

Index

A

- Accelerated shelf life tests (ASLT), 236, 239, 240
- Activated sludge treatment, 89
- Advanced oxidation processes (AOPs), 4, 8, 103
 - decontamination and disinfection, 91
 - HO, 89
 - irradiation, 89
 - mathematical modeling
 - kinetic models, 93, 94
 - mass balance, 92
 - momentum, 92
 - photoactivated processes, 92
 - simulation, 93
 - thermal processes, 92
 - quantitative risk assessment, 99
 - RTE vegetables (*see* Ready-to-eat (RTE) vegetables)
 - solar
 - chemical pollutants, 91
 - EDDS, 90
 - photocatalysis, 90
 - photo-Fenton, 90, 91
 - wastewater issues, 91
- American Institute of Baking (AIB), 17
- Antibiotic-resistant bacteria (ARB), 85, 91
- Antibiotic-resistant genes (ARG), 85, 91
- Appropriate level of protection (ALOP), 5
 - definition, 176
 - FSO, 178

B

- Bacillus cereus*, 187
- Baranyi model, 214
- Baseline (www.baselineapp.com), 216
- Boron-doped diamond (BDD), 68
- British Retail Consortium (BRC), 17

C

- Centering, 124
- Chemical oxygen demand (COD), 62, 84
- Chemical pollutants, 91
- Chemometrics
 - calibration samples
 - KS, 133
 - RS, 133
 - SPXY, 133
 - dimensionality reduction and band selection
 - GA, 130
 - iPLS, 132
 - SPA, 130
 - UVE, 131
 - evaluation parameters, 137
 - feature extraction, 128
 - Fourier transform, 129
 - image analyses, 127
 - image preprocessing and correction
 - correlation, 122
 - filtering, 122
 - geometry transformations, 123
 - histogram, 121

Chemometrics (*cont.*)

- linear point operation, 122
- quality, 121
- morphological image processing, 128
- spectral preprocessing
 - centering, 124
 - derivatives, 126
 - detrending, 126
 - MSC, 125
 - OSC, 127
 - smoothing, 124
 - SNV, 125
 - WT, 126, 127
- Chlorination, 66, 86
- Chlorine dioxide (ClO₂), 68
- Chlorophyll (Chl) degradation, 227, 228
- Clean water, 61
- Codex Committee on Pesticide Residues, 25
- Codex Alimentarius, 16, 17, 22, 26
- ComBase
 - described, 216
 - growth and inactivation data, 216
 - growth/no growth data, microorganisms, 216
 - platform, 217
 - recorded data, 217
- ComBase predictor (<http://www.combase.cc/index.php/en/>), 246
- Computer vision, 116, 117
- Contaminants of emerging concern (CECs), 84, 85

D

- Detrending, 126
- DiaClean[®], 68
- Dietary Guidelines for Americans, 30
- Discrete model, 166, 167
- Disinfection, 91, 102
- Disinfection by-products (DBPs), 66, 69, 70, 84, 86
- DMFit (computational tools), 246

E

- Electrochemical disinfection, 67
- Electrolyzed water (EW), 67, 225
- Emerging pathogens, 4
- Equilibrium modified atmosphere packaging (EMAP), 6
 - concept of, 198
 - defined, 193
 - film material

- EVA, 206
 - for fresh-cut vegetables, 207
 - OPP, 206
 - orientation, 206
 - PE, 206
 - PP, 206
 - thicknesses, 206
 - water condensation, 206
 - inorganic fillers, 207
 - microperforations, 207, 208
 - O₂-concentrations, 198
 - porous patch, 207
- Escherichia coli*, 213–215
- Escherichia coli* O157, 184, 187
- Escherichia coli* O157:H7, 78, 213–215
- Ethylene diamine-N,N'-disuccinic acid (EDDS), 90
- Ethylene vinylacetate (EVA), 201, 205, 206

