

1. Title
2. Copyright
3. Contents
4. Contributors
5. Preface of the second edition
6. Part I Chemical analysis of food
7. 1 - Basics and advances in sampling and sample preparation
8. 1 - Introduction
9. 2 - Types of samples and the analytical procedure
10. 3 - Trends in sample preparation for food analysis
11. 3.1 - From volatile organic solvents to ionic liquids and (natural) deep eutectic solvents
12. 3.2 - Use of deep eutectic and natural deep eutectic solvents in the food field
13. 4 - Conclusions
14. Acknowledgments
15. References
16. 2 - Chemometrics: multivariate analysis of chemical data
17. 1 - Introduction
18. 1.1 - From data to information
19. 2 - From univariate to multivariate
20. 2.1 - Histograms
21. 2.2 - Normality tests
22. 2.3 - ANOVA
23. 2.4 - Radar charts
24. 3 - Multivariate data analysis
25. 3.1 - Principal component analysis
26. 3.2 - Exploratory analysis of multidimensional data arrays
27. 3.3 - Signal preprocessing
28. 3.3.1 - Standard normal variate transform (SNV)
29. 3.3.2 - Derivatives
30. 3.3.3 - Horizontal alignment
31. 3.4 - Supervised data analysis and validation
32. 3.4.1 - Single evaluation set
33. 3.4.2 - Cross-validation (CV)
34. 3.4.3 - Repeated evaluation set
35. 3.5 - Supervised qualitative modeling
36. 3.5.1 - Classification and class-modeling
37. 3.5.2 - Evaluation parameters
38. 3.5.3 - Distance-based techniques
39. 3.5.3.1 - k nearest neighbors (k-NN)
40. 3.5.3.2 - A nonparametric class-modeling technique
41. 3.5.3.3 - Soft independent modeling of class analogy (SIMCA)
42. 3.5.4 - Probabilistic techniques
43. 3.5.4.1 - Linear discriminant analysis
44. 3.5.4.2 - Quadratic discriminant analysis
45. 3.5.4.3 - Unequal class models
46. 3.5.4.4 - Potential functions methods

47. 3.6 - Supervised quantitative modeling
48. 3.6.1 - Ordinary least squares
49. 3.6.2 - Principal component regression
50. 3.6.3 - Partial least squares
51. 3.7 - Artificial neural networks
52. 4 - Current trends and applications
53. Acknowledgments
54. References
55. 3 - Near-infrared, mid-infrared, and Raman spectroscopy
56. 1 - Introduction
57. 2 - Theory
58. 3 - Instrumentation
59. 3.1 - Near-infrared spectrometers
60. 3.2 - Mid-infrared spectrometer
61. 3.2.1 - Dispersive spectrometers
62. 3.2.2 - Fourier transform spectrometers
63. 3.3 - Raman spectrometers
64. 4 - Sample presentation
65. 4.1 - Near-infrared sample accessories
66. 4.2 - Mid-infrared sample accessories
67. 4.3 - Raman sample accessories
68. 5 - New generation of spectrometers
69. 5.1 - Online systems
70. 5.2 - Mapping and imaging systems
71. 5.3 - Hyphenated techniques
72. 5.4 - Advantages and limitations of spectroscopic techniques
73. 6 - Chemometric approach
74. 7 - Applications in food analysis
75. 7.1 - Geographic origin
76. 7.1.1 - MIR spectroscopy for the geographic authentication of wines
77. 7.1.2 - NIR spectroscopy for the geographic authentication of olive oil
78. 7.1.3 - FT-Raman spectroscopy for the geographic authentication of honey
79. 7.1.4 - Spectroscopic methods for the geographic authentication of cheese
80. 7.2 - Species discrimination
81. 7.2.1 - FT-MIR spectroscopy for the discrimination of meat products
82. 7.2.2 - NIR spectroscopy for the discrimination of botanical honey origin
83. 7.2.3 - Raman spectroscopy for the discrimination of green coffee varieties
84. 7.2.4 - Spectroscopic methods for the discrimination of phenolic compounds
85. 7.3 - Detection of adulteration
86. 7.3.1 - FT-MIR spectroscopy for the detection of adulteration of herbs and spices
87. 7.3.2 - FT-NIR spectroscopy for the detection of adulteration of milk powder
88. 7.3.3 - FT-Raman spectroscopy for the detection of adulteration of honey
89. 7.3.4 - Spectroscopic methods for the detection of adulteration of vegetable oils
90. 7.4 - Detection of contamination
91. 7.4.1 - MIR spectroscopy for the detection of wheat contamination
92. 7.4.2 - NIR spectroscopy for the detection of rice contamination

