch-based food, 185–186
Freezing behavior
of polymer gels, investigation of, 373–383
of water-saturated starch granules, 263–264
Freezing processes, dehydration processes vs., 338
Freezing rate
freeze-drying survival and, 144
water activity of sucrose-cell formulations after freeze-drying and, 144, 145
Freezing scheme for compartmentalized water, in polymer gels, 379–380
Freezing temperatures, various, evolution of starch-fraction moisture content in function of freezing time at, 189
Freshness testing paper, 599
Frozen desserts, ice recrystallization and, 348
Frozen dough
affinity constants for glucose uptake by Saccharomyces cerevisiae, 55t
centration of glucose and fructose in, made with 2 yeast and 2 added sucrose fermenting at 30°C, 54
factors related to shelf life of, 49
materials and methods, 52
manufacture of, 52
sugar extraction and analysis, 52
proofing power and, 49
results and discussion about, 52–53, 55
“solvent-water” concept and, 50–51
solvent water in, 51–52
structure of, 50
summary of mathematical model parameters, 55t
Frozen-dough segment of bakery industry, yeast-leavened part of, 49

Frozen foods
- crystallization of sugars in, 347
- differing stabilities of, 212
- phase separation of ice crystals in starch-based systems during freezing and practical implications for, 185–190

Frozen systems, water measurement and, 204

Fructose
- as antiplasticizer, 130
- approximate solubility of, in glycerol at 60°C after equilibration period of 10 days, 160
- carrot fiber as carrier in spray drying of fructose, 191–196
- conclusions, 196
- introduction, 191–193
- materials and methods, 193–194
- results and discussion, 194–196
- concentration of, in dough made with 2 yeast and 2 sucrose fermenting at 30°C, 54
- first-order phase transition (melting) of, by use of common sugar crystals, 433
- freeze-dried, amorphous, derivative of capacitance vs. temperature for, 194
- freeze-dried amorphous, $T_g$ from DSC and corresponding DEA frequencies for carrot fiber in, 195
- spray drying of, difficulties with, 191
- fructose-carrot fiber, spray-dried powders of, compared to those of fructose-maltodextrin, 191, 193, 195, 196
- Fructose content, glucose content and, in doughs, 53
- fructose-maltodextrin, spray-dried powders of fructose-carrot fiber compared to those of, 191, 193, 195, 196
- Fructose mixtures, spray drying of, 195–196
- Fruit flavors, sensory evaluation and assessment of, 657
- Fruit juice, spray drying of, difficulties with, 191

Fruit quality, aroma as major determinant of, 657

Fruit storage, chitosan and, 459

FTIR. See Fourier transform infrared spectroscopy

Fugiwara, T., 153

Fukuoka, M., 537

G

GAB equation. See Guggenheim-Anderson-de Boer equation

GAB value. See Guggenheim-Anderson-de Boer value

Galactose, intermolecular hydrogen bonds, NEB progress in the glassy matrix and, 576

Galatin samples, NMR study of water motion and relaxation in

Gallant, D. J., 253

Gaussian decay, 29, 30

Gaussian peaks, three best-fit, soy bread and, obtained from deconvolution, 180

Gay-Lussac-type pycnometer, density of sodium- or potassium-glucose-water ternary system measured with, 473, 474

Gelatin
- effect of water content on physicochemical and structural properties of, 292
- ice crystallization during rewarming observed with, 381–382
- protein-carbohydrated sheets prepared with, 578
- study of mechanical response to tensile loading of, 291
Gelatin films
  infrared maps for, in the hydrated state, 295, 295
  unstable crack propagation in, brittle-ductile transition and, 295–296
Gelatin gel, transmission electron microscopic image of freeze-etched replica of, 393
Gelatin-gum arabic-sucrose sheet
  best protection against oxygen with, 582
  highest values of Young’s modulus and tensile strength observed for, 580
Gelatinization
  acid hydrolysis, destruction of amorphous chains and, 265
  SEM and TEM micrographs of cassava and potato starches undergoing, 255
  starch-chain mobility during, 260–263
  starch-chain mobility $T_2$ distribution as measured by proton 90° pulse free-induction decay of deuterated cassava starch saturated with heavy water during, 262
  terminal extent of, 535
  of water-saturated starch granules, 260
Gelatinized potato-starch gels, differential scanning calorimetry rewarming traces obtained with, 382
Gelatinized starch
  five freeze-thaw cycles, $T_2$ distribution of protons in, 268
  in glassy state, brittle-to-ductile transition induced by water reported for, 581
Gelatinized starch paste, polydispersion of, in nature, 507
Gelatin-whey protein mixture
  heating, 244
  light-microscopic images of, at pH 5.4, induced by temperature and high-pressure processing, 245
Gelation, 239–249
  emulsion stabilization, 245
  mixed systems, 243–245
  single-protein systems, 239–242
    cold gelation, 242
    heat gelation, 239–242
  structuring by extrusion, 246–249
  expanded solid foams, 247–249
  fibrous and dense composites, 246–247
  intermediate to high water content, 246
  water holding, 242–243
Gelling state, in many biological systems, 373
Gels
  beta-lactoglobulin, 10, light-microscopic images of, at pH 5.3, 241
  particulate at pH 5.5 and transparent fine-stranded at pH 7.5, 240
Gennadios, A., 453, 457
Gervais, P., 76
Gibbs-Duhem equation, ice crystals estimated with, 377
Gidley, M. J., 124
Glalactose, embedding of, in glassy trehalose matrix, 572
Glass
  enthalpy relaxation time and macroscopic molecular mobility of, 446
  solid state of water and, 204
Glass formation, food activity and role of, 130, 132
Glass-rubber transition diagram, 93, 93
Glass-rubber transitions, measurements for pasta, candy, native cornstarch, and individual rice kernels, 435
Glass transition
  of amorphous food solids in dehydration at various water contents, 343
  brittle-ductile transition temperature comparable to, 106–107
  carbohydrate-water systems and dynamic properties close to, 364, 366
  changes in volume associated with endothermic and exothermic enthalpy relaxations around, 341
  of cross-linked dextrans containing small amount of water, 381
  enthalpy relaxations around, factors related to, 340
  flow in glassy and liquid states and, 336–339
  of food solids, collapse phenomena and, 335
  increase in water content, loss of crispness and correlation with, 105–106
Glass transition (continued)

influence of, on oxygen permeability of starch-based edible films, 641–644
mechanical and dielectric relaxations in amorphous materials below and around, 341, 342
NEB rate and, for samples of various glassy matrices, 573
for potato discs, 438
relationship among moisture content, texture properties, water activity and, for glassy tapioca-flour-based baked product, 595, 595–596
stickiness in amorphous food materials around, 345

Glass transition curve
defining dividing line for optimal storage conditions for hard candy with, 104–105
on state diagram, 91
Glass transition line
need for, in state diagram, 111
for sucrose, 101
Glass transition point, defined, 93
Glass transition stabilization, 599, 600
Glass transition temperature, 98, 100, 192, 256
of anhydrous lactitol and water, 274
of corn syrup-sucrose mixtures, 421
effect of carbohydrate molecular weight, on matrix density and on, 367
effect of starch chain length on, 641
of Eudragit E100, effect of low concentrations of water on, 405
as function of mass fraction of water for apple, cabbage, and potato in which Maillard reaction was developed, 13
as function of mass fraction of water for polymeric, lactose, and trehalose matrices in which Maillard reaction develops, 12
as function of mass fraction of water for polymeric and trehalose matrices in which beta-carotene was encapsulated, 19
as function of % relative humidity for hard-ball candy, 102

Glass transition temperature curve for sugar,
application of, on top of phase diagram of sugar-water mixture, 87
Glass transition temperature of glassy polymer
water and, 401–409
conclusions, 408–409
materials and methods, 402–403
results and discussion, 404–408
Glass transition theory, 93

Glassy carbohydrates
dual role of, in stabilization and delivery of active ingredients, 354
in food and pharmaceutical stability, 353–356

indomethacin, effect of low concentrations of water on, 404
indomethacin-Eudragit E100 mixture and effect of low concentrations of water on, 408
of lactitol, using to predict crystallization occurring at different storage temperatures and relative humidities, 278, 280–281
Maillard reaction in absence of water but below, 162
microdomain distribution in food matrices:
model dough system and, 61
microdomain distribution in food matrices and, 59, 66
in model dough systems, 59
molecular mobility, sub-$T_g$ relaxation and, 161
plasticization effect of water and decrease in, 491
of plasticized starch films, upper transition and lower transition, 643
relaxation times above, and effect of water plasticization on glass transition and relaxation times, 339, 339
of starch films having different degrees of polymerization, 644
state changes and temperature of storage in relationship to, 100
for sucrose, 142
values for moisture content and, of xanthine oxidase with various excipients, 601

Glass transition temperature curve for sugar,
application of, on top of phase diagram of sugar-water mixture, 87

Glass transition temperature of glassy polymer
water and, 401–409
conclusions, 408–409
materials and methods, 402–403
results and discussion, 404–408

Glass transition theory, 93

Glassy carbohydrates
dual role of, in stabilization and delivery of active ingredients, 354
in food and pharmaceutical stability, 353–356
local structure of, at molecular level, 355
molecular packing in, 359, 361–362
Glassy foods
materials and methods, 446
glass transition and enthalpy relaxation, 446
nonenzymatic browning reaction, 446
sample preparation, 446
nonenzymatic browning reaction and enthalpy relaxation of, 445–450
discussion, 449–450
introduction, 445–446
nonenzymatic browning reaction of, 571–576
results, 447–448
enthalpy relaxation time of glassy trehalose-glucose-lysine system, 447–448
glass transition and enthalpy relaxation, 447
progress of NEB in glassy trehalose matrix, 448
Glassy matrices, glass transition and NEB rate of samples of, 573
Glassy polymer
below a critical concentration, water decreases molecular mobility of, 409
LMM compound or diluent added to, 117
Glassy stable amorphous solid state, food storage and transition from, to rubbery amorphous solid state, 93
Glassy state
flow in, glass transition, 336–339
free volume of carbohydrate system matrix independent of degree of polymerization in, 361
types of relaxation occurring within, 116–117
viscosity in, 338
water diffusivity, rubbery state vs., 94
Glassy system, estimation of free volume available within, 94
Glassy tapioca-flour-based baked product, sorption isotherm: experimental data of, 594, 595
Glassy trehalose matrix, progress of nonenzymatic browning in, 448
Globulins
cold gelation and, 242
heat gelation and, 239
Glove bag, 273
Glucose, 130
addition of, to freezing solutions, 551
approximate solubility of, in glycerol at 60°C after equilibration period of 10 days, 160t
concentration of, in dough made with 2 yeast and 2 sucrose fermenting at 30°C, 54
embedding of, in glassy trehalose matrix, 572
first-order phase transition (melting) of, by use of common sugar crystals, 433t
fructose uptake and, in doughs, 53
glassy food model preparation and, 572
Glucose-lysine-trehalose solution
glass transition and enthalpy relaxation properties investigated, 446
nonenzymatic browning reaction for, 446
Glucose-salt-water solutions
partial phase diagram of, with constant weight ratio value of 9.09, 556
partial phase diagram of, with R value of 36.34, 556
Glucose solutions
concentrated aqueous, ice formation in, 465–470
intensity ratio of isothermal transformation measurement at varying temperature, 469, 469
introduction, 465–466
materials and methods, 466–467
results and discussion, 467, 469–470
simultaneous X-ray diffractory and differential scanning calorimetry of 53% glucose solutions, 467, 468
thermogram and image from cryomicroscope at temperatures indicated, 467, 468
leakage from large unilamellar vesicles at various concentrations of, that were previously cooled to −40°C and thawed to room temperature, 559
Glucose uptake in dough, hyperbolic equation, 52–53
Glucose-water mixtures, temperature dependence of ratio of rotational time of glucose and rotational time for water for various glucose concentrations in, 365
Gluten
changes in fracture stress and strain for, as function of moisture content, 124
inspection of DSC behavior of, 247
Gluten proteins
in dough, 50
scanning calorimetry of, as function of moisture content, 248
Glycerol, 130
approximate solubility of some sugars in, at 60°C after equilibration period of 10 days, 160
dielectric constants of, 159
Maillard reaction promoted by, 162
melting-enthalpy-moisture-content-relationships of konjac glucomannan films plasticized with sorbitol and, 125
mixtures of, in probiotic cultures, 285
processing of, for extruded rich starch study, 484–485
sorption behavior of extruded rice starch in presence of, 483–489
strongly polar water and solubility of, 160
tensile modulus of tapioca-starch films at different water activity as function of, 131, 131
water and interactive plasticizing-antiplasticizing effects of, 130–132
Glycerol osmotic stresses, strain-dependent response to, 76
Glycerol-water mixture, ESR use and increase in rotational mobility of spin probes within, 94
Gondek, E., 121
Gontard, N., 122
Gordon-Taylor equation
glass transition of cross-linked dextrans analyzed by means of, 381
modeling glass transition temperature of anhydrous lactitol, water and, 274
Gordon-Taylor fit, of effect of moisture content on glass transition temperatures of lactitol, 278, 280
Gordon-Taylor relationship, 337
Granulation processes, surface plasticization and dehydration as basis of, 343
Granule-associated proteins, molecular alterations and, applications of, 513
Gravimetric determination, of actual water content, 203
Gravimetric nuclear magnetic resonance, testing usefulness of, with range of food materials equilibrated at different water activities, 411
Gravimetric stepwise oscillatory experiments, on model bread crusts, 166–167
Green coffee, rehydrated, normalized fracture force of, as a function of water activity, 494, 495
Greenspan, L., 151
Green superabsorbents, developmental research on, 386
Guerrero, S. J., 126
Guggenheim-Anderson-de Boer equation
application of, to fit isotherm of glassy tapioca-flour-based baked samples, 595
bread crust isotherms described by, 168
coffee study and water-sorption isotherms fitted by, 493
corn flakes study, water-sorption isotherms obtained and fitted to, 584
quinoa seeds and sorption isotherms fitted to, 649–650
sorption behavior of food materials represented by, 483–484
water-sorption isotherms for potato powder at 23°C, fitted by, 439, 440
Guggenheim-Anderson-de Boer (GAB) form, protein hydration studies and, 238
Guggenheim-Anderson-de Boer model, 683
Guggenheim-Anderson-de Boer parameters fitting of sorption isotherms of raw and roasted coffee with, 494
for rice-glycerol extrudates, 487, 487
Guggenheim-Anderson-de Boer value, 14
Gum arabic
  as efficient encapsulation matrix for
  limonene in freeze drying, 577
  protein-carbohydrated sheets prepared
  with, 578
Gupta, A. S., 196
Guyot, S., 76

H
Hahn spin-echo data, analysis of, in potato
  powder samples, as function of
  water content, 441, 441
Hahn spin-echo sequence, evaluating water
  populations in cornflake study
  with, 584–585
Hahn spin-echo transverse relaxation time
  values, water content vs., for
  commercial cornflakes and sugar-
  frosted cornflakes, 586–587, 587
Halek, G. W., 121
Handa, A., 453
Hard-ball candy, 88, 111
  car interior temperature and effect on,
  101–102, 102, 104
  glass transition temperature as function of
  % relative humidity for, 102
  making, 101
  onset temperature for crystallization of, as
  function of relative humidity, 103
  states of, stored at different abuse
  conditions as compared to storage
  condition at or above $T_g$, 103
  stickiness of, 100–105
  visualization of states of, after
  humidification at 33% relative
  humidity and then temperature
  abused, 104
Hardening, food storage and, 93
Hardness
  of bread-crumbs, measuring, 607
  of innovative bread and standard bread
  crumb during storage, 608
  loss of, storage of food and, 105–108, 111
  rating, for tapioca-flour-based baked
  products, 593
Harris, M., 121
Hatley, R. H. M., 51