F

- Feature extraction, 128
- Fecal contamination, 151, 152
- Flow cytometry, 83
- Foodborne diseases (FBD), 15
- Foodborne pathogens
 - E. coli*, 31
 - L. monocytogenes*, 34
 - outbreaks, 31–33
 - protozoan parasites, 35
 - Salmonella* spp., 34
 - spore-forming pathogenic bacteria, 34
 - Staphylococcus aureus*, 34
 - viruses, 35
- Food chain risk model, 178
- Food safety, 115, 161
 - QMRA (*see* Quantitative microbial risk assessment (QMRA))
- Food safety control measures
 - advantage, 181
 - ICMSF, 180, 182
 - PCs, 180, 182
 - process and product criteria, 182
- Food safety objective (FSO), 5, 22
 - ALOP, 178
 - definition, 176
 - L. monocytogenes*, 186
 - and microbiological criteria, 181
 - Salmonella* and HAV, 184
- Food security, 11, 12
- Food transformation, 12
- Fourier transform, 129
- Fourier transform infrared (FTIR), 151

- Fresh-cut produce
 definition, 77
 lettuce outbreaks, 78
 processing steps, 78, 79
 water, 78
- Fresh-cut products
 commercial modified atmospheres, 246
 respiratory activity, 232
 temperature management, 231
 type II breakdown, 228
- Fresh produce, 183, 184, 186
 bacterial growth models, 214
 bacterial pathogens, 213
 as critical vectors, of foodborne illness, 213
 disease-causing microorganisms, 59
 industry, 59, 60
L. monocytogenes growth, on lettuce
 and cucumber, 215
 mesophilic microbiota, 64
 microbial contaminant, 63
 NEO, 68
 pathogens
 behaviour on, 214, 215
 prevalence of, 214
 postharvest processing, 64
 sanitization, 215
 sources, contamination, 214
 surveys of, 213
 washing tanks, 62
- G**
- Gap–segment derivative, 126
 General Agreement on Tariffs and Trade (GATT), 25
 Genetic algorithm (GA), 130
 Geometry transformations, 123
 GInaFiT (computational tools), 246
 Global Food Safety Initiative (GFSI), 17
 Gompertz model, 243
 Good agricultural practices (GAPs), 2, 13, 14, 115
 Good hygienic practices (GHP), 24
 Good manufacturing practices (GMPs), 3, 13–15, 115
 Growth models, 101, 105
- H**
- Hazard analysis and critical control points (HACCP) system, 3, 6, 13, 15, 16, 115, 182
 Hepatitis A virus (HAV), 184
 5-Hydroxymethylfurfural (HMF), 240
 HIS, *see* Hyperspectral imaging system (HIS)
 Hydrocoolers, 60
 Hydroxyl radicals (HO), 89
 Hyperspectral imaging system (HIS), 119
- I**
- Image preprocessing and correction
 correlation, 122
 filtering, 122
 geometry transformations, 123
 histogram, 121
 linear point operation, 122
 quality, 121
 Integrated pest management (IPM), 3, 13, 15
 International Commission of Microbiological Specifications for Foods (ICMSF), 6
 International Fresh-Cut Produce Association (IFPA), 1
 Interval partial least squares (iPLS), 132
- K**
- Kennard–Stone (KS) algorithm, 133
 Kinetic micro steady-state approximation (MSSA), 94
 Kinetic model, 94–97
 Knowledge gaps, 163, 164
- L**
- Least squares support vector machine (LS-SVM), 136
 Levenberg–Marquardt nonlinear regression, 96
 Life cycle assessment (LCA), 7
 applications, in vegetable processing industry
 in agriculture and the food sector, 269
 in broccoli, 273
 cradle to gate, 268
 to crop production stage, 270
 cultivation (production) method, 278
 electricity consumption, 279
 energy costs, 271
 environmental impact categories, 269
 eutrophication, 267
 food preservation methods, 272
 fresh-cut vegetables, RTE, 279–281
 functional unit, 269
 irrigation water, consumption of, 278
 ketchup production systems, 269
 land and water use, 279
 MPV, 270
 as multidimensional quantitative tool, 268

Life cycle assessment (LCA) (*cont.*)