Haugh unit
  of duck egg-white stored at room
  temperature for 18 days, 455, 455
  egg freshness and measurement of, 454
Heat, dissolution of soluble food powders
  and coupling of mass transfer and, 46
Heat gelation, 239–242
Heat-moisture-treated rice starch
  change in consistency index and flow
  behavior index of, at various
  moisture levels of treatment, 637
  relationship of shear stress and shear rate
  of native rice starch and, at 18%, 21%, 4%, and 27% moisture
  content over shear rate range of
  0–300 s$^{-1}$ and at 60°C, 638
  shear-thinning behavior in, following
  power-law model, 639
Heat-moisture treatment, of high-amylose
  rice-starch samples, 635, 636
Heat transfer, local, role in dissolution
  process, 47
Heldman, D. R., 121
Hemicellulose, in fibers, 192
Henderson-Pabis model
  moisture rate of rice grains predicted with,
  664
  rice varieties and, regression coefficient
  and percentage of root mean
  square error obtained from model
  fitted with, 667
Hen egg white, protein films developed
  from, 453
Hermansson, A-M., 239
Heterogeneity of food systems, 61
Heterogeneous system, complications in
  relaxation of, 257–258
Hexagonal ice, defined, 465
Hexose, intermolecular hydrogen bonds,
  NEB progress in the glassy matrix
  and, 576
High-density materials, antiplasticization
  and, 120
Highly polar solvents, dielectric constant of,
  159
High-mobility water, ratio of, to low-
  mobility water in water-excipient
  mixtures, 37
High resolution proton nuclear magnetic resonance, 26
High temperature-short time extrusion processes, flowing plasticized mass of food solids produced by thermal and water plasticization in, 344
Hills, B. P., 238, 239, 258
Hiltner, A., 123
Hirst, A. G., 387
HMT. See Heat-moisture treatment
Hofmeister series, 18
“Hole filling,” by diluent, 118
Hole size
  carbohydrate, suggested mechanisms leading to, increasing with water content in glassy state, 358
  of thermally annealed maltodextrin DE12 matrices prepared by solvent casting, as function of temperature for various water contents, 356, 357
Hole volume
  of annealed maltodextrin matrices with given equilibration as function of temperature for various molecular weight distributions, 360
  as function of weight fraction of water for a range of maltopolymer-maltose matrices equilibrated at water activities between 0 and 0.75, 363
Honey powder, onset of glass transition temperature of food powders measured by TMCT, DSC, and TMA, 434t
Hoover, R., 636
Hot inflection point, for bread dough, 630
Hot-pressed-pullulan-starch blends study, antiplasticizing effects of water in, 123–124
Howes, T., 195
Hsieh, F., 105
HTST processes. See High temperature-short time extrusion processes
Humidity
  hard-ball candy exposed to, 101–104
  high, stored food transitioning into rubbery zone as function of, 95
Humidity caking, reasons for, 345
Hydrated beta-cyclodextrins, structure of, 150
Hydrated food material, description of total 1H NMR signal amplitude obtained from, 412
Hydrated oils, lower solubility for estradiol and testosterone in desiccated oils vs. in, 330, 332
Hydrate formation, effects of water content on drug solubility in lipid vehicles and, 330
Hydrates, clathrate, 204
Hydration
  cracker results showing limited amount of material in carbohydrate matrix transferred to mobile phase during, 416
  main components of vegetable powders used for hydration experiments vs. fraction of matrix component mobilized during, 417t
  in starch gelatinization, 255
Hydration shells, formation of, 82
Hydration water
  ease of evaporation for, as determined by DSC and water-sorption isotherm measurements, 31
  molecular mobility of, as determined by NMR, 26–30
Hydraulic conductivity, of saturated porous medium, value of, 227
Hydric stresses, protein stability and, 16
Hydrodynamic flow
  mass transport in hierarchical structure and, 394
  schematic illustration of mass transport by, 395
Hydrogen bond
  model of local reaction promoting nonenzymatic browning reaction progress in glassy matrix and, 574, 575
  solvent-water concept and, 50
Hydrogen-bonding interactions, trehalose, enzyme stability and, 18
Hydrophilic biopolymers, 50
Hydrophilic protein-carbohydrate matrices, plasticizing of, by water, 577
Hydrophobic hydration, solvent-water concept and, 50
Hydrostatic pressure, high, *Escherichia coli* survival relative to combination low temperature and, 77–79
Hydrothermal treatment of starch, common use of, 635
Hydroxyethyl starch (HES)-glucose mixtures, effects of lowering average molecular weight of, 368–369
Hydroxypropyl cellulose (HPC) film
  effect of water content on physicochemical and structural properties of, 292
  infrared maps for, in the hydrated state, 295, 295
  notched, study of mechanical response to tensile loading of, 291
  in situ visualization of stable crack propagation for, at 69% relative humidity by using high-speed camera, 294, 294
  water content of, at 10% RH and 60% RH, 37
Hydroxypropylmethyl cellulose, water content of, at 10% RH and 60% RH, 37
Hyperosmotic perturbation
  effect of low temperature and, on *Escherichia coli* baroresistance, 79–80
  sequence of, on yeast cells, 72, 74
Hyperosmotic shock, cell shrinkage in response to, 76–77
Hysteresis, in adsorption-desorption, 238, 239

I
IB. See Innovative bread
Ice
  comparison of orientation about oxygen-oxygen hydrogen bond for, 206
  defined, 204
Ice cream, crystallization of amorphous lactose in, 347–348
Ice crystal lattice, schematic of, 205

Ice crystallization
  of compartmentalized water in polymer gels, scheme for, 380r
  in gels and foods manipulated by polymer network, 373–383
  during rewarming observed with various food biopolymer gels, 381–382
Ice crystal reduction and stability of frozen large unilamellar vesicles, 551–561
  composition of dimethyl sulfoxide-ethylene glycol salt solutions with constant weight ratios of 4.54 and 18.17, 553r
  composition of sugar-salt solutions with constant weight ratios of 9.09 and 36.34, 553r
  conclusions, 561
  effect of ice reduction on stability of frozen LUVs, 557–560
    nonpermeable CPAs, 557–560
    permeable CPAs, 560–561
  effect of nonpermeable and permeable CPAs on temperature depression, 555–557
    nonpermeable CPAs, 555–557
    permeable CPAs, 557
  introduction, 551–552
  materials and methods, 552–555
  phase volume of ice and unfrozen matrix, 555
  preparation samples, 552–554
    DMSO-salt and EG-salt solutions, 553
    LUV dispersions, 553–554
    sugar-salt solutions, 552–553
  results and discussion, 555–561
  stability of LUV dispersions, 555
  thermal analysis, 554–555
    DMSO/EG-salt-water, 554–555
    sugar-salt-water, 554
Ice crystals
  materials and methods
    measurement of freezable and bound water by differential scanning calorimetry, 186–187
    preparation of pregelatinized starch, 186
    phase separation of, in starch-based systems during freezing, 185–190
    conclusion, 189–190

Ice crystals
  materials and methods
    measurement of freezable and bound water by differential scanning calorimetry, 186–187
    preparation of pregelatinized starch, 186
    phase separation of, in starch-based systems during freezing, 185–190
    conclusion, 189–190
Ice crystals (continued)
introduction, 185–186
materials and methods, 186–187
results and discussion, 187–188
effect of initial water content and
freezing temperature on rate of
freeze concentration, 188
effect of initial water content and
freezing temperature on starch-
Fraction moisture content after
freezing, 187–188
Ice formation, recrystallization and, 348
Ice formation in concentrated aqueous
glucose solutions, 465–470
introduction, 465–466
materials and methods, 466–467
results and discussion, 467, 469–470
Ice lattice, clathrate lattice vs., 204
Ice melting, endothermic trend due to,
verifying assumption, 378
Ice recrystallization, frozen dessert quality
and, 348
Idealized modulus vs. diluent content curve,
of solid polymer-diluent blends,
118
IDF. See International Dairy Federation
IGC. See Inverse gas chromatography
IIFs. See Independent interaction factors
Image analysis
bread dough study, 629–630, 632
in evaluation of shrinkage and
department of potato slabs during
drying, 615
macroscopic shrinking and deformation in
potatoes studied with, 613
observing structures and obtaining data in
nanoscopic and microscopic fields,
674
ImageJ 1.34 software, 621
ImageJ 1.37 software, 516
Image processing
evaluation of disintegration and diffusion
of pharmaceutical solid matrices
by, 515–520
shrinkage and deformation of agave slices
evaluated during convective drying
with, 620, 625
IMFs. See Intermediate moisture foods
Independent interaction factors, for rice
starch-glycerol mixtures, 483, 488,
489
Indomethacin
effect of low concentrations of water on
glass transition temperature of,
404
effect of water on glass transition
temperature of, 401, 402
Indomethacin-Eudragit E100 mixture
effect of low concentrations of water on
glass transition temperature of, 408
water and antiplasticization relative to,
407
Infant formula, sticking or caking in, during
storage of, 100
Infrared spectroscopy, vibrational motions
measured with, 216
Inhomogeneous reaction kinetics in dough
matrix, investigating, 64–66
Innovative bread, 605, 607
hardness of, during storage, 608t
proton free-induction decay of, fresh and
after 7 days of storage, 609, 610
Innovative mixing
analysis of parameters characterizing
water properties in fresh and stored
breads, 608–609
softer bread product at 7 days of storage
as result of, 611
In situ visualization
comparing water-dependent fracture
behavior of different biopolymer
films and visualizing crack
propagation with, 291, 292
of crack propagation, 293–294
of stable crack propagation for
hydroxypropyl cellulose film and
cassava starch film at 69% relative
humidity by using high-speed
camera, 294, 294
Instant dairy powders, manufacture of,
surface plasticization and
dehydration as basis of, 343
Instron universal testing machine, sample
taken from mesoglea, for puncture
test where stress and strain were
recorded in, 388
Insulin degradation, differential coupling of overall rate constant for, and fraction dimerization to \( T_g \) in amorphous lactose formulations at 25°C and varying percent water, 327
Intermediate moisture foods, 90
International Dairy Federation, 675
International Symposium on the Properties of Water
central theme, since first meeting of, 203
continuing advancement in understanding water’s role through, 217
first meeting of, 89
protein hydration lectures at, 237
RVP measures and correlations as theme at, 212
Intrinsic permeability of a medium, as function of pore structure and geometry, 227
Inulin, in fibers, 192
Inverse gas chromatography
determination of glass transition temperature by, 403
glass transition temperature of polymer as function of environmental RH as determined by, 402
Ion-dipole force, solvent-water concept and, 50
“Islands of mobility”
densification of glass and, 118
in glassy structure, 419
Isoflavone profile, of soy bread, altering, 175
ISOPOW. See International Symposium on the Properties of Water
Isoteric heat of sorption, moisture-content plots of food colloids exhibiting a maximum \( Q_s \) value vs., 128
Isothermal solution calorimetry, 41
Isotherm sorption experiments, on model bread crusts, 166
Isotropic shrinking, 616
Isoviability diagram, of \textit{Saccaromyces cerevisiae} vs. temperature and water activity, 75
Israkarn, K., 508

J
Jasmine rice, 663, 664
comparison of experimental and predicted solid loss of milled rice grains from waxy milled rice, Sao Hai and, as function of soaking time at various temperatures, 670
effective diffusion coefficient for, at different temperatures, 669t
experimental and predicted moisture contents of, as function of soaking time at various temperatures, 666
Page model parameters for water uptake by, at different temperatures, 668t
power-function model parameters for loss of solids from, at different temperatures, 671t
regression coefficient and percentage of root mean square error obtained from model fitting using various models, 667t
temperature and water uptake of, 667
Jellyfish (\textit{Aurelia aurita})
composition of polysaccharides in, 392
dialyzed and freeze-dried, high-resolution magic angle spinning nuclear magnetic resonance images of, 386
grainy surface of, and transport canals, 390
life cycle and accessibility of, 387, 387
microstructure of, 385, 389–393
structural analysis of, 386–387
water-holding and texture properties of, 385, 386, 387–389
water retention by superabsorbent polymers and, as function of salt concentration, 388
Jellyfish network, transmission electron microscopic image of freeze-etched replica of, 393
Johari, G. P., 118
Jouppila, K., 100, 479
JSM-6460LV scanning electron microscope, 460
K
Kaffir lime peel oil, minimum inhibitory concentrations of, and potassium sorbate against *Rhizopus stolonifer* and *Aspergillus flavus*, 547
Kaffir lime peels, preliminary examination of, for antifungal activities by an agar dilution method, 545
Kaminski, W., 484
Kamman, J. F., 162
Kapsalis, J. G., 121
Karel, M., 87, 88, 91, 98, 286, 345, 346, 347, 348
Karl Fischer coulometer, residual moisture content of xanthine oxidase samples measured with, 601
Karl Fischer titration, 207
Karl Fischer method, 29
Katz, E. E., 105, 121
Kelvin effect, 377
Kelvin equation, 230
water activity converted to tension head by, 229
KGM films. See Konjac glucomannan films
Kinetic properties, temperature and, 208
Kinetics of potato slabs, during drying at 55°C, air velocity = 1/7 m/s, and thickness = 2.5 mm, 615, 615
Kinsho, T., 81
Kohlrausch-Williams-Watts approach, enthalpy relaxation time of trehalose-glucose-lysine system and, 448
Kohlrausch-Williams-Watts equation, enthalpy relaxation data and, 422, 423, 425
Kohlrausch-Williams-Watts parameters, for corn syrup-sucrose mixtures, 423
Koichi, Y., 275
Kollidon K12, molecular weight for, 318
Konjac glucomannan-carboxy methylcellulose films, changes in tensile strength and strain at break of, as function of water activity, 123
Konjac glucomannan films, plasticized with glycerol and sorbitol, melting-enthalpy-moisture-content relationships of, 125
Kostaropoulos, A. E., 129
Krishnan, P., 654
Krokida, M. K., 616
Krusch, L., 98
Arrhenius plot for crystallization of lactose, at three different moisture contents from data of, 99
KWW equation. See Kohlrausch-Williams-Watts equation
L
Labuza, Katherine, 101
Labuza, T. J., 107
Labuza, T. P., 100, 105, 106, 121, 162
Lactic acid bacteria, freeze drying and stabilization of, 141
Lactitol
amorphous, preparation of, 272
BET water-sorption isotherms of, 478
crystallizing amorphous, modeling moisture content of, 273–274
freeze-dried
comparison of water sorption and crystallization behaviors of, 477–482
experimental glass transition temperature and water contents after storage of 98h for, 479, 479–480
Gordon-Taylor fit of effect of moisture content on glass transition temperatures of, 278, 280, 281
increased use of, in foods, 271
materials and methods in comparative study, 478
melting temperatures of, stored at 20°C at 49%, 58%, and 81% RH and 32°C at 41%, 64%, and 81% RH, 276
moisture content and $T_g$ as useful tools in predicting stability of, 281
moisture sorption of, stored at various temperatures and relative humidities, 279
sample preparation for differential scanning calorimetry, 274
water content of, during storage at 25°C at various relative vapor pressures, 480, 480–481
X-ray powder diffraction patterns of, at end of storage at 25°C at various relative vapor pressure of 66%, 481, 481
Lactitol crystallites melting temperatures of, 275–276 leveling off, 277
Lactitol crystallization melting enthalpy measured as function of time for, 277 plateau melting enthalpies for, at 20° and 32°C storage temperatures and relative humidities, measured after initial period of, 278t rate and extent of, 276–278 thermograms of, at 20° and 49% RH, 275
Lactitol samples, sample water peak melting enthalpy and moisture content of, grouped according to their storage conditions and relative humidity, 280
Lactobacilli strains, dehydration tolerance differences among, 141
*Lactobacillus plantarum,* synergism between high pressure and subzero temperature on, 78
*Lactobacillus rhamnosus* GG effects of freezing, freeze drying and storage relative water-vapor pressure on viability of, 285–289
glass transition temperature at various relative humidities of freeze-dried systems in presence and absence of, 287t
scanning electron microscopy of, encapsulated in trehalose and lactose-trehalose glass, with data for colony forming units, 289
Lactose amorphous state diagram of, 349
water-sorption and time-dependent crystallization and recrystallization of, 347
approximate solubility of, in glycerol at 60°C after equilibration period of 10 days, 160t 
Arrhenius plot for crystallization of, at three different moisture contents, 99 
BET water-sorption isotherms of, 478 embedding of, in glassy trehalose matrix, 572
endothermic response and recrystallization of, in food samples, 47
first-order phase transition (melting) of, by use of common sugar crystals, 433t
freeze-dried comparison of water sorption and crystallization behaviors of, 477–482 
experimental glass transition temperature and water contents after storage of 94h for, 479, 479–480
glass transition of maximally freeze-concentrated solutes and onset temperature of ice melting of, 287t
Lactose (continued)

intermolecular hydrogen bonds, NEB progress in the glassy matrix and, 576
materials and methods in comparative study, 478
water content of, during storage at 25°C at various relative vapor pressures, 480, 480–481
X-ray powder diffraction patterns of, at end of storage at 25°C at various relative vapor pressure of 54%, 481, 481

Lactose crystallization
modified Williams-Landel-Ferry plot for, 99
proteins and, 17
retarding of, proteins or biopolymers and, 11, 14
Roos and Karel’s work on, 98
Lactose glass transition, in dehydrated dairy foods, 336
Lactose glass transition temperature, as function of mass fraction of water, 14
Lactose-trehalose glass, scanning electron microscopy images of 

*Lactobacillus rhamnosus* GG
encapsulated in trehalose glass and, with data for colony forming units, 289
Lactose-trehalose solutions, glass transition of maximally freeze-concentrated solutes and onset temperature of ice melting of, 287t

Laminar flow, Poiseuille equation for, 223
Land, L. M., 328, 330
Lang, K. W., 683
Laplace equation
capillary flow in porous media and, 223
height of capillary rise expressed as, 225
Laplace-Young equation, ice crystals estimated with, 377
Large unilamellar vesicles
calculation of percentage of CF from, 555
effect of ice crystal reduction on stability of, 551–561
conclusions, 561
introduction, 551–552
materials and methods, 552–555
results and discussion, 555–561
frozen, effect of ice reduction on stability of, 557–561
nonpermeable CPAs, 557–560
permeable CPAs, 560–561
leakage from added with various concentrations of dimethyl sulfoxide or ethylene glycol solutions, after cooling of mixture, 560
at various concentrations of sugar solutions previously cooled to −40°C and then thawed to room temperature, 559
scanning electron micrographs of those cooled to −40°C at 10°C/min, 559
Laroche, C., 76
Lawal, M. O., 675
Lazar, M. E., 344
Lebedeva, T. L. F., 321
Legumes, Fick’s laws of diffusion and water absorption of, 663
Legume starches, limited swelling capability of, 507
Leslie, R. B., 129
Levine, H., 90, 98, 158, 212, 470
Lewicki, P. P., 121t
*LGG*. See *Lactobacillus rhamnosus* GG
Li, Y., 121t
Lifschitz-van der Waals interactions, 305

Lignin

Agave atrovirens Karw, convection drying and, 619
in fibers, 192
Lillford, Peter, 25
Limbach, H. J., 355
Lindner, K., 153
Linear low-density polyethylene, first-order phase transition (melting) of, by use of common sugar crystals, 433t
Lipid-based drug-delivery vehicles
formulation properties and consequences of water’s presence in, 328
self-association of water at higher moisture levels observed in, 332
water present in natural oils and other components of, 327
Lipid phase separation, endovesicle formation and scission of membrane invaginations promoted by, 74
Lipids, in fibers, 192
Lipophilic drugs, cyclodextrins and solubility, stability, and bioavailability of, 150
Liquefying, 42
Liquid model, adapting to dough, 49
Liquid state
flow in, glass transition, 336–339 of water, 205–206
Liquid uptake, modeling, 220
Lithium chloride salts, in tapioca-flour-based baked products study, 593
Liu, J., 74
Lloyd, R. J., 100
L-menthol, encapsulated, 499
effect of water activity on and $n$ values for release of from spray-dried powder at $50^\circ C$ storage, 503
effect of water activity on release-rate of, at $50^\circ C$, 503
flavor powder preparation, 500
release time of, in spray-dried powders stored at various relative humidities, 502
LMM diluents. See Low molecular mass diluents
Local reaction, NEB progress in glassy matrix promoted by, 574, 575
Lorentzian decay, 29, 30
antibiotic hydrates and, 35, 36
Lourden, D., 130, 132
Loveday, S. M., 52
Low-density hydroxypropy cellulose, water content of, at 10% RH and 60% RH, 37t
Low-density materials, antiplasticization and, 120
Low-density polyethylene, first-order phase transition (melting) of, by use of common sugar crystals, 433t
Low-mobility water, ratio of, to high-mobility water in water-excipient mixtures, 37t
Low-moisture foods
brittleness of, in glassy state, 583–584
knowledge of water plasticization and crystallization behaviors of sugars and sugar alcohols important for use in, 482
protection for, by encapsulation in glassy protein-carbohydrate films and/or matrices, 577
Low-moisture systems, molecular mobility changes and, 216
Low molecular mass diluents
antiplasticization of food polymer systems by, 115–133
as antiplasticizers at $T$ less than $T_g$, 130
conclusion, 133
introduction, 115–116
moisture content reduction in food polymer system and, 119
nonwater diluents as antiplasticizers at $T$ less than $T_g$, 130–132
polymer-diluent interactions: plasticization vs. antiplasticization, 116–119
properties of diluent (water), 126–129
thermodynamics of water sorption, 128–129
water diffusivity, 129
properties of food polymer-water blend, 119–120, 122–126
gas transport properties, 126
mechanical properties, 119–120, 122–124
thermal properties, 124–126
uses for, 115
Low molecular weight solutes, in dough, 50
Low-water foods, control of physicochemical and flow properties of, 335
Low-water food systems
collapse phenomena, 341–345
collapse requirements, 345
stickiness and caking, 344–345
crystallization, collapse, and glass transition in, 335–349
conclusions, 349
Low-water food systems (continued)
introduction, 335–336
state diagrams, 348–349
crystallization phenomena, 345–348
crystallization of amorphous sugars, 346–348
ice formation and recrystallization, 348
flow in glassy and liquid states, 336–341
glass transition, 336–339
glass transition as characteristic property of, 337
relaxation phenomena of amorphous foods, 339–341
enthalpy relaxations, 340
structural relaxations, 341
Lucas, C. H., 387
Lucas-Washburn equation
rehydration modeling and, 223
variation of, for modeling rehydration of dried foods, 233
Lucifer yellow stained cells, Saccharomyces cerevisiae, hyperosmotic treatments and increase in, 73, 74
LUVs. See Large unilamellar vehicles
Lycopene solubility, in complex microemulsion, addition of water and changes in, 329
Lyophilized protein formulations, correlations observed for stability of, 26
Lyovac GT2 freeze dryer, 564
Lysine
embedding of, in glassy trehalose matrix, 572
glassy food model preparation and, 572
M
Macadamia nuts
integral entropies of, 683, 684
lyophilized, water-sorption date for, 683
Magnesium chloride
effect of, on sucrose curves, 17
evaluating effect of, on kinetics of nonenzymatic browning, 539–544
in tapioca-flour-based baked products study, 593
Magnesium nitrate, in tapioca-flour-based baked products study, 593
Magnetic resonance imaging
findings related to characterization of water fraction of soy bread with, 175
monitoring water distribution inside food body with, 533
Maier, A., 551
Maillard reaction, 10–15, 157, 354, 544
controlling kinetics of, 11
factors governing rate of, 539
fried potato color and, 526
glass transition temperatures as function of mass fraction of water for polymeric, lactose and trehalose matrices and development of, 12
glass transition temperatures as function of water for apple, cabbage, and potato and development of, 13
influences on, 11
molecular mobility and, 161–162
in absence of water but below glass transition temperature, 162
potato disc study and, 438
structural effects related to, 20–21
water uptake and mobility, pharmaceutical stability in amorphous solids, 325
Maize starch
starch granule-associated proteins and, 508
waxy, Fickian diffusion used to describe sorption dynamics of, 166
Major length, fractal analysis of agave slices during convective drying and, 621
Makower, B., 95, 96, 97, 346
Maltitol
BET water sorption isotherms, 478–479
freeze-dried
comparison of water sorption and crystallization behaviors of, 477–482
experimental glass transition temperature and water contents after storage of 98h for, 479, 480
materials and methods in comparative study, 478
Index

water content of, during storage at 25°C at various relative vapor pressures, 480, 480–481
X-ray powder diffraction patterns of, at end of storage at 25°C at various relative vapor pressure of 54%, 481, 481
Maltodextrin DE 12, thermally annealed, hole size of, in glassy and rubbery states, 356, 357
Maltodextrin DE 21, effect of water and fat contents on enthalpy of dissolution of, 42
Maltodextrin-fructose mixture
spray-dried, Tg and yield from DSC of carrot fiber-fructose and, at different ratios, 196t
spray-dried powders of fructose-carrot fiber compared to those of, 191, 193, 195, 196
Maltodextrin matrix
annealed, hole volume and specific volume of, with given equilibration as function of temperature for various molecular weight distributions, 360
average fractal dimension of edge of, within first 30s of their disintegration and diffusion, 516, 516
average fractal dimension of side face of, within first 30s of their disintegration and diffusion, tangential perspective showing three layers, 517, 517
evaluation of disintegration and diffusion of, by image processing and nonlinear dynamics, 515–520
showing disintegration process comparable to opening of petals of flower, with fractures during such opening, 517, 520
Maltodextrin powders
dispersability and wettability evaluated at different feed concentrations and drying air temperatures in production of, 677t
influence of high air-drying temperatures and high feed concentration on, 678
materials and methods, 674–675
microstructure and morphology of particles, 674
physical properties, 675
rehydration properties, 675
testing materials, 674
microstructural, physical, and rehydration properties of, obtained by spray drying, 673–678
conclusion, 678
introduction, 673–674
results and discussion, 675, 677–678
microstructure of, obtained at 40% total solids feed concentration and inlet/outlet drying air: 249°C/120°C and 140°C, 676
moisture content, bulk and tapped density, and angle of repose of, evaluated at different feed concentrations and drying air temperatures, 676t
Maltodextrins
as capsule materials, 564
relationships between glass transition temperature, water activity, and water content of, 566
of varying molecular weight distribution, oxidation of citrus oil encapsulated in, at 45°C, 367–368, 368
Maltodextrin-water mixture, ESR use and increase in rotational mobility of spin probes within, 94
Maltooligomers, Arrhenius plot of diffusion coefficient of water in, for three carbohydrate concentrations, 364, 365, 366
Maltooligomer-water mixtures, temperature dependence of free-volume fraction of, at carbohydrate concentration of 90wt%, 362
Maltooligomer-maltose matrices, hole volume as function of weight fraction of water for range of, equilibrated at water activities between 0 and 0.75, 363
Maltose
- approximate solubility of, in glycerol at 60°C after equilibration period of 10 days, 160
- BET water-sorption isotherms of, 478
- embedding of, in glassy trehalose matrix, 572
- first-order phase transition (melting) of, by use of common sugar crystals, 433
- freeze-dried comparison of water sorption and crystallization behaviors of, 477–482
- experimental glass transition temperature and water contents after storage of 94h for, 479, 479–480
- intermolecular hydrogen bonds, NEB progress in the glassy matrix and, 576
- materials and methods in comparative study, 478
- water content of, during storage at 25°C at various relative vapor pressures, 480, 480–481
- X-ray powder diffraction patterns of, at end of storage at 25°C at various relative vapor pressure of 76%, 481, 481

Mandala, I. G., 121

Mannitol, in freeze-dried formulations, 20
Manuel, H., 636
Maourulis, Z. B., 616

Marine-inspired water-structured biomaterials, 385–395
- gel structures, hierarchy, and mass transport, 393–395
- introduction, 385–386
- jellyfish (Aurelia aurita), 386–387
- microstructure of, 389–393
- water-holding and texture properties of, 387–389
- life cycle and accessibility, 387
Marles, C., 91
Marzec, A., 121

Mass spectrometry, fruit flavor assessment and, 657

Mass transfer
- dissolution of soluble food powders and coupling of heat and, 46
- limited crystal growth and, 272

Mass transport, illustration of, by hydrodynamic flow, capillary flow, and diffusion, 394, 395
Mateus, M. L., 497

Mathematical modeling for rehydration of dried foods, 220–222
- diffusion model, 221–222
- empirical and semiempirical models, 220

Matric potential, 225

Maximum force of compression, onset of glass transition temperature and, at different water contents for commercial cornflakes, 587, 588

Maximum forces moisture content vs., for control potato slices fried at given temperatures, 529, 529
Mazzobre, M. F., 16, 18, 104
MC. See Moisture content
MCA. See Mean cell area
MCC. See Microcrystalline cellulose
McLaren, C., 101
McMinn, W., 487

Mean cell area, image processing of bread dough and, 632, 633

Meat protein, protein films developed from, 453

Mechanical disturbance, time-dependent response of amorphous materials to, 341

Mechanical properties, 133
- complex food products wherein water acts as antiplasticizer on, 121
- for cornflakes, measurement of, 584
- of duck egg-white film made from shell eggs, 456–457, 457
- of food polymer-water blend, 119–120, 122–124

shelf-life stability and textural properties of food products and, 583
Mechanical relaxation, in amorphous materials below and around glass transition, 342
Mechanistic enzyme competitive inhibition equations, 53
Melting, glass transitions overlapping with, at some levels of water plasticization, 337
Melting enthalpy, thermal properties of KGM films and, 125, 125
Melting-enthalpy-moisture-content relationships, of konjac glucomannan films plasticized with glycerol and sorbitol, 125
Melting-point curves, on state diagram, 91
Membrane state, survival of osmotic stresses linked to, 77
Mesoglea, 385, 389, 390
capillary flow and diffusion in, 394
confocal laser scanning microscopic images of cells and fibers in, 391
different cation contents of seawater, dialyzed jellyfish and, 392
filamentous structures in, with interdispersed cells, close to surface, 390
gel structures, hierarchy, and mass transport in, 393–395
illustration of possible structural roles of proteogelcans in, 394
sample taken from, for puncture test where stress and strain were recorded in Instron universal testing machine, 388, 388
TEM and CLSM images of, 392, 392
Metal-oxide semiconductor sensor, aroma analysis and, 658
Methanol
dielectric constants of, 159t
mixtures of, in probiotic cultures, 285
Methyl cellulose, water content of, at 10% RH and 60% RH, 37t
Metrics for water, 206–217
amount of water, 207–208
molecular mobility approach to, 212–217
phase and state diagrams, 212–216
spectroscopic approach to, 216–217
sorption isotherms, 211–212
thermodynamic approach to, 208–211
Mettler Toledo balance, 584
Mexican agave. See Agave atrovirens Karw
Mexican National Council of Science and Technology, 520
Mexican tequila industry, Mexican agave’s importance for, 619
MF. See Maximum forces
MIC. See Minimum inhibitory concentration
Microbial inactivation
parallel changes with pressure and temperature of protein behavior, water structure and, 80–82
synergistic effects of high pressure and low or subzero temperatures on, 78
Microbial stabilization, lactic acid bacteria commercialization and, 141
Microcapsules, defined, 564
Microcrystalline cellulose, 126
apparent crystallinity index of, obtained from x-ray diffraction and Fourier transform infrared spectroscopy, 310
compaction properties of, 302
materials and methods
mechanical properties, 303
microcrystalline cellulose, 302
preparation of compacts, 302–303
solid fraction and porosity, 304
true density, 304
moisture-induced antiplasticization of: permeability of water and octane, tensile strength, Young’s modulus, and crystallinity, 127
moisture-sorption isotherm of, measured at 25°C, 305
plasticization-antiplasticization threshold of water in, 301–313
conclusions, 313
introduction, 301–302
materials and methods, 302–304
results and discussions, 304–312
plots of porosity vs. compaction pressure showing compressibility of, under different conditions of relative humidity, 306, 306
Microcrystalline cellulose (continued)
relationship between tensile strength and compaction pressure of, 309
typical rehydration data for, at 25°C, 231
typical water-sorption and water-retention data for, 230
typical water-sorption isotherm for, 229
unique place of, in pharmaceutical applications, 301
water content of, at 10% RH and 60% RH, 37t
Microcrystalline cellulose compacts, tensile strength of, effect of relative humidity on at constant porosity of 0.3 and 0.1, 307
Microcrystalline cellulose powder, packing ability of, 305
Microdomain distribution in food matrices conclusions, 66
glass transition temperature, water mobility, and reaction kinetics evidence in model dough system, 59–66
ESR experiments, 60–61
introduction, 59–60
mathematical model, 61
NMR experiments, 60
sample preparation, 60
results and discussion
glass transition temperature, 61
reaction kinetics, 64–66
water mobility, 62–64
Microemulsions, complex microstructures of, 329
Microorganism viability, role of water in, 71
Microstructural domains, defined, 59
Microstructure of porous foods, X-ray microtomography and observation of, 234
Mille, Y., 74
Milled rice, cooking time for, 663
Milled rice grains
materials and methods, 664–665
determination of diffusion coefficient of water, 665
determination of moisture content during soaking, 664–665
determination of solid loss during soaking, 665
rice samples, 664
results and discussion, 665, 667–669
solid loss of rice grains during soaking, 668–669
water diffusion in rice grains during soaking, 668
water uptake of rice grains during soaking, 665, 667–668
water uptake and solid loss during soaking, 663–671
conclusion, 669
introduction, 663–664
Miller, D. P., 543
Milli-Q grade water, lactitol mixed with, 272
Minimum inhibitory concentration antifungal activity of essential oils and, 546
of essential oils and potassium sorbate against Rhizopus stolonifer and Aspergillus flavus, 547t
Minimum integral entropy occurrence of, 682
as related to food stability, assessment of, 681, 682, 684, 685, 686
Minitab 13 software, 516
Miscible components in foods, composition-dependent glass transition behavior in, 336–337
Mitutoyo Digimatic Thickness Gauge, egg-white film thickness determined with, 454
ML. See Major length
MLRs. See Multiple linear regressions
Modified Page model
moisture rate of rice grains predicted with, 664t
rice varieties and, regression coefficient and percentage of root mean square error obtained from model fitting with, 667t
Moisture, storage longevity of seeds and, 647
Moisture content adsorption surface and integral entropy changes as function of, 684, 685
of agave slices, 620
changes in, for starch fraction during freezing at various temperatures for samples with 30%, 40%, and 50% initial moisture content, 187
changes in fracture stress and fracture strain for gluten and starch as function of, 124
in dough samples, ESR spectral patterns for TEMPO and, 64
effect of, on thermodynamic response of dissolving powders, 42
enthalpy of food powder dissolution and effects of, 41, 42, 45, 46, 47
expanded solid foams and, 247
for gelatinized Cassava starch, 186
Gordon-Taylor fit of effect of, on glass transition temperatures of lactitol, 278, 280, 281
integral entropy of sorption as function of, for macadamia, yogurt, zeolite clinoptilolite, and zeolite Valfor, 683, 684
of lactitol samples, grouped according to their storage conditions and relative humidity, 280
loss of crispness relative to, 105–106
of maltodextrin powders, evaluating, 675
maximum forces vs., for control potato slices fried at given temperatures, 529, 529
mechanical properties of food polymer-water blend and, 120
of milled rice varieties, 664
modeling of, for crystallizing amorphous lactitol, 273–274
potato chips during frying and, 527
reduction of, in food polymer system, 119
relationship among texture, water activity, glass transition and, for glassy tapioca-flour-based baked product, 595, 595–596
rice starch-glycerol mixtures, 488, 488
scanning calorimetry of gluten protein as function of, 248
soaking of milled rice grains and, 664–665
soy bread samples, migration during storage and, 179
in spray drying of fructose mixtures, 195–196
stability of food matrix and, 59
for standard and innovative bread crumb samples, 609
in starch fraction, after freezing at −3, −40, and −50°C for samples with 30%, 40%, and 50% overall moisture content, 188
of starch fraction, effect of freezing temperature on time needed to freeze 50% and 100% of available freezable water and corresponding amount of, 189
texture of glassy tapioca-flour-based baked product as function of, 591–596
transition temperatures of chocolate wafers as function of, 110
values for glass transition temperature and, for xanthine oxidase with various excipients, 600, 601
Moisture dependency, mechanical properties and, 120
Moisture increase, influence of, on state change, 93
Moisture in foods, typical D_\text{eff} values for, 222
Moisture pickup, transition from glassy to rubbery state in stored food and, 95
Moisture ratio, of milled rice grains, 664, 664t
Moisture sorption, variations in mechanical behavior in response to, 120
Moisture-sorption isotherms, 211
designing stable multicomponent food materials and, 411
of microcrystalline cellulose measured at 25°C, 305
schematic representation of, 211
Moisture toughening, 119
Mojonnier method, fat content of model powder samples determined by, 43
Mold growth, bread spoilage and, 545
Molds, defeating, *Lactobacillus coryniformis* Si3 and, 142

Molecular diffusion of gases, transport flow in porous media and, 233

Molecular dynamics simulations, 353
for exploring molecular organization of lipid components, water, and solute in lipid-based drug-delivery vehicles, 329
investigating dynamic properties close to glass transition and, 364
observations from PALS experiments verified with, 361
PALS studies on physics of glassy carbohydrate matrices related with, 355–356
snapshot from, of 60% tricaprylin-40% 1-monocaprylin lipid mixture saturated with water at 37°C, 329, 330
snapshot of carbohydrate-water system, 359
spatial distributions of water molecules obtained in, from two instantaneous structures of PVP glasses containing 0.5% and 10% water by weight, 320, 320
water’s role in nonaqueous pharmaceutical systems and, 317–318

Molecular entities, types of motions for, 158

Molecular mobility
glass transition temperature, sub-$T_g$ relaxation and, 161
Maillard reaction and, 161–162
quinoa seed longevity and, 647–654 understanding, 158
Molecular mobility approach to metrics for water, 212–217
phase and state diagrams, 212–216
spectroscopic approach to, 216–217