- non-thermal techniques, 272
- novel technologies, 272
- on-farm stage, 273
- packaging, 270
- post-farm stage, 271, 273
- pre-farm stage, 273
- processing and distribution, 278
- refrigeration and packaging, 278
- RTE fresh fruits and vegetables, 268, 269
- in strawberry, 273
- sustainable processing, 267, 268
- systems, vegetable processed, 273, 274
- transportation, of raw materials, 272
- unit operations, 271
- waste minimization, 270
- water and energy consumption, 271
- definition, 255
- evaluations
 - Coca-Cola company (1969), 256
 - on fossil fuels, 256
- general methodological framework, 257
- goal and scope definition
 - allocation, 258
 - description, 257
 - evaluation, 258
 - functional unit, 258
 - types, environmental studies, 258
- interpretation
 - completeness checks, 266
 - comprehensive report, 267
 - conclusions, recommendations and reporting, 266
 - consistency check, 266
 - description, 257
 - sensitivity checks, 266
 - in standards ISO, 257
 - steps, 266
- inventory analysis (*see* Life cycle inventory (LCI) analysis)
- packaged lettuce salad, production
 - abiotic resource depletion, 289
 - acidification potential, 288
 - agricultural and processing steps, 285
 - electricity, consumption of, 288
 - environmental burden, 289
 - eutrophication potential, 289
 - goal and scope definition, 282, 283
 - greenhouse gas emissions, 288
 - human toxicity potential impact category, 288
 - LCI, 283, 284
 - LCIA, 283–285
 - water, 287, 288

- phases, 256

- stages and flows, 255, 256

- by standards ISO, 257

- workshops, 256

Life cycle impact assessment (LCIA)

- characterization, 261
- classification, 260
- description, 257
- endpoint approach, 261
- impact categories, 260–262
- midpoint approach, 261
- normalization factors, 261
- packaged lettuce salad, 283–285
- ReCiPe methodology, 265, 266
- steps, 260
- weighting, 261

Life cycle inventory (LCI) analysis

- calculations procedure, 260
- data collection, 259
- data quality, 260
- impacts allocation, 260
- interpretation, 267
- packaged lettuce salad, 283, 284
- parameters, 266
- stages, 283
- system boundaries, 260

Listeria monocytogenes, 78, 180, 187–189, 213–215

Local rate of photon absorption (LRPA), 93, 95

M

Maximum residue limits (MRL), 25

Membrane filtration, 82, 88

Microbial contamination and risk factors, 149, 151

- post-harvest

- harvest, 41, 42

- processing, 42

- transportation and storage, 42, 43

- pre-harvest

- climate and weather factors, 39, 40

- irrigation water, 37, 38

- landscape and geographical factors, 41

- manure application, 38, 39

Microbial detection methods, 24

Microbial responses viewer (MRV), 7, 216

- classes, 216

- ComBase, database (*see also* ComBase) databases, 216

- for *E. coli*, in culture medium, 217, 219

- environmental parameters, 219

- growth and inactivation data, 216

- interface of, 217

- retrieval interface, 217, 218
 - for *Salmonella* spp., on fruits and vegetables, 217, 220
 - Microbial risk
 - mitigation strategies and control measures
 - bacteriophages, 46
 - irradiation, 45
 - pre-harvest, 43, 44
 - washing and disinfection, 44, 45
 - Microbiological criteria, 22, 181–183
 - MicroHibro (www.microhibro.com), 7, 216, 246–248
 - Microperforations, 205, 207, 208
 - Minimally processed fruits and vegetables (MPFV)
 - biochemical changes
 - browning reactions, PPO, 227
 - Chl degradation, 228
 - lipid oxidation, 229
 - contamination, microbial, 231
 - deterioration, cause of, 230
 - lactic acid bacteria, 229
 - microbial spoilage and pathogen growth, 223, 224
 - minimal processing (*see* Minimal processing, MPFV)
 - natural microbiota, 230
 - organoleptic changes, 223
 - physicochemical deterioration, 223
 - physiological changes, 229
 - Pseudomonas* spp., 229
 - as quality deterioration parameters, 237
 - respiratory activity, 232
 - shelf life, determination of (*see* Shelf life, in MPFV)
 - spoilage, microbial, 230
 - temperature management, 231
 - Minimally processed vegetables (MPV), 198, 270
 - EMAP, 198 (*see also* Equilibrium modified atmosphere packaging (EMAP))
 - filling process, 209
 - packaging design, 203–205
 - packaging machines, 209
 - permeability of plastics, 200
 - respiration rate, quantification method, 201–203
 - sealing, 209
 - super atmospheric oxygen packaging, 199
 - Minimal processing, MPFV
 - classification, 225
 - EW, use, 225
 - operations, 224, 226
 - packaging and MAP, 226
 - peeling, cutting and shredding, 225
 - selection, raw materials, 224
 - storage, 226
 - washing, 225
 - Modified atmosphere packaging (MAP), 226, 246–248
 - Morphological image processing, 128
 - Multiple linear regression (MLR), 134
 - Multiple-tube/most probable number (MPN), 82
 - Multiplicative scatter correction (MSC), 125
 - Multispectral imaging, 117, 118
- N**
- National Health and Nutrition Examination Survey (NHANES), 29
 - Near-infrared spectroscopy (NIRS), 118, 119
 - Neutral pH electrolyzed (NEO), 68
 - NIRS, *see* Near-infrared spectroscopy (NIRS)
 - Normalized root mean square logarithmic error (NRMSLE), 96, 97
- O**
- Organic contamination, 84
 - Oriented polypropylene (OPP), 201, 206
 - Orthogonal signal correction (OSC), 127
 - Ozonation, 87, 88
- P**
- Packaging design
 - at equilibrium, principle, 203
 - O₂-concentration, evolution of, 205
 - oxygen transfer rate (OTR), 205
 - partial pressure difference, 204
 - permeability, 204
 - in respiration rates, 205
 - Packed fresh produce
 - microbiological processes
 - cross-contamination, 197
 - fungi, 195, 196
 - gram-negative bacteria, 196
 - gram-positive bacteria, 196
 - intrinsic factors, 196
 - intrinsic properties, 195
 - metabolite production, 197
 - temperature and atmosphere, 196
 - viruses, 197
 - yeast growth, 196
 - physiological processes
 - aerobic respiration, 194
 - anaerobic conditions, 194
 - packaging, 194, 195
 - respiration rate, 194, 195
 - shredding process, 195

- Partial least squares (PLS), 148
- Partial least squares discriminant analysis (PLSDA), 141
- Partial least squares regression (PLSR), 135, 147, 149
- Pathogenic microorganisms
- healthy diet, 29
 - microorganisms, 30
- Performance criterion (PC), 176
- Performance objective (PO)
- Bacillus cereus*, 187, 189
 - definition, 176
 - E. coli* O157, 184
 - FSO, 184
 - irrigation water and process criteria, 184
 - L. monocytogenes*, 186
 - microbial processes
 - cross-contamination, 179
 - growth and inactivation, 179
 - prevalence and concentration, 179
 - Salmonella*, 180
- Permeability of plastics, 200, 201
- Peroxyacetic acid (PAA), 68
- Pesticide residues, 24
- Phenylalanine ammonia-lyase (PAL), 229
- Photocatalytic disinfection
- bacteria, 95
 - kinetic model, 94–97
- Photo-Fenton reaction, 90, 91
- Photoreactor design, 97, 98
- Poisson log-linear model, 216
- Polyamide (PA), 200, 208
- Polyethylene (PE)
- gas permeability, 200
 - HDPE, 206
 - LDPE, 206
- Polyethylene terephthalate (PET), 200, 204
- Polyphenol oxidase (PPO), 195, 227, 229, 238
- Polypropylene (PP)
- cast (cPP), 201
 - as food packaging material, 206
 - gas permeability, 200
 - oriented (OPP), 201, 206
 - and PE, 200
- Potable water, 60
- Predictive microbiological models, 224, 241, 244, 246, 248
- description, 241, 242
 - disinfection models, 102
 - food chain, 100
 - growth models, 101, 105
 - mathematical model, 100
 - primary models
 - Baranyi and Roberts model, 244
 - description, 241
 - Gompertz model, 243
 - logistic model, 244
 - secondary models
 - description, 244
 - probabilistic models, 245
 - square root models, 245
- Principal component analysis (PCA), 135
- Priority pollutants (PPs), 84, 85
- Process analytical technologies (PAT), 4
- Process and product criteria, 182, 187
- Process water
- foodborne illness, 72
 - in food safety, 63, 64
 - fresh-cut industry, 63
 - organic load, 70
 - pH, 68
 - residual concentration, 66
 - treatment, 71
 - turbidity, 69
 - washing tanks, 62
- ## Q
- Quality
- defined, 115
 - deterioration, 237
 - external
 - color and texture, 139, 140
 - defects, 141
 - shapes and size, 138, 139
 - internal
 - beet sugar, 144, 147
 - bell pepper, 144, 147
 - carrot, 143, 146
 - onion, 144, 148
 - pickling cucumber, 143, 146
 - potato, 144, 147
 - tomatoes, 142, 143, 145, 146
- Quality management system (QMS)
- GAP, 13, 14
 - GMP, 14, 15
 - HACCP system, 15, 16
 - IPM programs, 15
- Quantitative methods, 2
- Quantitative microbial risk assessment (QMRA), 5, 183
- discrete population scale, 166, 167
 - E. coli*, 164
 - fresh produce, 162
 - knowledge gaps, 163, 164
 - mathematical models, 161