Molecular mobility of water in API hydrates, 26–36
correlation of, as determined by NMR with that as determined by DSC and water-sorption isotherm measurements, 31, 34–36
as determined by NMR, 26–30
ease of evaporation for hydration water as determined by DSC and water-sorption isotherm measurements, 31
apparent correlations between stability of solid APIs and, 25–26
coeexistence of, with pharmaceutical excipients, 36
Molecular packing, 356
in glassy carbohydrates, 359, 361–362
Molecular relaxation, 161
Monocaprylin-OH oxygen groups, radial distribution function for water oxygen with, 331
Monocaprylin oxygen atoms, radial distribution function for water oxygen with tricaprylin C=O oxygen atoms and, 331
Monoexponential decay curves, for quinoa seeds equilibrated at low RHs, 650
Monoglycerides, water uptake, distribution, and effects on drug solubility in lipid vehicles composed of, 326–330, 332
Monoglyceride-water mixtures, freeze-fracture electron microscopy study of organization of lipid molecules in, 329
Monomolecular layer water, 159
Monosaccharides mixtures of, in probiotic cultures, 285
survival during drying and, 141
Moraru, C. I., 121r
Moreira, R. G., 527
Morel-Seytoux, H. J., 228, 229
Morita, Y., 635
Morris, V. J., 245
Morrison, William, 95
MPEG-Beta-PCL
Fourier transform spectroscopy spectra of, 461, 461
purifying, 460
synthesis of, for blend homogeneous film with chitosan, 459
MR. See Moisture ratio
MSIs. See Moisture-sorption isotherms
Multicomponent systems, predicting sorption profile of, 484
Multidomain foods, storage problems with, 94
Multiple linear regressions, 144
Mung-bean (MB) starch granules
  effect of modifier on transition temperatures in second endotherm at different levels of water content, 510
  in first endotherm, effect of water content and protein modifiers on phase-transition characteristics of, 509–510, 509t
light micrograph of, under visible light and cross-polarized light, 510
materials and methods, 508–509
gel microstructure, 508–509
statistical analysis, 509
thermal properties, 508
role of protein modifiers on, as less significant than water’s role on, 513
water and protein modifier effects on phase transitions and microstructures of, 507–513
conclusions, 513
introduction, 507–508
results and discussion, 509
Mung-bean starch gel
  confocal laser scanning micrographs of, containing 60% water content (wt/wt) prepared by autoclaving at 121°C for 15 min., 511
  micrographs of, containing 50% water content (wt/wt) prepared by autoclaving at 121°C for 15 min. under same observation field, 512
Mung bean (Vigna radiata), as major starch crop in Thailand, 507
Murray, B. J., 466, 470
Mustapha, W. A. W., 162
Mycotoxins, molds, bread spoilage and, 545
Mylärinen, P., 486
Myosin, gel formation and, 241
N
Na-caseinate-lactose sheets, protection against oxygen with, 582
Na-caseinate-trehalose-lactose sheets, protection against oxygen with, 582
Nanostructured (NSM) food-model systems, minimum integral entropy as related to food stability and, 681
Nanotechnology, new food materials development and, 681
National Center for Genetic Engineering and Biotechnology (Thailand), 513
National Council for Science and Technology (Mexico), 687
National Polytechnic Institute of Mexico, 678, 686
Natural flavors, controlled kinetics of Maillard reaction and, 11
Navier-Stokes analog, fluid flow in porous media and, 233
N-deacetylation of chitin, chitosan produced by, 459
NDS. See Nondissolvable solids
NEB. See Nonenzymatic browning
Neutron scattering
  in combination with PALS, for insight into structure of carbohydrate-water system, 359
  investigating dynamic properties close to glass transition and, 364
  probing properties of carbohydrates in glassy state with, 355
Newton’s equation of motion, molecular dynamics simulations and, 317
Ngamdee, P., 460
Nicholls, R. J., 107, 123
Nifedipine, amorphous, crystallization rate in solid dispersion formulations, 26, 27
Nikoladis, A., 106
Nimmo, J. R., 228, 229
NL-6 quinoa seeds
  amplitude of signal of lipid component of, with different water activities, 652
  genotype description of, 648
NL-6 quinoa seeds (continued)
percent germination of, during storage at 32°C and 43% or 75% relative humidity, 650
percent viability of, assessed by tetrazolium test, 651
relaxation times of lipid component of, with different water activities, 652
sorption isotherms of, 651t viability and germination values for, 650
NMR. See Nuclear magnetic resonance
Nonaqueous pharmaceutical systems, water’s role in, 315–332
Noncovalent bonds, 158
Noncrystalline solids, glass transition as characteristic property of, 337
Nondissolvable solids, rehydration process and use of, 219–220
Nonenzymatic browning, 11, 90
food quality in processing and storage and importance of, 437–438
in glassy matrix, model of local mobility promoting progress of, before storage at 25°C, storage at 70°C, and storage at 50°C and 60°C, 450, 450
importance of prediction and control of, in dry foods, 571
inhibition or acceleration by magnesium chloride, 539–544
conclusion, 543–544
introduction, 539–540
materials and methods, 540–541
results and discussion, 541–543
model of local reaction promoting progress of in glassy matrix, 574, 575
progress of, in glassy trehalose matrix, 448
proton NMR studies of molecular mobility in potato systems in relation to, 437–442
quality changes caused by, 445
rate of, related to degree of interactions between water and solid molecules and with physical state of food matrix, 442
Nonenzymatic browning reaction of glassy foods
conclusions, 576
discussion, 574–576
introduction, 571–576
materials and methods, 572–573
DSC measurement, 572–573
evaluation of initial NEB rate, 572
preparation of glassy food model, 572
results, 573–574
glass transition and NEB rate of samples of various glassy matrices, 573
glass transition and NEB rate of samples of various reducing sugars, 574
Nonenzymatic browning reaction rate
Arrhenius plot of for samples of varying glassy matrices, 573, 573
for samples of varying reducing sugars embedded in glassy trehalose matrix, 574
glass transition and, for various reducing sugars, 574
Nonenzymatic Maillard browning, color development due to, in waterless environment at 100°, 115°, and 130°C, 163
Nonequilibrium amorphous structures, higher enthalpy and volume in, vs. in equilibrium crystalline structures under same conditions, 337, 338
Nonequilibrium states, collapse phenomena in foods resulting from time-dependent flow in, 337
Nonisotropic shrinkage, 616
Nonlamellar phases, low water concentrations and, 77
Nonlinear dynamics applications of, 515
evaluation of disintegration and diffusion of pharmaceutical solid matrices by, 515–520
Non-nanostructured (NNS) food-model systems, minimum integral entropy as related to food stability and, 681
Nonpermeable cryoprotective agents
effect of, on temperature depression, 555–557
effect of ice reduction on stability of
frozen LUVs and, 557–560
permeable cryoprotective agents vs., 552
Nonpolar bonds, 158
Nonpolar solvents, dielectric constant of, 159
Nonsolvent fractions, 50
Nonsolvent water, 115, 127
frozen dough and, 49
in semisolid foods, 53, 55
Nonstoichiometric water uptake
of bulk drug active pharmaceutical
ingredient as function of percent
relative humidity at 25°C, 319
moisture uptake in pharmaceutical solids
and, 318
Nonwater diluents, as antiplasticizers at T
less than T_g, 130
Noodles, cooked, texture of and water-
content distribution in after
boiling, 533
Normalized Weibull distribution function
curve fitting of rehydration data and, 221
rehydration studies and, 220
Nova-Sina, 90
Noyes, A., 41
Nuclear magnetic resonance, 25
in combination with PALS, for insight
into structure of carbohydrate-
water system, 359
correlation of water mobility as
determined by, with that as
determined by DSC and water-
sorption isotherm measurements, 31, 34–36
for determination of T_g, glass transition
temperature and, 61
higher mobility of protons as measured
by, in rubbery vs. glassy state, 94
hydration effects at level of molecular
mobility studied with, 411
investigating dynamic properties close to
glass transition and, 364
measuring distribution of water in bread
with, 176
molecular mobility of hydration as
determined by, 26–30
probing properties of carbohydrates in
glassy state with, 355
proton-relaxation data from dough fitted
with continuous spectra featuring
three distinct peaks shown by, 51
sensitivity of technique, to rotational and
translational motions of water, 216
usefulness and limits with determining
water mobility by, 36
Nuclear magnetic resonance relaxation
measurements
quinoa seed conditioning and, 649
quinoa seed samples and spin-spin
relaxation time measurement, 649
Nuclear magnetic resonance spectra, for
dialized and freeze-dried jellyfish,
386–387
Nuclear magnetic resonance spectrometers,
water movement and, 251–252
Nuclear magnetic resonance spin-spin
transverse relaxation, analysis as
function of presence of magnesium
chloride and/or brown pigment,
543, 543
Nuclear magnetic resonance T_2 distribution,
discriminating, 257–258
Nucleation, 94
Nutritional value, nonenzymatic browning
and changes in, 445
Nylon film, sorption dynamics of, 166
O
O'Felt, C. W., 176
Off-aroma scores, of fresh and freeze-thaw
Smooth Cayenne and Queen
pineapples, 660
Oil fractions, absorption mechanisms in fried
potato cylinders and, 525–526
Oil-uptake fractions, kinetics of, in control
potato slices during frying at
180°C, 527, 528
Okada, C. Y., 74
Okaka, J., 675
Oligosaccharides
in dough, 50
in fibers, 192
Oliveira, A. C., 80
Olive oil, dielectric constants of, 159t
Oliver, A. E., 553
1,2-dipalmitoyl-rac-glycero-3-phosphocholine, LUV dispersions and investigation of effect of ice formation on stability of phospholipid bilayers with, 551, 553
Onset temperatures, ease of evaporation for hydration and factors related to, 31
Oostergetel, G. T., 253
Oscillatory sorption experiment adsorption and desorption rates of starch-rich model bread crust during, 172
on bread crust, 170, 170–171
Osmotic stress cell shrinkage in response to, 77
membrane state linked to survival of, 77
yeast survival and effect of combined thermal stress and, 75–77
Oven drying, water measurement and, 207
Oxidation foods susceptible to, edible oxygen-barrier films and, 641
unsaturation in structure of carotenes and, 18–19
Ox-tran 2/20 ML modular system, 642
Oxygen-oxygen hydrogen bond, comparing orientation about, for ice and clathrate, 206
Oxygen permeability effect of starch chain length on, 641
of 40% noncrystallizing sorbitol-plasticized starch films at various degrees of polymerization, 643t
for protein-carbohydrate sheets, 581 close to their glass transition temperature, 577, 578
of starch films discussion on, 642–643 measuring, 642
Oxygen permeability tester, 579
Oxygen uptake, by carbohydrate-encapsulated citrus oils, 367–368, 368 P
PA. See Projected area
Page model predicting moisture rate of rice grains with, 664t
rice varieties and, regression coefficient and percentage of root mean square error obtained from model fitting with, 667, 667t
Page model parameters, for water uptake by milled rice grains at different temperatures, 668t
PALS. See Positron annihilation lifetime spectroscopy
Paprika capsules preparation of, with alginic acid, 681, 683
with and without nanostructures, chemical stability and its relation to minimum entropy studied for, 685
Parametric models, for relating water content to tension head, 226, 227
Partial pressure of water, sample, general configuration of a cell for determination of, 209
Particulate protein gels at pH 5.5, 240
pores in, 242
Pasta cooked, texture of and water-content distribution in after boiling, 533
glass-rubber transitions measured for, 435
rehydration of, radial nuclear magnetic resonance study of, 224
Pasta dough, heated at 5°C, 246
Pasta systems, dry, Maillard reaction in, 162
Pasteurization, effects of various perturbations on, 72
Pasting properties, of heat-moisture-treated rice starches, 636
Pasting temperature relationship of setback to moisture of treated rice starch and, 638
of rice starch, 635
Payne, C., 107
PCA. See Principal component analysis
Peaches, volume decrease or shrinkage studied in, 613
Pectin gel, syneresis study of, 267
Pedreschi, F., 527
Peleg, M., 108, 120, 345
Peleg’s model
curve fitting of rehydration data and, 221
liquid transport into dried solid matrix and, 233
Penetrated surface oil, absorption
mechanisms in fried potato cylinders and, 526
Pentose, intermolecular hydrogen bonds,
NEB progress in the glassy matrix and, 576
Peptone, mixtures of, in probiotic cultures, 285
PerkinElmer Spectrum GX Series Fourier transform infrared spectrophotometer, 460
Permeability
softening of a polymer and, 402
water’s antiplasticizing effect and, 404–405
Permeability values of water
in Eudragit E100, as function of relative humidity, 406
in Eudragit E100, as function of water content, 405
Permeable cryoprotective agents
effect of, on temperature depression, 557
effect of ice reduction on stability of frozen LUVs and, 560–561
nonpermeable cryoprotective agents vs., 552
Pharmaceutical excipients, molecular mobility of water coexisting with, 36
Pharmaceutical industry
cyclodextrins used in, 150
decoupling of mobility of water from mobility of carbohydrate molecules in approach to glass transition and implications for, 366–369
Pharmaceutical products, knowledge of water plasticization and crystallization behaviors of sugars and sugar alcohols for, 482
Pharmaceutical sciences
carbohydrate polymers and role in, 301
water as most common plasticizer in, 401
Pharmaceutical solid matrices
evaluation of disintegration and diffusion of, by image processing and nonlinear dynamics, 515–520
conclusions, 520
introduction, 515
methods, 515–516
results and discussion, 516–517, 519–520
Pharmaceutical stability, glassy carbohydrates in, 353–356
Pharmacology, cyclodextrins used as drug-carrier systems in, 150
Phase diagrams
molecular mobility approach in water measurement and, 212–214
temperature-composition, for binary aqueous system, 213
Phase-separated water, in soy bread with and without almond during storage and, 182
Phase separation, gelation of mixed systems and, 245
Phase-transition phenomena, interaction of high pressure and subzero temperature in microbial inactivation and, 78
Phosphate salts, mannitol crystallization during freeze drying and, 20
Physical aging, 419
Physical product stability, criteria for, 366
Physical state changes, of foods in storage, 93–94
PID principles. See Proportional integral derivative principles
Pigments, controlled kinetics of Maillard reaction and, 11
Pineapple off-aroma
effect of freeze-thaw cycle on, by using electronic nose technique, 657–661
conclusion, 661
introduction, 657–658
results and discussion, 659–661
materials and methods, 658–659
electronic nose measurements, 659
freezing and thawing, 658
Pineapple off-aroma (continued)
sample preparation, 658
sensory evaluation, 659
statistical analysis, 659

Pipemidic acid
differential scanning calorimetric
thermograms for, 32
endothermic peak for, 31
water-sorption isotherms for, 33
Pipemidic acid hydrates, temperature
dependence of $T_2$ for, 34
Pittia, P., 121t, 493
Pizzoli, M., 381
Plasma membrane, cell mortality and
changes in fluidity of, 76

Plasticization, 122
antiplasticization vs.: polymer-diluent
interactions, 116–119
depiction of feasible explanation for
association between
antiplasticization and, based
on bulk free volume, 311,
311–312
water, glass transition temperature of
glassy polymer and, 401–402

Plasticization threshold, 117, 120

Plasticizers
increased molecular mobility and, 158
primary effects of, 116

Plasticizer threshold
gas transport properties and, 126
glycerol and, 132

Plasticizing effect of water
loss of sensory brittleness in foods relative
to, 108, 111
in raw and roasted coffee beans, 491
textural properties of raw and roasted
coffee and, 494

PMMA. See Polymethyl methacrylate
Poiseuille equation, for laminar flow, 223

Polarity, relative, of various compounds,
159t
Polarity of solvent, determining, 159–160

Polyacrylamide gels
cross-linked, ice crystallization during
rewarming of, 373
ice crystallization exotherm during
rewarming of, 377

Polyethylene, first-order phase transition
(melting) of, by use of common
sugar crystals, 433t
Poly (lactide-co-glycolide), anomalous
antiplasticization effects of water
in relation to some mechanical
properties demonstrated in, 122
Poly-L-hydroxyproline, water acting as
antiplasticizer by increasing
rigidity to maximum value, 123

Polymer-diluent interactions, plasticization
vs. antiplasticization, 116–119

Polymer gels
freezing behavior and, 373–383
conclusions, 382
freezing scheme for compartmentalized
water in polymer gels, 379–380
glass transition of cross-linked dextrans
containing small amount of water, 381
ice crystallization during rewarming
observed with various food
biopolymer gels, 381–382
ice crystallization exotherm during
rewarming observed with cross-
linked dextran gels, 374–375, 377

introduction, 373–374
origin of endothermic trend observed
prior to exotherm during
rewarming, 377–379
vitrified water in a frozen G25 gel, 379
physical state of unfrozen water in, 374
scheme for ice crystallization of
compartmentalized water in, 380t

Polymeric glassy matrices, enzyme stability
and, 16

Polymerization, glass transition temperatures
of starch films with different
degrees of, 644

Polymer matrix
intermolecular hydrogen bonds and, 575
model of local reaction promoting
nonenzymatic browning reaction
progress in glassy matrix and, 574,
575
Polymers
based on phenylpropane units, in fibers, 192
as effective stabilizers, 600
elongation, permeability, and softening of, 402
importance of, in various disciplines, 301
inhibiting crystallization and, 17
plasticizers and softening effect in, 401
synthetic
enthalpy relaxations in, 340
similarities between collapse
temperature and glass transition behavior of, 345
Polymethyl methacrylate, crack propagation by void formation in CS films compared with crazing mechanism observed in, 294
Polyols, 163
acting as antiplasticizers in variety of biopolymer systems, 131
crystallization of, 272
use of, in food industry, 483
waterlike solvation property of, 159–161
Polypropylene, first-order phase transition (melting) of, by use of common sugar crystals, 433
Polysaccharides
in fibers, 192
in jellyfish, 389, 390, 392
Polyunsaturated fatty acids, oxygen uptake and, 367
Polyvinylacetate, water uptake profiles for, 318
Polyvinyl chloride, crack propagation by void formation in CS films compared with crazing mechanism observed in, 294
Polyvinylpyrrolidone, 315
intermolecular hydrogen bonds and, 575
radial distribution functions between oxygen atoms in water and carbonyl oxygen atoms in or hydrogen atoms in PVP methylene groups at 0.5% water content, 320–321, 321
representative displacement profiles vs. simulation time for two water molecules in, at 0.5% wt/wt water and 298K, 322–323, 323
self-association of water at higher moisture levels observed in, 332
water uptake and its distribution in, 318–322
Polyvinylpyrrolidone carbonyl oxygen atom, probability distributions for number of water molecules surrounding, or given water molecule in simulated PVP glass with 10% wt/wt water, 322
Pommet, M., 124
Poole, P. L., 238
Popcorn, hot-oil puffed, loss of crispness in, 105
Pore size index, 226
Pore sizes, in particulate protein gels, 242, 243
Porosity
changes in blanched potato slices fried at 180°C, 529, 530
plots of compaction pressure vs., compressibility of microcrystalline cellulose under different conditions of relative humidity and, 306, 306
potato chip frying and, 526
of tablet, defined, 304
Porous media. See also Unsaturated porous media
capillary flow in, 222–224
developing theory of flow in, 228–231
prediction and validation of retention curve from water-activity data, 230–231
retention curve, 230
retention-curve validation, 231
water-sorption isotherm, 229
kinetics of liquid penetration and characterization of, 232
rehydration of foods and use of, 231–232
water-retention curve and, 225–227
Positron annihilation lifetime spectroscopy, 353
exploring molecular structure of amorphous carbohydrates in glassy state with, 355, 356, 357
insight into structure of carbohydrate-water system by combining other techniques with, 359
Post-deformation plastic zone, of biopolymer films, 295
Post-deformation plastic zones, Fourier transform infrared spectroscopy used with, in monitoring fracture behavior of biopolymer films prepared from aqueous solutions, 292
Potassium acetate salts, in tapioca-flour-based baked products study, 593
Potassium carbonate, in tapioca-flour-based baked products study, 593
Potassium chloride, in tapioca-flour-based baked products study, 593
Potassium chloride-glucose-water mixture, at 25°C, differences in relative viscosities of ternary solutions with, 474, 475
Potassium iodide, in tapioca-flour-based baked products study, 593
Potassium ions
effects of, on viscosities in sodium/potassium-glucose-water ternary system, 473–475
sodium ions vs., roles of, in living bodies, 473–474
Potassium sulfate, in tapioca-flour-based baked products study, 593
Potato, volume decrease or shrinkage studied in, 613
Potato chips
crispness of, 526
effect of violent drying during frying on texture, color, oil content, and porosity of, 525, 526, 527, 529–530
frying of control slices, observed and predicted water loss during, 527, 528
loss of crispness in, 105
low-fat and fat-free, consumers’ preferences for, 525
materials and methods, 526–527
analysis, 526–527
frying conditions, 526
materials, 526
modeling water loss, 527
moisture content and loss of crispness in, 106
tapioca flour in, 591
water content and physical properties of, 525–530
conclusions, 529–530
introduction, 525
results and discussion, 527, 529
Potato discs, color development at 70°C in, at different water activity, changes in luminosity value, 439
Potato growth rings, 253
Potato powder
spin-spin relaxation time obtained by single 90° pulse by proton NMR for, as a function of temperature, 440, 441
spin-spin relaxation time obtained by spin-echo Hahn sequence for, as function of water content, 441, 441
water-sorption isotherms for, at 23°C, fitted by Guggenheim-Anderson-de Boer equation, 439, 440
Potato slabs
effect of temperature on kinetics of lateral projected area of, during drying at air velocity = 1.7 m/s and thickness = 2.5 mm, 615, 616
kinetics of, during drying at 55°C, air velocity = 1.7 m/s, and thickness = 2.5 mm, 615, 615
two shrinkage-deformation stages during convective drying of, 613, 615, 616, 617
variation in lateral projected area of, during drying at conditions indicated, 616, 617
Potato slabs during convective drying
evaluation of deformation and shrinking
of, 613–617
conclusions, 617
introduction, 613–614
materials and methods, 614
drying equipment and image acquisition
system, 614
image processing, 614
materials, 614
results and discussion, 615–616
image analysis in evaluation of
shrinkage and deformation, 615
influence of drying conditions on
shrinkage and deformation, 615–616
Potato slices
blanched and fried at 180°C
changes in porosity of, 529, 530
color evolutions of, 529, 530
control
kinetics of oil-uptake fractions and total
oil in, during frying at 180°C, 527, 528
maximum forces vs. moisture content
for, fried at given temperatures, 529, 529
effective moisture diffusivity during
frying of, at given temperatures, 527, 528
Potato starch
leveling of melting enthalpies for, 277
undergoing gelatinization, SEM and TEM
micrographs of, 255
Potato-starch extrudates, amorphous,
water as antiplasticizer and, 126
Potato-starch gels, gelatinized, differential
scanning calorimetry rewarming
traces obtained with, 382
Potato starch synthesis, impact of drought
on, 252
Potato systems
proton NMR studies of molecular mobility
in, relative to nonenzymatic
browning, 437–442
conclusions, 442
introduction, 437–438
materials and methods, 438–439
results and discussion, 439–442
Potter, N., 675
Povidone, water content of, at 10% RH and
60% RH, 37t
Powder agglomeration, surface plasticization
and dehydration as basis of, 343
Powdered anhydrous milk systems, Maillard
reaction below glass transition
temperature in, 162
Power-function model parameters, for loss
of solids from milled rice grains at
different temperatures, 671t
Power-law model, 165
shear-thinning behavior in heat-moisture-
treated rice-starch pastes according
to, 639
sorption dynamics for dry, crispy bread
crust described by, 165, 167
Prado, S. M., 20
Preferential exclusion mechanism, 599
Premix chamber, 605, 606
Pressure potential, 225
Principal component analysis
elaboration of sensor responses and, 658
for fresh and freeze-thaw Smooth Cayenne
and Queen pineapple cultivars
determined by e-nose, 659, 660
Probiotic bacteria
entrainment of, in frozen cryoprotectants
and viability in freeze drying,
285–289
introduction, 285–286
materials and methods, 286–287
results and discussion, 287–289
Probiotic bacteria cells, entrainment of, in
frozen and freeze-dried
carbohydrate (cryoprotectant)
matrices, 288
Progesterone, water content and solubility
of, 330
Progressive chain association, gels, syneresis
and, 242
Projected area
fractal analysis of agave slices during
convective drying and, 621
image analysis and qualifying parameters
related to, 613
Prokaryotic cells, physical or physicochemical environment changes and stress on, 71
Proofing (or proving) stage, frozen dough, 49
Propeller method, advance caking point by, 100, 101
Property curve, in state diagram for binary aqueous system, 214
Propidium iodide/Lucifer yellow double-stained cells, viability of *Saccharomyces cerevisiae* vs. water activity and use of, 73, 74
Proportional integral derivative principles, 430
Propylene glycol, dielectric constants of, 159
Protective media for biological systems/ingredients, controlled kinetics of Maillard reaction and, 11
Protein behavior, parallel changes with pressure and temperature of, plus microbial inactivation and water structure, 80–82
Protein-carbohydrate sheets abbreviations, composition, feed rate of the solid and water and total feed rate, 578
Arrhenius plot of alpha relaxation and beta relaxation of dielectric spectra for, 580, 580
mechanical and oxygen permeability properties determined for, 580–581, 581
Protein-carbohydrate sheets produced by twin-screw extruder
physical properties of, 577–582
conclusions, 582
introduction, 577–578
materials and methods, 578–579
results and discussion, 579–581
Protein films, development of, 453
Protein hydration in structure creation, 237–249
gelation, 239–249
emulsion stabilization, 245
mixed systems, 243–245
single-protein systems, 239–242
structuring by extrusion, 246–249
water holding, 242–243
hydration studies, 238–239
introduction, 237
Protein modifiers, influences of, on starch network architecture at intermediate water content, 511
Proteins
beneficial effects with prior denaturation of, during raw material preparation, 247
crispiness in tapioca baked samples and, 596
delay in lactose crystallization and, 17
freeze-dried, mechanisms of stabilization of, by excipients during dehydration, 600
functional performance of, 237
gelation of, determination of, 239
mixed systems and, 243–245
protein-carbohydrated sheets prepared with, 578
structure of water and thermal denaturation of, 81
water holding capacity for, 242–243
Protein stability, in solid state vs. in liquid state, 16
Proteoglycans
in mesoglea, illustration of possible structural roles of, 394
water-holding capacity in jellyfish and, 392–393
Proton nuclear magnetic resonance, 26
findings related to characterization of water fraction of soy bread with, 175
spin-spin relaxation time obtained by 90° pulse by, for potato powder as a function of temperature, 440, 441
spin-spin transverse relaxation time measured by, 583, 584
water mobility determination with, in magnesium chloride and kinetics of NEB analysis, 539, 541
Proton relaxometry, continuous model of, in application to food systems, 257
Proton spin-spin relaxation time, *T*₂, water mobility in model dough system and, 62–64
P6 gel, ice crystallization exotherm during rewarming of, 377
PSO. See Penetrated surface oil
PUFAs. See Polyunsaturated fatty acids
Puffed cereal products, sensorily perceived moisture hardening or toughening in, 122
Puffed curls, tapioca flour in, 591
Puffed-rice cakes, loss of crispness in, 105
Pullulan, anomalous antiplasticization effects of water in relation to some mechanical properties demonstrated in, 122
Pulque, extraction of, from Agave atrovirens Karw, 619
Pulsed nuclear magnetic resonance, mobility of water in foods investigated by, 540
Pummelo peel oil, minimum inhibitory concentrations of and potassium sorbate against Rhizopus stolonifer and Aspergillus flavus, 547
Pummelo peels, preliminary examination of, for antifungal activities by an agar dilution method, 545
PV Ac. See Polyvinylacetate
PVC. See Polyvinyl chloride
PVP. See Polyvinylpyrrolidone
PVP glass
relationship between diffusion coefficient for water in, containing 0.5% or 10% wt/wt water and the number of first-shell water molecules, 324, 324–325
simulated, water mobility in, 322–325
PVP systems, Maillard reaction rate and, 11
Pyris Diamond differential scanning calorimeter, 485
Pyris 1 differential scanning calorimeter, 642
Queen pineapple, 657
freezing and thawing of sample, 658
fresh and freeze-thaw off-aroma scores of, 660
principal component analysis plot for, as determined by e-nose, 659, 660
sample preparation, 658
Quinidine sulfate
differential scanning calorimetric thermograms for, 32
free-induction decay exhibited by, 30
Gaussian-type decay exhibited by, 29
Quinidine sulfate hydrate, endothermic peak for, 31
Quinine hydrochloride
differential scanning calorimetric thermograms for, 32
endothermic peaks for, 31
R
Raffinose
adding to cotton candy, onset time of crystallization and, 98
gelatin and inhibiting crystallization of, 17
Raffinose matrices, intermolecular hydrogen bonds and, 575
Rahman, M. S., 91
Raman spectroscopic studies, on Sephadex gels, 379
Raman spectroscopy, vibrational motions measured with, 216
Reactant molecules, collisions between, 158
Reaction kinetics
correlations between details of moisture sorption isotherm and, 211
important modifiers of, 21
Reaction kinetics evidence microdomain distribution in food matrices: model dough system, 64–66
in model dough systems, 59
Reaction rate constant (k)
distribution of, as function of moisture content in dough at 288 k, 65
distribution of, as function of temperature for 35% moisture dough, 65
microdomain distribution in food matrices and, 59
Rechsteiner, M., 74

Q
Quality of food, distribution of microstructural domains and assessment of, 66
Quartz microbalance sensor, aroma analysis and, 658
Recombinant human factor XIII, stabilization of, 600
Recrystallization
ice formation and, 348
time-dependent, of amorphous lactose, 347
Redispersion, 42
Redissolution, 42
Reducing sugars
intermolecular hydrogen bonds and, 576
model of local reaction promoting
nonenzymatic browning reaction
progress in glassy matrix and, 574, 575
Rehydration, 42
membrane structure and fluidity and, 71
understanding plasma membrane changes
occurring during, 77
Rehydration data, empirical models
frequently used in curve fitting of, 221
Rehydration modeling, interdisciplinary
approaches to, 223
Rehydration modeling of food particulates
principles of water transport in porous
media and, 219–234
capillary flow in porous media,
222–224
conclusions, 234
diffusion model and, 221–222
empirical and semiempirical models, 220
flow in unsaturated porous media,
224–232
introduction, 219–220
mathematical modeling, 220–222
new approaches and other advances,
232–234
research needs, 234
Rehydration of food powders, operating
conditions in spray drying and, 673
Rehydration of pasta, radial nuclear
magnetic resonance study of, 224
Rehydration process, new interdisciplinary
insights into mechanisms involved
in, 233
Rehydration ratio, 220
Rehydration step, interdependence of
changes occurring in dehydration
step and, 74
Reid, D. S., 207
Reidy, G. A., 121
Reifenberger, E., 55
Reineccius, G. A., 367, 500
Relative humidity
adsorption and desorption rates, and
relative change of weight of
starch-rich bread crust during
isotherm experiment and single
exponential model as function of,
169
crystallization of lactose dependence on
water content and, during storage,
272
effect of, on release of D-limonene from
spray-dried powder, 501
effect of, on release of L-menthol from
spray-dried powder, 502
glass transition temperature of lactitol,
and predicting crystallization
at different levels of, 278, 280–281
levels in desiccators, saturated salt
solutions used in maintenance of,
303
low and high, summary of fitted
diffusional coefficient and
goodness of fits of diffusion and
exponential models for, 171
onset temperature for crystallization of, as
function of, 103
permeability of water in Eudragit E100 as
function of, 406
sample water peak melting enthalpy and
moisture content of lactitol
samples grouped according to
storage conditions and, 280
saturated salt solutions at varying levels
of, at 20° and 32°C, 273
water sorption and transport in dry,
crispy bread crust relative to, 167
Relative vapor pressure, 208
food stability and, 212
schematic representation of moisture-
sorption isotherm and, 211
water content of lactose, maltose, lactitol,
and maltitol during storage at 25°C
and, 480, 480–481
Relative water content model. See also
Water content
application of, to wheat-flour dough
during boiling, 534
water migration in multiphase food
systems described by, 533
Relaxation, types of, occurring within glassy
state, 116–117
Rennet milk gels, structure of, 242
Residual saturation, defined, 228
Residual water content, defined, 226
Response surface methodology, 143
Retention curve
developing theory of flow in porous media
and, 230
prediction and validation of, from water-
activity data, 230–231
Retention-curve validation, flow in porous
media and, 231
Rewarming
ice crystallization during, observed with
various food polymer gels,
381–382
ice crystallization exotherm during, as
observed with cross-linked dextran
gels, 374–375, 377
origin of endothermic trend observed
prior to exotherm during,
377–379
RH. See Relative humidity
Rheological properties, of high-amylose rice
starch, 635–639
Rhizopus stolonifer
combined effect of cinnamon essential oil
and water activity on, 545–550
introduction, 545
materials and methods, 546–547
results and discussion, 547, 549–550
effect of cinnamon and relative humidity
on growth inhibition of Aspergillus
flavus on bread during storage at
30°C, 549
effect of cinnamon oil and water activity
on inhibition of, on bread model
agar, 546, 547, 548, 549
minimum inhibitory concentrations of
esential oils and potassium
sorbate against, 547t
Rhodotorula rubra, baroprotective effect of
solute and, 79
Rice, cooked, texture of and water-content
distribution in after boiling, 533
Rice-based starches, oxygen permeability
and, 641
Rice flour, five freeze-thaw cycles, $T_2$
distribution of protons in, 267, 268
Rice-glycerol extrudates, Guggenheim-
Anderson-de Boer parameters
obtained for, 487, 487t
Rice grains, diverse soaking characteristics
of different cultivars of, 664
Rice kernels, glass-rubber transitions
measured for, 435
Rice Research Center (Thailand), 635
Rice starch
extruded, sorption behavior of in presence
of glycerol, 483–489
conclusions, 488–489
introduction, 483–484
extruded, sorption isotherms for, with 0%,
5%, 10%, 20% glycerol, 485–486,
486
extruded, X-ray diffraction patterns for,
with 0%, 5%, 10%, and 20%
glycerol, 485, 486
five freeze-thaw cycles, $T_2$ distribution of
protons in, 267, 268
heat-moisture-treated, relationship of
apparent viscosity and shear rate of
native rice starch and, at 18%,
21%, 4%, and 27% moisture
content over shear rate range of
0–300 s$^{-1}$ and at 60°C, 637
materials and methods, 484–485, 635–636
DSC, 485
DVS, 485
flow behavior, 636
heat-moisture treatment, 636
pasting properties, 636
WAXD, 485
results and discussion, 485–488, 636
DVS, 485–486
flow behavior, 636
modeling sorption isotherms, 487
pasting properties, 636
Index