- outbreaks
 - EU, 169
 - fresh produce, 170
 - STEC O157, 169, 170
- pathogens growth rate, 166
- prevalence, contamination, 168, 169
- sanitized washing, 186
- sQMRA tool, 166
- vegetable industry (*see* Vegetables)
- Quantitative polymerase chain reaction (qPCR), 83, 84
- Quantitative risk assessment, 99

- R**
- Random sampling (RS), 133
- Ready-to-eat (RTE) vegetables
 - chlorine, 103
 - disinfection and transfer models, 105
 - microbial processes, 103
 - oxidizing agent, 103
 - risk assessment, 103, 104
- Recycled water, 61–63, 70, 71
- Risk analysis
 - ALOP, 178
 - food safety control measures, 180, 182
 - FSO, 178
 - L. monocytogenes*, 188
 - PO, 179, 180
- Risk assessment, 175
- Root mean square error for cross-validation (RMSECV), 137
- Root mean square error of calibration (RMSEC), 137
- Root mean square error of prediction (RMSEP), 137

- S**
- Salmonella*, 78, 180, 184, 185
- Salmonella enterica*, 213
- Sample set partitioning based on joint X–Y distances (SPXY), 134
- Sanitary and phytosanitary (SPS), 176
- Sanitation standard operating programs (SSOP), 3, 15
- Savitzky–Golay algorithm, 126
- Shelf life, in MPFV
 - ASLT, 239
 - microbiological analyses, 234, 235
 - physicochemical analyses
 - colour, 237
 - enzymatic browning, 238
 - ethanol and acetaldehyde production, 238
 - high added value substances,
 - deterioration of, 239
 - humidity/water content, 237
 - light oxidation, 239
 - lipid oxidation, 239
 - maturity index (MI), 236
 - phenolic compounds and tannins, 238
 - pH value, 235
 - sugars enzymatic reactions, 238
 - titratable acidity (TA), 235
 - total soluble solids (TSS), 235
 - vitamins oxidation, 238
 - volatile compounds, 237
 - water activity (aw), 237
 - weight loss, 237
 - sensorial analyses
 - aroma, 233
 - colour, 232
 - flavour, 233
 - sensorial analysis, 232, 233
 - sensory evaluation, 234
 - texture, 234
- Shelf life, in vegetables
 - computational tools, 245, 246
 - defined, shelf life of foods, 240
 - initial steps, 240, 241
 - predictive models
 - applications, 241, 242
 - described, predictive microbiology, 241 (*see also* Predictive microbiological models)
 - ready-to-eat (RTE) lettuce, MicroHibro *L. monocytogenes*, 247, 248
 - MAP, 246
 - model development, 247
- Shiga toxin-producing *E. coli* (STEC), 184
- Smoothing, 124
- Sodium hypochlorite, 70
- Soluble solids content (SSC), 4
- Spoilage microorganisms, 46, 49–51
 - bacteria and fungi, 47–49
 - contamination of vegetables, 31
 - control measures
 - fungicides, 49
 - heat processing, 50
 - ionizing radiation, 51
 - prevention of injury, 50
 - resistance to infection, 49, 50
- Standard normal variate (SNV), 125
- Successive Projection Algorithm (SPA), 130
- Superatmospheric oxygen packaging, 199
- Sym'Previus (www.symprevius.org), 216