Rice starch (continued)
prediction of sorption isotherms, 487–488
WAXD, 485
Rice starch, high-amylose
effect of hydrothermal treatment
on rheological properties of, 635–639
conclusion, 639
introduction, 635
relationship of apparent viscosity and
shear rate of heat-moisture-treated
rice starch at 18%, 21%, 4%, and
27% moisture content over shear
rate range of 0–300−1 and at 60°C,
637
Rice-starch-based film, oxygen permeability
values of, 643, 643t
Rice starch–glycerol mixture
interaction factor and error function for,
487, 487t
interaction factors vs. moisture content of,
488, 488
Richards equation
boundary, initial conditions and, 227
solving, retention-curve validation and,
231
Roe, K., 101
Roos, J., 100
Roos, Y., 87, 88, 91, 98, 106, 160, 286, 345,
346, 347, 348, 479
Roozen, M. J. G. W., 94, 100
Rosenberg, M., 500, 504
Rossi, C., 228
Rotational diffusion, 419
Rotational motion, 158, 161
liquid state of water and, 205
of water, nuclear magnetic resonance
techniques and sensitivity to,
216
Rotronics, 90
Roudaut, G., 105, 106, 121t
RR. See Rehydration ratio
RSM. See Response surface methodology
Ruan, R. R., 61, 259
Rubbery amorphous solid state, food storage
and transition from glassy stable
amorphous solid state to, 93
Rubbery state
free volume of carbohydrate system
matrix independent of degree of
polymerization in, 361
water diffusivity, glassy state vs., 94
Rupley, J. A., 238
Rusk roll, sorption experiments performed
on crusts of, 166–167
Rutnakornpituk, M., 460
RVP. See Relative vapor pressure
RWC model. See Relative water content
model
Ryshkewitch analysis, 312
tensile strength as function of relative
humidity at porosity of zero
obtained with, 308
Ryshkewitch equation, tensile strength of
MCC compacts at zero porosity
obtained with, 307
S
Saccharin sodium, differential scanning
calorimetric thermograms for, 32
Saccharin sodium hydrates, endothermic
peaks for, 31
Saccharomyces cerevisiae
affinity constants for glucose uptake by, as
reported in various studies, 55t
cell resistance to thermal and osmotic
stress and surface topology of, 77
isoviability diagram of, vs. temperature
and water activity, 75
synergism between high pressure and
subzero temperature on, 78
variations in average cell volume and cell
viability of, after osmotic shock,
73
viability of, vs. water activity by use of
two probes: Lucifer yellow and
propidium iodide, 73
Saccharomyces cerevisiae cells, glucose and
fructose in dough and, 53
Saccharomyces cerevisiae membrane,
isoorisotropy of, vs. temperature
and water activity, 76
Index

751

Saenger, W., 153
Safety of food, distribution of microstructural domains and assessment of, 66
Sajama quinoa seeds
amplitude of signal of lipid component of, with different water activities, 652
genotype description of, 648
percent germination of, during storage at 32°C and 43% or 75% relative humidity, 650, 650
percent viability of, assessed by tetrazolium test, 651
relaxation times of lipid component of, with different water activities, 652
sorption isotherms of, 651
viability and germination values for, 650
Salinity changes, jellyfish water-holding and texture properties relative to, 388, 388–389
Salt
in bread formulation and production, 606
carotene encapsulation, mannitol and, 20
effect of, phase diagram of sugars, 17
sugar crystallization kinetics and enzyme inactivation and, 18
Salt concentration, water retention by superabsorbent polymers and jellyfish as function of, 388
Saltine crackers, loss of crispness in, 105
Salt solutions, saturated, preparation of, 272–273
Sao Hai rice, 663, 664
comparison of experimental and predicted solid loss of milled rice grains from waxy milled rice, jasmine rice and, as function of soaking time at various temperatures, 670
effective diffusion coefficient for, at different temperatures, 669
experimental and predicted moisture contents of, as function of soaking time at various temperatures, 666
Page model parameters for water uptake by, at different temperatures, 668
t-power-function model parameters for loss of solids from, at different temperatures, 671
regression coefficient and percentage of root mean square error obtained from model fitting using various models, 667
temperature and water uptake of, 667
SAPs. See Superabsorbent polymers
Saravacos, G. D., 129
Sarcoplasmic proteins, gel formation and, 241
Saturated hydraulic conductivity, 226, 231
Saturated salt solutions preparation of, 272–273
of varying relative humidity measured at 20° and 32°C, 273
Sauvageot, F., 105
Sawai, H., 635
SB. See Standard bread
Scanning electron micrograph images, of surfaces and fracture surfaces of chitosan film, 90: 10 blend film, 80:20 blend film, and 70:30 blend film, 462, 462
Scanning electron microscopic images, of agave dried slices, longitudinal and transverse cuts, 624, 624
Scanning electron microscopy crystalline amylopectin lamellae alignment as evidenced by, 253
images of Lactobacillus rhamnosus GG encapsulated in trehalose and lactose-trehalose glass, with data for colony forming units, 289
Scanning electron micrographs, of cassava and potato starches undergoing gelatinization, 255
SCF. See Sugar-frosted cornflakes
Schebor, C., 162
Schmidt, A., 91
Schmidt, S. J., 216
Schubert, H., 675
SCM. See Soft condensed matter
Scopolamine hydrobromide differential scanning calorimetric thermograms for, 32
endothermic peaks for, 31
water-sorption isotherms for, 33
Scopolamine hydrobromide hydrates
free-induction decay exhibited by, 30
Gaussian-type decay exhibited by, 29
Scott, W. J., 89
Seafood products, chitosan and storage of, 459
Secondary relaxation processes, glassy state and, 117
SEM. See Scanning electron microscopy
Semicrystalline lamellae, starch granule, 254
Semiempirical models
liquid transport into dried solid matrix and, 233
rehydration studies and, 220
Semimoiest foods, Arrhenius relationship and reactions limiting storage stability of, 98
Semisolid solvents, dielectric constant of, 159
Semisolid foods, solvent and nonsolvent water in, 55
Semisolid phase, in dough, 50
Semisolid viscoelastic phase, in dough, 50
Sensor array-based aroma analysis technology, 658
Sensory crispness, ability of water to plasticize polymer structure related to, 108
Sensory crispness intensity, as function of temperature for wafer cookie at 5% moisture content and intersection representing critical point for onset of crispness loss, 110
SENT specimens. See Single-edge notched tension specimens
Seow, C. C., 116, 129
Sephadex G25 gel
differential scanning calorimetry rewarmed traces obtained with, 375, 375
differential scanning calorimetry rewarmed traces obtained with, containing small amount of water, 381
frozen and containing 50% water, two-dimensional x-ray diffraction images obtained with, 378
ice crystallization during rewarming observed with, 382
ice crystallization exotherm during rewarming observed with, 374–375, 377
vitrified water in, 379
Serrano, R., 55r
Shalaev, E. Y., 74
Shamblin, S. L., 426
Shamekh, S., 643, 644
Shear-thinning behavior, of rice-starch pastes after heat-moisture treatment, 636
Shelf life of food mechanical and thermal properties and, 583
predicting, temperature dependence of physical and chemical reactions and, 98
texture loss and reduction in, 105
water distribution in foods and, 533
Shiozawa, S., 228
Shittu, T. A., 675
Shogren, R. L., 130
Short-range mobility, crystallization and, 94
Shrinkage isotropic, 616
nonisotropic, 616
studying in vegetables, 613
Shrinkage and deformation of agave slices during convective drying, image processing and fractal analysis used in study of, 620–621
of potato slabs during drying, image analysis in evaluation of, 615
Shrinkage-deformation kinetics, agave samples and, 621, 624
Sigma Scan 5.0, 516
Sigma Stat 2.0 software, 516
Silage, Lactobacillus coryniformis Si3 as additive to, 142
Single-edge notched tension specimens, 291
Sinkability, quality of food powder properties obtained by spray drying and, 674
Skimmed milk, mixtures of, in probiotic cultures, 285

Skim-milk powder
- effect of water and fat contents on enthalpy of dissolution of, 42
- onset of glass transition temperature of food powders measured by TMCT, DSC, and TMA, 434t

Slade, L., 90, 98, 158, 212, 470

Slaninova, I., 74

Smooth Cayenne pineapple, 657
- freezing and thawing of sample, 658
- fresh and freeze-thaw off-aroma scores of, 660t
- principal component analysis plot for, as determined by e-nose, 659, 660
- sample preparation, 658

SMP. See Skim-milk powder

SO. See Surface oil

Sodium, water content of, at 10% RH and 60% RH, 37

Sodium-caseinate, protein-carbohydrated sheets prepared with, 578

Sodium chloride
- maximum load of 2.4 mm probe penetrating jellyfish at speed of 0.5 mm/s at increasing additions of, 389, 389–390
- in tapioca-flour-based baked products study, 593

Sodium chloride-glucose-water mixture, at 25°C, differences in relative viscosities of ternary solutions with, 474, 475

Sodium ions
- effects of, on viscosities in sodium/potassium-glucose-water ternary system, 473–475
- potassium ions vs., roles of in living bodies, 473–474

Sodium/potassium-glucose-water ternary system
- effects of sodium and potassium ions on viscosities in, 473–475
- introduction, 473–474
- materials and methods, 474
- results and discussion, 474–475

Soesanto, T., 344

Soft condensed matter
- background, 88–93
- conclusions, 111
- examples of use of state diagrams and glass transition curve, 94–108, 111
- loss of crispness or hardness, 105–108, 111
- stickiness of hard candy, 100–105
- sugar recrystallization in storage of foods: sucrose and cotton candy, 95–100
- introduction, 87–88
- perspective on physics of food states and stability, 87–111
- physical state changes in foods in storage, 93–94

Softening, food storage and, 93

Softening of crispy food in storage, moisture pickup and, 95

Soil science, retention curve in, 226

Soles, C. L., 132

Solid active pharmaceutical ingredients, apparent correlations between stability of, and molecular mobility of water, 25–26

Solid foams, expanded, 247–249

Solid food materials: thermal mechanical compression test, 429–436
- applications, 433–434, 436
- design of sample cell, 431
- determining onset of glucose melting temperature based on mechanical behavior measured by TMCT, 433
- diagram of sample cell, 430
- introduction, 429–430
- methodology, 430–433
- design and setup of TMCT, 430–431
- operation protocol of TMCT, 431–433
- onset of melting temperature of sugar crystals and some plastic polymer beads measured by TMCT and DSC, 433
- performance of heater controller, 431
- standard operation protocols for TMCT, 432

Solid foods, rheological and textural properties of, 119

Solid fraction, of a tablet, defined, 304
Solid polymer-diluent blends, idealized and antiplasticized modulus vs. diluent content curve of, 118
Solid state of water, 204
Solid system states, solid food matrix state, 90
Solubility
approximate, of some sugars in glycerol at 60°C after an equilibration period of 10 days, 160
quality of food powder properties obtained by spray drying and, 674
water of hydration, API hydrate and, 26
Solubility curve of solute, thermodynamic phase diagram for binary aqueous system and, 214, 215
Soluble solids of cooked rice, analysis of, 665
Soluble starch, antiplasticizing effect of water and, 311
Solution viscosities, influence of sodium ions and potassium ions on, 474
Solvent fractions, 50
Solvent water in dough, 51–52
food freezing and removal of, 338
in semisolid foods, 55
Solvent-water concept in dough, 49, 50–51
frozen dough and, 49
Sommier A., 630
Soottitantawat, A., 500, 502, 504
Sorbitol
anhydrous, sucrose crystal dissolving in, at 100°C, 160
dielectric constants of, 159
melting-enthalpy-moisture-content-relationships of konjac glucomannan films plasticized with glycerol and, 125
as plasticizer, in egg-white film preparation, 454
tensile strength for egg-white films plasticized with 50% and 60%, 456–457
tensile strength of starch-based films at low moisture contents and, 132
viscosities of egg-white solutions after addition of, 455
water-vapor permeability values of duck egg-white film with addition of, 457
Sorption isotherms
determining for beta-cyclodextrins, 151
for extruded rice starch with 0%, 5%, 10%, and 20% glycerol, 485–486, 486
modeling for rice-glycerol extrudates, 487
prediction of, for rice starch-glycerol mixtures, 487
for quinoa seed samples, 649–650
Sorption mechanisms, distinguishing between, 166
Sorption moisture studies, for beta-cyclodextrins, 152–153
Soya mixed systems in, 244
non-denatured, inspection of DSC behavior of, 247
Soy bread “freezable” water in, 181, 181
magnetic resonance proton-intensity signal images of, on days 0 and 6 of storage at 4°C, 179
moisture content and specific loaf volume of almond-soy bread and, 179
regular, formulations of, 177
schematic of changes occurring in, with and without almond during storage, 182
Soy bread with and without almond materials and methods
differential scanning calorimetry, 178
preparation of samples, 176–177
specific loaf volume measurement, 177
thermogravimetric analysis, 177–178
results and discussion, 178–183
differential scanning calorimetry, 181–183
loaf volume, 178
moisture loss and migration during storage, 179
water state, thermogravimetric analysis, 180–181
water state and distribution during storage of, 175–183
introduction, 176
Soy protein

history behind addition of, to bread, 176
inclusion of, in U.S. diet, 175
protein films developed from, 453
Spaghetti, describing sorption dynamics of, 166
Specific volume, of annealed maltodextrin matrices with given equilibration as function of temperature for various molecular weight distributions, 360
Spectroscopic approach, to metrics for water, 216–217
Spectroscopy, measurement of frequencies and amplitudes of signals with, 216
Spiess, W. E. L., 493
Spin-lattice relaxation, for Na₃HPO₄·12H₂O and Na₂HPO₄·2H₂O, 27, 28
Spin-spin relaxation

measuring rotational mobility of water molecules and, 62
molecular mobility of hydration water in API hydrates determined by, 27
usefulness and limitation of determination of water mobility by NMR and, 36
Spin-spin transverse relaxation time, measuring of, by proton nuclear magnetic resonance, 583, 584
Sponge cake, Fickian diffusion used to describe sorption dynamics of, 166
Spray-dried food powders, onset of glass transition temperature of food powders measured by TMCT, DSC, and TMA, 434, 434r
Spray drying

adsorption surface changes as function of water activity of sucrose-calcium powders at 25°C by, 686
benefits with, 191
of citrus juice, with maltodextrin as a carrier, 196
drying aids and, 192
of fructose mixtures, 195–196
main requirements for, 342–343
microstructural, physical, and rehydration properties of maltodextrin powders obtained by, 673–678
operating conditions in, and rehydration of food powders, 673
quality of food powder properties obtained by, 674
Stability of food, distribution of microstructural domains and assessment of, 66
Standard bread, 605, 607

hardness of, during storage, 608t
proton free-induction decay of, fresh and after 7 days of storage, 609, 610
Starch

changes in fracture stress and fracture strain for, as function of moisture content, 124
crispiness in tapioca baked samples and, 596
from different sources, different molecular weights for, 641
enzyme stability and, 16
hydrothermal treatment of, common use, 635
ice crystallization during rewarming observed with, 373, 381–382
influence of water behavior in, 251
water mobility in, 256
Starch acid hydrolysis treatment, 264–265, 267
Starch-based food, understanding effects of freezing in, 185–186
Starch-chain mobility, during gelatinization, 260–263
Starch chain mobility T₂ distribution, as measured by proton 90° pulse free-induction decay of deuterated cassava starch saturated with water during gelatinization, 262
Starch films and coatings, as good oxygen barriers, 641
Starch fraction
  effect of freezing temperature on time needed to freeze 50% and 100% of available freezeable water, and corresponding moisture content of, 189
  moisture content in, after freezing at −3, −40, and −50°C, for samples with 30%, 40%, and 50% overall moisture content, 188
Starch-fraction moisture content
  effect of initial water content and freezing temperature on, after freezing, 187–188
  evolution of, in function of freezing time at various freezing temperatures, 189
Starch gelatinization, hydration in, 255
Starch genetics and biosynthesis, drought and, 252
Starch glass transition, phase separation of ice crystals in starch-based systems during freezing and effects on moisture content and, 185–190
Starch granule-associated proteins, defined, 508
Starch granules
  in dough, 50
  understanding nature of, and seasonal changes affecting properties of, 268
  water-saturated freezing behavior of, 263–264
  gelatinization behavior of, 260
Starch granule structure, redrawn from Gallant and others, 254
Starch growth ring, components of, 253
Starch retrogradation, 119
Starch samples, syneresis and freeze-thaw stability in, 267
Starch state diagram, to show freeze concentration of starch fraction during freezing for system initially at 50% moisture content, 186
Starch-water films, sorbitol added to, 132
Starchy food during cooking
  method, 534–535
  modeling, 534–535
  water-holding capacity profile, 535
  predicting water migration in, 533–544
  conclusion, 538
  introduction, 533–534
  nomenclature, 538
  results and discussion, 535–537
  starch gelatinization and conversion of, into multiphase body, 533
STARe software, 584
State change
  influence of temperature and moisture increase on, 93
  key to understanding of, 100
State diagrams
  of amorphous lactose, 349
  generating, 214
  low-water food systems and use for, 348–349
  molecular mobility approach in water measurement and, 212–216
  need for glass transition line in, 111
  optimizing efficiency of biomolecular dehydroprotectant agents and development of, 18
  showing equilibrium and amorphous regions: sugar mix, cereal dough, soft cookie or caramel, hard-ball candy, cotton candy, or crisp cookie, 92
  showing saturated, ambient temperature; eutectic temperature; glass transition temperature; solute-specific glass transition temperature; and melting temperature, 92
  state changes and use of, 94–108, 111
  loss of crispness or hardness, 105–108, 111
  stickiness of hard candy, 100–105
  sugar recrystallization in food storage: sucrose and cotton candy, 95–100
  temperature-composition, for binary aqueous system, 214
  theoretical development of, 91
Steponkus, P. L., 74
Sterilization, effects of various perturbations on, 72
Steroids, water content and solubility of, 330
Stickiness
of amorphous food powders, 344–345
of amorphous food solids in dehydration
at various water contents and, 343
collapse phenomena in food systems and, 335
of food storage and, 93
of hard candy, 100–105
Sticky point temperature, 100
StO. See Structural oil

Stoichiometric water uptake
of bulk drug active pharmaceutical
ingredient as function of percent
relative humidity at 25°C, 319
moisture uptake in pharmaceutical solids
and, 318

Strain, changes in, at break of tapioca starch,
konjac glucomannan, and konjac
 glucomannan-carboxy
 methylcellulose films as function
of water activity, 123

Structural oil, absorption mechanisms in
fried potato cylinders and, 525
Structural relaxation, 161, 419
amorphous materials and, 341
Student’s t-test analysis, for identifying
differences between breads
produced with different mixers at
same storage time, 608

Sub-\(T_g\) (or secondary relaxation), brittle-
ductile transition of synthetic
amorphous or partially crystalline
polymers and, 117
Sub-\(T_g\) relaxation, molecular mobility, glass
transition temperature and, 161

Sucrose
addition of, to freezing solutions, 551
amorphous, crystallization of, 346
approximate solubility of, in glycerol at
60°C after equilibration period of
10 days, 160r
cotton candy and: sugar recrystallization
in storage of foods, 95–100
effects of, on storage stability of xanthine
oxidase, 599, 601, 601t, 602, 603
first-order phase transition (melting) of, by
use of common sugar crystals, 433r
freeze-dried products and, 142
glass transition line for, 101
protein-carbohydrated sheets prepared
with, 578
time to crystallization of, as function of
water activity, 96
Sucrose-calcium powders, 681
adsorption surface changes as function of
water activity of, at 25°C, 686
cryogenic process, 682
spray drying, 682
Sucrose-cell formulations, water activity of,
after freeze-drying, 144, 145
Sucrose crystals
density of, 101
dissolving of, in anhydrous sorbitol at
100°C, 160

Sucrose glass transition temperature, as
function of mass fraction of water:
sucrose solubility curve; and
water-melting curve, 17

Sucrose hydrolysis, in mixed doughs, 53
Sucrose recrystallization, raffinose and, 98

Sucrose-salt-water solution
partial phase diagram of, with constant
weight ratio value of 9.09, 556
partial phase diagram of, with R value of
36.34, 556

Sucrose solution, leakage from large
unilamellar vesicles at various
concentrations of, that were
previously cooled to \(-40°C\) and
thawed to room temperature,
559

Sucrose-water mixture, ESR use and
increase in rotational mobility of
spin probes within, 94

Sugar
amorphous, crystallization of, 346–348
in bread formulation and production, 606
molecular structures and properties of
sugar alcohols and, 477
Sugar alcohols, molecular structures and
properties of sugar and, 477
Sugar concentrations in dough, expressions
of, 49
Sugar content, carrot fiber powder size and,
194
Sugar crystallization, enzyme stability and, 16
Sugar crystals, first-order phase transition (melting) of crystalline food solids by use of, 433t
Sugar extraction, dough manufacture and analysis of, 52
Sugar-free confectionary products, with lactitol, moisture content and $T_g$ as useful tools in predicting stability of, 281
Sugar-free products, market demand for, 272
Sugar-frosted cornflakes
differential scanning calorimetry thermograms of, at 7.5% and 5.2% water content, 585, 585
Hahn spin-echo transverse relaxation time values vs. water content for, 586–587, 587
relationship between relaxation time constant determined by free-induction decay analysis and temperature for, 586, 586
water content for, 583, 584
Sugar glasses, glycerol as antiplasticizer and enhancing bioprotective properties of, 132
Sugar recrystallization in storage of foods, sucrose and cotton candy, 95–100
Sugars
acting as antiplasticizers in variety of biopolymer systems, 131
crystallization of, food properties and, 271
Maillard reaction and, 11
protecting enzymes during drying and storage with, 16
Sugar-salt-water systems, concentrated, measurements of electrical conductivity in, 17
Sugar snap cookies
brittle-ductile transition study on, 107
brittle-ductile transition temperature plot as function of moisture at constant temperature for, 108
Sugar-water mixtures, thermal, mechanical, and dynamic properties of, 465
Sulfated polysaccharides, in jellyfish, 392
Sulpyrine
differential scanning calorimetric thermograms for, 32
endothermic peak for, 31
Sun, W. Q., 101
Sunflower oil, in bread formulation and production, 606
Superabsorbent gel, transmission electron microscopic image of freeze-etched replica of, 393
Superabsorbent polymers
acrylate-based, drawbacks with, 386
transmission electron microscopic image of freeze-etched replica of, 393
water retention by jellyfish and, as function of salt concentration, 388
Superabsorbents
developmental research on, 385–386
water uptake reduction in, by addition of salt, 387
Supercooled liquids
glass transition for, 336
spatially heterogeneous dynamics in, 18
Surface acoustic wave sensor, aroma analysis and, 658
Surface integration, limited crystal growth and, 272
Surface oil, absorption mechanisms in fried potato cylinders and, 526
Surface tension, 225
Surfactants, water interactions and, 157
Suwonischon, T., 121t
Sweet potato, volume decrease or shrinkage studied in, 613
T
Tablet making
environmental moisture and, 302
mechanical strength of, 301
Tablets, as special type of dispersion, 304
Takahashi, K., 78
TAM. See Thermal activity monitor
Tang, H. R., 258
Tapioca flour, uses for, in various food products, 591
Tapioca-flour-based baked products
glassy, relationships between water
activity, texture properties, glass
transition, and moisture content
of, 595, 595–596
glassy, texture of, as function of moisture
content, 591–596
introduction, 591–592
materials and methods, 592–593
dynamic differential scanning
calorimetry, 593
mechanical measurement, 593
proximate analysis, 592
sample preparation, 592
sorption isotherm, 593
texture assessment: crispness, hardness,
and work sensory evaluation,
593
results and discussion, 594–596
adsorption isotherm, 594–595
food properties, 594
relationship among texture, water
activity, and glass transition,
595–596
Tapioca starch
anomalous antiplasticization effects of
water in relation to some
mechanical properties
demonstrated in, 122
changes in tensile strength and strain at
break of, as function of water
activity, 123
oxygen permeability of, 641
Tapioca-starch-based film
oxygen permeability values of, 643, 643r
tensile modulus of, at different water
activity as function of glycerol
content, 131, 131
Taylor, L. S., 318, 321
Tea leaves, capillary-flow approach for
modeling temperature and
anisotropic effects during
rehydration of, 231–232
TEG. See Terminal extent of gelatinization
TEM. See Transmission electron microscopy
Temperature
bread-dough study, 628
brittle fracture and, 106
critical state for powders during storage
and, 100–101
defining/predicting kinetic coefficients of
desirable and undesirable changes
in foods, 9–10
extent of freeze concentration and, 338
influence of, on state change, 93
isoanisotropy of Saccharomyces cerevisiae
membrane, vs. water activity and,
76
isoviability diagram of Saccharomyces
cerevisiae vs. water activity and,
75
low
combination of high hydrostatic
pressure and, on Escherichia coli
survival, 77–79
effect of hyperosmotic perturbation and,
on Escherichia coli baroresistance,
79–80
Maillard reaction rate, PVP systems and,
11
solvent water in dough and, 51
stability of food matrix and, 59
storage, glass transition temperature of
lactitol, and predicting
crystallization at different levels
of, 278, 280–281
storage longevity of seeds and, 647
thermodynamic and kinetic properties
influenced by, 208
transition, of chocolate wafers as function
of moisture content, 110
vapor pressure and, 210
water uptake of rice grains and, 667
Temperature-concentration diagrams,
213
Temperature dependence
of chemical reactions, Arrhenius
relationship and, 98
of partial pressure of water in system and
partial pressure above pure water
at same temperature, 210
Temperature depression
nonpermeable cryoprotection agents and
effect on, 555–557
permeable cryoprotection agents and
effect on, 557
Temperature kinetics
for bread dough, 630
inside dough during baking at three
different locations, 628, 629

TEMPO
dissolving of, in dough matrix, reaction
kinetics and, 64–66
NMR and ESR experiments with wheat
flour dough and, 60–61

Tensile strength
changes in, at break of tapioca starch,
konjac glucomannan, and konjac
 glucomannan-carboxy
methylcellulose films as function
of water activity, 123
for egg-white films plasticized with 50%
and 60% sorbitol, 456–457
highest value of, observed for gelatin-gum
arabic-sucrose sheet as compared
with other sheets, 580
relationship between compaction pressure
and, in microcrystalline cellulose, 309

Tensile strength of microcrystalline cellulose
compacts, effect of relative
humidity on, at constant porosity
of 0.3 and 0.1, 307

Tension head, 225
parametric models for relating water
content to, 226, 227
water activity converted to, by Kelvin
equation, 229
Tension head and capillarity, flow in
unsaturated porous media and,
224–225
Terminal extent of gelatinization, 535

Testosterone
equilibrium solubility of, in triglyceride
oils that were either desiccated or
water saturated, 331
water content and solubility of, 330, 332

Tetrazolium test for viability, for quinoa
seeds, 649

Texture, product quality and loss of, 105
Texture Expert Exceed software, 303
Texture of food, water distribution in foods
and, 533

Texture properties
mechanical and thermal properties and,
583
of raw and roasted coffee, water
plasticization and antiplasticization
effects and, 494
relationship among moisture content,
water activity, glass transition and,
for glassy tapioca-flour-based
baked product, 595, 595–596
small changes in moisture and, 483

TGA. See Thermogravimetric analysis

Thailand Research Fund, 639

Thermal activity monitor, water uptake and
mobility on pharmaceutical
stability in amorphous solids and
measurements by, 325
Thermal expansion coefficient, free volume
available within glassy system and, 94
Thermal mechanical analysis, 429, 430
onset of glass transition temperature of
food powders measured by, 434t
Thermal mechanical compression test
accuracy and robustness of, in analysis of
solid food samples, 436
development of, 430
as ideal tool for measuring phase
transition of solid food materials, 433
onset of glass transition temperature of
food powders measured by, 434t
Thermal mechanical compression test: solid
food materials, 429–436
applications, 433–434, 436
introduction, 429–430
methodology, 430–433
design and setup of TMCT, 430–431
operation protocol of TMCT, 431–433

Thermal plasticization, effect of, on
mechanical, flow, and collapse
phenomena on relaxation times
and time-dependent changes in
food solids, 340
Thermal properties
of food polymer-water blend, 124–126
shelf-life stability and textural properties
of food products and, 583
Thermal stress
  protein stability and, 16
  yeast survival and effect of combined osmotic stress and, 75–77
Thermodynamic approach, to metrics for water, 208–211
Thermodynamic behavior of soluble food powders, demonstration of, 41–46
Thermodynamic phase diagram, for binary aqueous system, 214, 215
Thermodynamic properties of water, critical importance of, in survival of microorganisms, 82–83
Thermodynamics, of water sorption, 128–129
Thermogravimetric analysis findings related to characterization of water fraction of soy bread with, 175
  measuring distribution of water in bread with, 176
  soy bread, typical weight-loss first-derivative curve from, 180, 180
Thirathamthavorn, D., 642
Thixotropic behavior, of high-amylose rice starch, 635, 636, 639
Three-point beam-bending method, mechanical properties of microcrystalline cellulose tablets measured with, 303
Three-point-bending test, 120, 126
Thymol release of, during storage, 154–155, 155
  sorption characteristics of beta-cyclodextrins formed with, and their release, 149
storage study on, 151
  in thyme essential oil, 150
  water sorption and stability of beta-cyclodextrin complexes with, 155
Time domain (td) proton nuclear magnetic resonance combining classic moisture-sorption isotherms with, 411
  microdomain distribution in food matrices and measured values ascertained with, 60
Time-resolved NMR spectroscopy, studying water status and metabolic changes in biological systems with, 647–648
Timmermann, E. O., 14, 439
TMA. See Thermal mechanical analysis
TMCT. See Thermal mechanical compression test
To, E. T., 345
Tolstoguzov, V., 245
Tomato powder
  hydration experiments on, 414
  water-sorption isotherms and dependence of relative mobile tdNMR signal on hydration for, 417
  water-sorption isotherms for, 415–416, 417
  Total oil (TO), kinetics of, in control potato slices during frying at 180°C, 527, 528
Transition temperatures, of chocolate wafers as function of moisture content, 110
Translational diffusion, 419
Translational motion, 94, 158, 161
  glass transition temperature, collapse phenomena and, 336
  liquid state of water and, 205
  of water, nuclear magnetic resonance techniques and sensitivity to, 216
  of water molecules in pharmaceutical glasses, 322
Transmission electron micrographs, of cassava and potato starches undergoing gelatinization, 255
Transmission electron microscopic images of freeze-etched replica of superabsorbent polymer, superabsorbent gel, gelatin gel, and jellyfish network, 393
  showing area of mesoglea consisting of open network structure composed of polysaccharides and proteins, 392, 392
Transmission electron microscopy crystalline amylopectin lamellae alignment as evidenced by, 253
  microstructure of jellyfish characterized by, 385, 391
Transparent fine-stranded gel, at pH 7.5, 240
Transport phenomena in foods, Fickian approach in modeling of, 222
Trehalose, 142
addition of, to freezing solutions, 551
amorphous, mean radius of holes in, as function of water content at 25°C, 356, 358
anhydrobiosis and, 132
enzyme stability and, 18
glass transition of maximally freeze-concentrated solutes and onset temperature of ice melting of, 287
protecting enzymes during drying and storage with, 16
protein-carbohydrated sheets prepared with, 578
raising T_g of, inhibiting rate of crystallization of lactose and, 104
scanning electron microscopy images of Lactobacillus rhamnosus GG encapsulated in lactose-trehalose glass and, with data for colony forming units, 289
Trehalose-glucose-lysine system
glass transition and enthalpy relaxation results for, 447
glassy, enthalpy relaxation time of, 447–448
time courses of ABS_280 for, at given temperatures, 448, 449
Trehalose hydrolysis, interactions of, with magnesium chloride and/or with water as role in browning inhibition, 541
Trehalose matrix
intermolecular hydrogen bonds and, 575, 576
model of local reaction promoting nonenzymatic browning reaction progress in glassy matrix and, 574, 575
Trehalose-salt-water solution, partial phase diagram of, with constant weight ratio value of 9.09, 556
Trehalose solution, leakage from large unilamellar vesicles at various concentrations of, that were previously cooled to -40°C and thawed to room temperature, 559
TRF. See Thailand Research Fund
Tricaprylin C=O oxygen atoms, radial distribution function for water oxygen with monocypryl oxygen atoms and, 331
Tricaprylin-monocaprin, water uptake in, at 37°C and 100% relative humidity as function of molar concentration of monoglyceride component, 328, 328
Tricaprylin-monocaprylin, water uptake in, at 37°C and 100% relative humidity as function of molar concentration of monoglyceride component, 328, 328
Triglyceride-monoglyceride-water mixtures freeze-fracture electron microscopy study of organization of lipid molecules in, 329
self-association of water at higher moisture levels observed in, 332
Triglycerides, water uptake, distribution, and effects on drug solubility in lipid vehicles composed of, 326–330, 332
True density of microcrystalline cellulose powder, measuring, 304
TS. See Tensile strength
T_2
distribution of values of probability density function for, in microsecond range, for 30% moisture dough at different temperatures, 63
distribution of values of probability density function for, in millisecond range for 30% moisture dough at different temperatures, 63
T_2 line, state diagram and equilibrium curves combined with, 91
T_2 values, water mobility in dough samples and comparison of, 62–63
Twin-screw extruder, protein-carbohydrate sheets prepared with, 577, 579
Two-term exponential model
predicting moisture rate of rice grains
with, 664t
rice varieties and, regression coefficient
and percentage of root mean
square error obtained from model
fitting with, 667t

2-Want quinoa seeds
amplitude of signal of lipid component
of, with different water activities, 652

genotype description of, 648
percent germination of, during storage at
32°C and 43% or 75% relative
humidity, 650, 650
percent viability of, assessed by
tetrazolium test, 651

relaxation times of lipid component of,
with different water activities, 652
sorption isotherms of, 651t
viability and germination values for, 650

U
Ubbelohde viscometer, 474
Unfreezable water, 115, 119, 127
Unfreezable water fraction, 51
Unfrozen water, physical state of, in polymer
gels, 374

Uniform-penalty inversion program, coffee
samples analysis and, 494
Uniform-penalty inversion $T_2$ relaxograms,
of raw coffee samples rehydrated
at different water contents, 496, 496–497

Unsaturated porous media flow, 224–232
capillarity and tension head, 224–225
developing theory of flow in porous
media, 228–231
prediction and validation of retention
curve from water-activity data,
230–231
retention curve, 230
retention-curve validation, 231
water-sorption isotherm, 229
rehydration of foods using porous media,
231–232
Richards equation, boundary, and initial
conditions, 227–228
water-retention curve, 225–227

UPEN. See Uniform-penalty inversion
program

Urbani, R., 424
Urea, 130
UTM dynamometer model 4301, 493

V
Vacuum oven drying, measuring amount of
water and, 207

van Bruggen, E. F. J., 253
van der Waals forces, 158
van der Waals interactions, solvent-water
concept and, 50
van Genuchten model, for relating water
content to tension head, 226, 227

Van Hecke, E., 121t
van Vliet, T., 242

Vapor pressure
measuring, 209
solvent-water concept and, 50
temperature and, 210

Vapor state of water, 206

Vegetable foods, complexity of, 613

Vegetable powders
hydration experiments on, 414
main (dry-mass based) components of,
used for hydration experiments
vs. fraction of the matrix
component mobilized during
hydration, 417t
water-sorption isotherms and dependence
of relative mobile tdNMR signal
on hydration for, 417

water-sorption isotherms for, 415

Vegetable tissues, understanding structural
changes occurring during drying
of, 617
Vertical liquid penetration, studies of,
232

Vibrational motion, 158
liquid state of water and, 205
Vickers, Z. M., 105

Viscosity
changes in
stickiness and caking in amorphous
food materials and, 344
structural relaxations around and above
glass transition and, 341
Viscosity (continued)
of film-forming ability of duck egg-white separated from shell eggs, 456
of ternary solutions, with sodium chloride-glucose-water and potassium chloride-glucose-water at 25°C, 474, 475

Vitamins, cyclodextrins and solubility, stability, and bioavailability of, 150

Vitrification, of protective sugars, 16
Vitrified water, in frozen G25 gel, 379

Vogel-Tamman-Fulcher model, relaxation times above glass transition modeled with, 339

Volume decrease, studying in vegetables, 613

Volume relaxation, 419

Vuataz, G., 346

W

Wafer cookie
sensory crispness intensity as function of temperature for, at 5% moisture content and intersection point representing critical point for onset of crispness loss, 110
stress/strain plot for, at 0.05% relative humidity and 23°C, 109