T

Traceability, 19, 20
 Trihalomethanes (THMs), 69
 Turbidity, 62

U

Ultrasound, 69
 Ultraviolet radiation (UV), 69
 Uninformative variable elimination (UVE), 131
 UV-C irradiation, 87

V

Vegetable products
 color assessment, 140
 computer vision, 117
 external quality
 color and texture, 139, 140
 defects, 141
 shape and size, 138, 139
 fecal contamination, 151, 152
 food safety and quality
 application of quantitative methods, 4–7
 aspects, 2–4
 microbial spoilage and contamination, 3
 internal
 beet sugar, 144, 147
 bell pepper, 144, 147
 carrot, 143, 146
 onion, 144, 148
 pickling cucumber, 143, 146
 potato, 144, 147
 tomatoes, 142, 143, 145, 146
 microbial contamination, 149, 151
 quality and safety
 computer vision, 116
 HIS, 119
 multispectral imaging, 117, 118
 NIRS, 118, 119
 shape assessment, 139
 Vegetables
 irrigation water, 183–186
 product and process criteria, 187
 ready-to-eat (RTE), 187, 189
 Vegetables production
 approaches, 12
 audits, 18, 19
 chemical risk, 24, 25
 contaminating microorganisms and
 vegetable-borne diseases, 23
 detection method, residue, 26
 food security, 11, 12

legislative alignment, MRL, 25, 26
 maximum allowable limits and
 regulations, 25
 microbial detection methods, 24
 multiresidue analysis, 27
 QMS
 GAP, 13, 14
 GMP, 14, 15
 HACCP system, 15, 16
 IPM programs, 15
 quality and non-quality cost, 20
 quality certifications, 17, 18
 reduction of microbiological risks, 23
 regulations, 13, 16, 17
 risks, 21, 22
 traceability of products, 19, 20

W

Wash water treatment
 activated sludge systems, 86
 bio-treatment, 86
 chemical treatments, 86
 chlorination, 86
 membrane filtration, 88
 ozonation, 87, 88
 quality, 78
 UV-C irradiation, 87
 Wastewater, 61–63
 reuse, 80
 quality standards, 89
 Water
 bubbling, 60
 characteristics, 60
 disease-causing microorganisms, 59
 environmental impact, 70, 71
 in food safety, 63–65
 fresh-cut products, 60
 intervention strategies, 61
 quality, 59
 Water disinfection
 BDD, 68
 boron-doped diamond, 68
 chemical and microbial contaminants, 71
 chlorination, 66, 67
 CT concept, 66
 hypochlorite solutions, 67
 microbiological quality, 65
 PAA, 68
 pathogens, 66
 physicochemical characteristics, 62
 Quality and Safety Laboratory, 68
 sanitation, 67

- ultrasound, 69
- UV, 69
- water-based process controls, 72
- Water quality
 - analytical methods
 - direct total microbial count, 83
 - flow cytometry, 83
 - membrane filtration, 82
 - MPN, 82
 - plate count, 82
 - presence-absence tests, 82
 - qPCR, 83, 84
 - chemical parameters, 81
 - wastewater reuse, 80
 - water policy, 80
- Wavelet transformation (WT), 126, 127
- Web-based predictive tools, *see* Microbial responses viewer (MRV)