Walstra, P., 242

Washburn equation, capillary flow in porous media and use of, 222–223

Washburn-Rideal equation, rehydration modeling and, 223

Water
as antiplasticizer on mechanical properties in complex food products, 121
biopolymer interaction with, 291
bound, 115, 127
in bread formulation and production, 606
dielectric constants of, 159
external mechanical antiplasticization by, 116
free, 115, 128
glass transition temperature of glassy polymer and, 401–409
glycerol and interactive plasticizing-antiplasticizing effects of, 130–132
heat gelation and, 239
heterogeneous nature of, in various starch domains, 268
loss of sensory brittleness of foods and plasticizing nature of, 108, 111
measurement of influence of, 203
monomolecular layer, 159
in most biological systems, 157
as most common plasticizer in pharmaceutical and food sciences, 401
nonsolvent, 115, 127
nonwater diluents as antiplasticizers at T less than Tg, 130–132
phase-separated, in soy bread with and without almond during storage and, 182
as plasticizer of choice, in preparation of compacts, 302
properties of, 126–129
properties of, as diluent thermodynamics of water sorption, 128–129
water diffusivity, 129
properties of food polymer-water blend, 119–120, 122–129
gas transport properties, 126
mechanical properties, 119–120, 122–124
thermal properties, 124–126
role of, in food drying process, 673
salts and tetrahedral hydrogen-bond network of, 18
as solvent of life, 203
soy-almond bread and plasticizing effect of, 183
structure of carbohydrate classes and effects of, 356–357, 359
as ubiquitous diluent, as antiplasticizer at T less than Tg, 119–132
ubiquity of, in food systems, 203
unfreezable, 115, 119, 127
Water activity, 203
effect of, on n values for release of encapsulated D-limonene and L-menthol from spray-dried powder at 50°C, 503
effect of, on release-rate constant of encapsulated $D$-limonene and $L$-menthol at 50°C, 503

enthalpy dissolution of food powder samples tested as function of, 44

enthalpy relaxation as function of, 424–425

isoanisotropy of *Saccharomyces cerevisiae* membrane, vs. temperature and, 76

isoviability diagram of *Saccharomyces cerevisiae* vs. temperature and, 75

measured, food stability and general rules with respect to, 89–90

relationship among moisture content, texture properties, glass transition and, for glassy tapioca-flour-based baked product, 595, 595–596

structure of beta-cyclodextrins and, 150

of sucrose-cell formulations after freeze-drying, 144, 145

tensile strength and strain changes at break of tapioca starch, konjac glucomannan, and konjac glucomannan-carboxy methylcellulose films as function of, 123

time to crystallization of sucrose as function of, 96

typical dissolution calorimetry curves of food powder samples containing 14.3% fat equilibrated at various levels of, 45

Water-activity data, prediction and validation of retention curve from, 230–231

Water activity stability diagram, of relative relation rate vs. $a_w$, 89

Water-activity theory, 157

on stability of biological materials, 158–159

Water content

for biopolymer films, prediction of dependence of fracture characteristics on: brittle-ductile transition, 295–296

changes in crystallinity of microcrystalline cellulose as function of, 313

effect of, on physicochemical and structural properties of biopolymer films, 292–293

enthalpy dissolution of all food powder samples tested as function of fat contents and, 46

Hahn spin-echo transverse relaxation time vs., for commercial cornflakes and sugar-frosted cornflakes, 586–587, 587

hydrate formation and effects of, on drug solubility in lipid vehicles, 330

illustration of typical behavior of the $S_w/S_m$ as function of, 413, 413

of lactose, maltose, lactitol, and maltitol during storage at 25°C at various relative vapor pressures, 480, 480–481

low, complex lipid phase behavior and, 77

moisture-sorption isotherm and plotting of, against relative vapor pressure, 211

pattern of seed aging and, 647

permeability values of water through Eudragit E100 as function of, 405

physical properties of potato chips and, 525–530

of protein-carbohydrate sheets, 578

fresh sheet and equilibrated sheet, 580

residual, 226

thermal transitions, mechanical properties, and molecular mobility in corn flakes as affected by, 583–588

various levels of, glass transition, stickiness, and collapse properties of amorphous food solids in dehydration at, 343

Water content of systems, defining/predicting kinetic coefficients of desirable and undesirable changes in foods and, 9–10

Water crystallization, degree of, freeze-dried products and, 142

Water-diffusion process, in rice grains during soaking, 665, 668
Water diffusivity, 129
effective, comparison of, for granular hydrates and gelatinized amioca and hylon 7, obtained from drying-curve data at 60°C, dry basis, 130
rubbery vs. glassy state, 94
Water distribution
in food biopolymers, 251
NMR relaxation and, 256
Water-excipient mixtures, ratio of high-mobility water to low-mobility water in, 37
Water-holding capacity
defined, 534
for proteins, 242–243
of starchy food, extent of starch gelatinization and, 535
Water-holding capacity profiles
for calculation of transient water-content profile in slab of wheat-flour dough during boiling, linear, convex, and concave schematics, 535, 535
in starchy food during cooking, 533
with three bending points, in slab of wheat-flour dough, for boiling time and dry basis, 537, 537
Water-imbibition theory, applicability of, in modeling rehydration of dried porous food, 219, 224
Waterless environment, color development due to nonenzymatic Maillard browning in, at 100°, 115°, and 130°C, 163
Waterless system
waterlike functions of other biological compounds in, 157–163
conclusions, 162–163
glass transition, molecular mobility, and sub- $T_g$ relaxation, 161
introduction, 157–158
molecular mobility and the Maillard reaction, 161–162
understanding molecular mobility, 158
water-activity theory on stability of biological materials, 158–159
waterlike solvation property of polyols, 159–161
Water loss, potato chips and modeling of, 527
Water measurement, 203–217
conclusion, 217
introduction, 203–204
metrics for water, 206–217
amount of water, 207–208
molecular mobility approach, 212–217
 sorption isotherms, 211–212
 thermodynamic approach, 208–211
states of water, 204–206
liquid state, 205–206
solid state, 204
vapor state, 206
Water mobility
chemical reactivity in low-moisture and intermediate-moisture systems and, 10, 21
correlation of, as determined by NMR with that as determined by DSC and water-sorption isotherm measurements, 31, 34–36
decoupling from mobility of carbohydrate molecules in approach to glass transition, technological implications of, 366–369
Maillard reaction rate and analysis of, 15 in model dough systems, 59
quinoa seed longevity and, 647–654
in simulated PVP glasses, 322–325
in solid pharmaceuticals, 25–38
molecular, coexisting with various pharmaceutical excipients, 36
molecular, in API hydrates, 26–36
usefulness and limitation of determination of, by NMR, 36
Water mobility (proton spin-spin relaxation time $T_2$) microdomain distribution in food matrices: model dough system and, 62–64
microdomain distribution in food matrices and, 59
Water molecules, as universal solvent supporting all living systems, 251
Water partitioning in colloidal systems as determined by nuclear magnetic resonance, 251–268
acid hydrolysis, 264–265, 267
amylose, amylopectin, and more, 252–253
cassava starch, 258
conclusions, 268
discriminating NMR $T_2$ distribution, 257–258
freezing behavior of water-saturated starch granules, 263–264
gelatinization behavior of water-saturated starch granules, 260
hydration, 255
introduction, 251–252
NMR, 258–260, 259
nondiscriminating properties, 256
starch, 252
starch-chain mobility during gelatinization, 260–263
syneresis and freeze-thaw stability, 267
water distribution, 256–257
Water peak, 207
Water plasticization, effect of, on mechanical, flow, and collapse phenomena on relaxation times and time-dependent changes in food solids, 340
Water-proton relaxation times, change in, during compression of cooked beef, 244
Water protons, spin-spin relaxation time of API protons and, 27
Water-related effect of combined physical stresses on cells, 71–83
combination of high hydrostatic pressure and low temperature on Escherichia coli survival, 77–79
conclusions, 82–83
based on combination of high pressure, temperature, and osmosis, 82
effects of combined high hydrostatic pressure, low temperature, and hyperosmotic perturbations, 77–82
effects of combined hyperosmotic and temperature perturbation: example 1, 72–77
combined osmotic and thermal stress, 75–77
conclusions on combined osmosis and temperature, 77
hyperosmotic perturbation of yeast cells, 72, 74
effects of low temperature and hyperosmotic perturbation on Escherichia coli baroresistance, 79–80
introduction, 71–72
parallel changes with pressure and temperature of protein behavior, microbial inactivation, and water structure, 80–82
Water relationships, food polymer science approach to study of, 116
Water-replacement hypothesis, 355
Water retention
determining, traditional method of, 226
by superabsorbent polymers and jellyfish, as function of salt concentration, 388
Water-retention curve, porous media and, 225–227
Water-retention data, typical, for microcrystalline cellulose, 230
Water-saturated oil phase, 208
Water-saturated starch granules freezing behavior of, 263–264
gelatinization behavior of, 260
Water sorption stability of beta-cyclodextrin complexes with thymol and cinnamaldehyde and, 155
thermodynamics of, 128–129
Water sorption and transport in dry, crispy bread crust, 165–173
conclusion, 173
introduction, 165–166
materials and methods, 166–167
results and discussion, 167–173
Water-sorption behaviors, in pharmaceutical excipients, 36
Water-sorption data, typical, for microcrystalline cellulose, 230
Water-sorption isotherm data, 25
Water-sorption isotherm measurements
correlation of water mobility as
determined by NMR with that as
determined by DSC and, 31, 34–36
ease of evaporation for hydration as
determined by differential scanning
calorimetry and, 31
Water-sorption isotherms, 256
for active pharmaceutical ingredient
hydrates, 33
of beta-cyclodextrin and beta-
cyclodextrin-cinnamaldehyde and
beta-cyclodextrin-thymol
complexes, 152
for cereal cracker sample, 416
developing theory of flow in porous media
and, 229
enabling better understanding of, food
hydration behavior and, 417–418
for microcrystalline cellulose, 229
for porous cracker sample, 415
for raw and roasted coffee, 494
for two vegetable powders displaying
distinct differences, 415–416, 417
Water-sorption isotherms of food materials
molecular mobility interpretation of, by
means of gravimetric NMR,
411–418
conclusions, 417–418
discussion, 416–417
hydration experiments, 414
introduction, 411–412
results, 415–416
theory, 412–414
$T_2$ analysis, 414–415
Water’s role in nonaqueous pharmaceutical
systems, 315–332
conclusions, 332
implications of water uptake and mobility
on pharmaceutical stability in
amorphous solids, 325–326
introduction, 315–317
molecular dynamics simulations,
317–318
uptake, distribution, and effects on drug
solubility in lipid vehicles
composed of triglycerides and
monoglycerides, 326–330, 332
water uptake and its implications in
amorphous glass, 318–326
water mobility in simulated PVP
glasses, 322–325
water uptake and its distribution in
PVP, 318–322
Water state and mobility
mechanical properties of coffee beans at
different hydration degrees related
to, 491, 497
in soy-containing breads, for improved
dough handling and loaf
homogeneity, 180
Water structure, parallel changes with
pressure and temperature of protein
behavior, microbial inactivation,
and, 80–82
Water substitution, 599, 600
Water uptake, of rice grains during soaking,
665, 667–668
Water-vapor permeability, of chitosan
and blend films, 462–463,
463t
Water-vapor permeability values
of duck egg-white film, effect of increased
storage time and sorbitol content
on, 457
for egg-albumen films, 453
WAXD. See Wide-angle X-ray diffraction
Waxes, in fibers, 192
Waxy milled rice, 663, 664
comparison of experimental and
predicted solid loss of milled
rice grains from jasmine, Sao
Hai and, as function of soaking
time at various temperatures,
670
effective diffusion coefficient for, at
different temperatures, 669t
experimental and predicted moisture
contents of, as function of soaking
time at various temperatures,
666
Page model parameters for water uptake
by, at different temperatures,
668t
power-function model parameters for loss
of solids from, at different
temperatures, 671t
regression coefficient and percentage of root mean square error obtained from model fitting using various models, 667

temperature and water uptake of, 667

Waxy rice starch, five freeze-thaw cycles, \( T_2 \)
distribution of protons in, 267, 268

Webb, S. W., 229

Webb, T., 51

Weibull distribution function
curve fitting of rehydration data and, 221

liquid transport into dried solid matrix and, 233

rehydration studies and, 220

Weight determination, for amount of water, 207

Weller, C. L., 453

Wettability
of maltodextrin powders, determining, 675

maltodextrin powders evaluation, at different feed concentrations and drying temperatures in production of powders, 677

quality of food powder properties obtained by spray drying and, 674

Wetting process, food powder samples and exothermic nature of, 45

Wharton, John C., 95

Wheat flour
extruded, light micrograph of, showing starch as continuous structure with protein particles included, 249

sorption kinetics of, 166

tapioca flour as partial substitute for, 591

Wheat flour crackers, hydration experiments on, 414

Wheat-flour dough during boiling
relative water content model applied to, 534

water-holding capacity profiles used for calculation of transient water-content profile in, 535, 535

water-content profile in slab of, calculated using water-holding capacity profiles in, 536, 536–537

water-holding capacity profile with three bending points in, for boiling time and dry basis, 537, 537

Wheat gluten
anomalous antiplasticization effects of water in relation to some mechanical properties demonstrated in, 122

protein films developed from, 453

Wheat growth rings, 253

Wheat semolina, in bread formulation and production, 606

Wheat starch, five freeze-thaw cycles, \( T_2 \)
distribution of protons in, 267, 268

Whey, mixed systems in, 244

Whey powder
comparison of glass transition temperature measured by TMCT, DMTA/TMA, and DSC for, 434

onset of glass transition temperature of food powders measured by TMCT, DSC, and TMA, 434

Whey-protein gel mixture
light-microscopic images of, at pH 5.4, induced by temperature and high-pressure processing, 245

moisture loss as function of temperature and salt concentration for, 243

White-bread structural evolution
confirmation of three stages of baking in, 627, 632

image-processing results: mean cell area, cell density vs. dough center temperature, and MCA vs. mass loss, 632, 633

materials and methods, 628–630

baking experiments, 628
dough preparation, 628
image processing, 629–630

ingredients, 628

mass-loss kinetics, 629
real-time bread-height measurements, 629

temperatures measurement, 628

results and discussion, 630–632
changes in crumb during baking, 631–632

image processing, 632
mass-loss kinetics, 630–631
temperature kinetics, 630
White-bread structural evolution (continued)
study of, by means of image analysis
and associated thermal history
and water-loss kinetics,
627–634
conclusions, 632
introduction, 627–628
Whitney, W. R., 41
Whorton, C., 499
Wide-angle X-ray diffraction, starch
conversion assessed with, 484
Williams, M. C., 344
Williams, M. L., 98
Williams-Landel-Ferry equation, 98,
111
Williams-Landel-Ferry plot, modified, for
lactose crystallization, 99
Williams-Landel-Ferry power law, relaxation
times above glass transition
modeled with, 339
Winger, R. J., 52
WLF power law. See Williams-Landel-Ferry
power law
Wolf, W. R., 493
Wollny, M., 675
WVP values. See Water-vapor permeability
values
X
Xanthine oxidase
freeze-dried, effects of excipients on
storage stability of, 599–603
discussion, 602–603
introduction, 599–600
results, 601–602
freeze-dried, illustration of, in different
glasy matrices: sucrose, sucrose +
bovine serum albumin, and sucrose
+ dextran, 603, 603
materials and methods, 600–601
assay of xanthine oxidase activity, 601
determination of water content, 601
differential scanning calorimetry, 601
preparation of freeze-dried xanthine
oxidase samples, 600
remaining activity of, with various
excipients after preparation and
subsequent storage at 25°C, 602, 602
values for glass transition temperature and
moisture contents of, with various
excipients, 601f
Xiang, T-X, 318
XOD. See Xanthine oxidase
X-ray diffraction
apparent crystallinity index of
microcrystalline cellulose, obtained
from, 310, 310
freeze-thaw behavior of aqueous glucose
solutions within concentration
range of 10%–60% wt/wt studied
by, 466
X-ray diffraction patterns
for extruded rice starch, with 0%, 5%,
10%, and 20% glycerol, 485, 486
of model food powders, 43
X-ray diffraction powder patterns
for cotton candy stored for 2h at
45% relative humidity and
23°C, 97
for fresh cotton candy, 96, 97
for lactose, maltose, lactitol, and maltitol
at end of storage at 25°C at
relative vapor pressures of 54%,
76%, 66%, and 54% respectively,
481, 481
X-ray diffraction studies, on amorphous
sucrose, 95
X-ray microtomography (MCT),
microstructure of porous foods
observed with, 234
X-ray scattering
in combination with PALS, for insight
into structure of carbohydrate-
water system, 359
investigating dynamic properties
close to glass transition and,
364
XRD-DSC measurements, endothermic
trend due to ice melting,
verifying assumption with,
378
Xylose
embedding of, in glassy trehalose matrix, 572
intermolecular hydrogen bonds, NEB progress in the glassy matrix and, 576

Y
Yang, P., 238
Yeast, in bread formulation and production, 606
Yeast activity, shelf-life of frozen dough and retention of, 49
Yeast cells
in dough, 50
sequence of hyperosmotic perturbation of, 72, 74
Yeast survival
combined osmotic and thermal stresses on, 75–77
osmosis and temperature combined for improvement in, 77
Yielding, brittle fracture vs., 106

Yogurt
integral entropies of, 683, 684
lyophilized, water-sorption date for, 683
Yoshii, H., 500, 502
Yoshioka, S., 325
Young’s modulus, 124, 126
fracture response of food material and, 107
highest value of, observed for gelatin-gum arabic-sucrose sheet as compared with other sheets, 580
microcrystalline cellulose compact and, 303

Z
Zein film, sorption dynamics of, 166
Zeolite clinoptilolite, integral entropies of, 683, 684
Zeolite Valfor, integral entropies of, 683, 684
Zeolite Valfor 100, in paprika-containing algic acid capsules, 681
Zografi , G., 101, 426
Zygosaccharomyces bailii, baroprotective effect of solutes and, 79