- 93. 7.4.3 - FT-Raman spectroscopy for the detection of food contamination
- 94. 7.4.4 - Spectroscopic methods for the detection and identification of biofilms
- 95. 7.5 - Process control
- 96. 7.5.1 - FT-NIR spectroscopy to control meat composition
- 97. 7.5.2 - Raman spectroscopy to control chocolate bloom
- 98. 7.5.3 - Spectroscopic methods to control oil properties
- 99. 7.5.4 - Spectroscopic methods to monitor wine fermentation
- 100. 7.6 - Physicochemical properties
- 101. 7.6.1 - FT-MIR spectroscopy for the determination of peroxide value of vegetable oils
- 102. 7.6.2 - NIR spectroscopy to estimate the antioxidant capacity
- 103. 7.6.3 - FT-Raman for the determination of honey composition
- 104. 7.6.4 - Spectroscopic methods for the determination of alcohol content in alcohol beverages
- 105. 7.7 - Food quality
- 106. 7.7.1 - FT-MIR spectroscopy for the determination of quality parameters of beers
- 107. 7.7.2 - NIR spectroscopy for the analysis of white pudding
- 108. 7.7.3 - Raman spectroscopy for analysis of fish
- 109. 7.7.4 - Spectroscopic methods for analysis of milk fat
- 110. 7.7.5 - IS-NIR spectroscopy for quality evaluation of fruits, the case of apples
- 111. 7.7.6 - Development of handheld spectrometers for fruit analysis
- 112. 8 - Conclusion
- 113. References
- 114. 4 - Nuclear magnetic resonance
- 115. 1 - Introduction
- 116. 2 - Specialties of NMR spectroscopy
- 117. 2.1 - One-dimensional high-resolution liquid state NMR (1D HR-NMR)
- 118. 2.2 - Site-specific natural isotope fractionation by NMR (SNIF-NMR)
- 119. 2.3 - Two-dimensional NMR spectroscopy (2D NMR)
- 120. 2.4 - Solid state NMR spectroscopy
- 121. 2.5 - Magnetic resonance imaging (MRI)
- 122. 2.6 - Low-field NMR: relaxometry, diffusometry and spectroscopy
- 123. 3 - Recent advances in NMR spectroscopy
- 124. 3.1 - High-resolution liquid state NMR
- 125. 3.2 - High-resolution solid-state NMR spectroscopy
- 126. 3.3 - Low-field NMR: relaxometry, diffusometry and spectroscopy
- 127. 4 - Selected applications
- 128. 4.1 - High-resolution liquid state NMR
- 129. 4.2 - Solid-state NMR
- 130. 4.2.1 - CPMAS
- 131. 4.2.2 - HRMAS
- 132. 4.3 - Magnetic resonance imaging
- 133. 4.4 - Low-field NMR: diffusometry, relaxometry, spectroscopy
- 134. 5 - Concluding remarks
- 135. References
- 136. 5 - Recent trends in molecular techniques for food pathogen detection

- 137. 1 - Introduction
- 138. 2 - Nucleic acids: the backbone of all molecular techniques
- 139. 2.1 - RNA
- 140. 2.2 - DNA
- 141. 3 - Recent molecular techniques for detection of food borne pathogen
- 142. 3.1 - Polymerase chain reaction
- 143. 3.2 - Nested PCR
- 144. 3.3 - Multiplex PCR
- 145. 3.4 - Reverse transcription (rt) PCR
- 146. 3.5 - Real-time (RT) PCR
- 147. 3.6 - Digital PCR (dPCR)
- 148. 4 - Advanced molecular techniques for detection of foodborne pathogens
- 149. 4.1 - Loop-mediated isothermal amplification
- 150. 4.1.1 - Primers for LAMP
- 151. 4.1.2 - Steps of LAMP process
- 152. 4.1.3 - Visualization of LAMP amplification products
- 153. 4.2 - Nucleic acid sequence-based amplification
- 154. 4.3 - OVATION amplification
- 155. 4.4 - Multilocus sequence typing
- 156. 4.5 - Ligase chain reaction
- 157. 4.6 - Microarrays
- 158. 5 - Genotyping methods for detection of foodborne pathogens
- 159. 5.1 - Pulse field gel electrophoresis
- 160. 5.2 - Rapid amplified polymorphic DNA
- 161. 5.3 - Restriction fragment length polymorphism
- 162. 5.4 - Amplified fragment length polymorphism
- 163. 5.5 - Ribotyping
- 164. 5.6 - Denaturing gradient gel electrophoresis
- 165. 6 - DNA sequencing methods for detection of foodborne pathogens
- 166. 6.1 - DNA sequencing: technology
- 167. 6.1.1 - First-generation sequencing methods
- 168. 6.1.1.1 - Maxam–Gilbert sequencing
- 169. 6.1.1.2 - Sanger sequencing
- 170. 6.1.2 - Next-generation sequencing
- 171. 6.1.2.1 - Roche 454
- 172. 6.1.2.2 - Illumina SBS
- 173. 6.1.2.3 - SOLiD sequencing
- 174. 6.1.2.4 - Ion PGM sequencing
- 175. 6.1.2.5 - Pacific biosciences SMRT sequencing
- 176. 6.1.2.6 - Oxford nanopore sequencing
- 177. 6.2 - DNA sequencing: application in foodborne-pathogen identification approaches
- 178. 6.2.1 - Whole genome sequencing
- 179. 6.2.2 Whole metagenomic sequencing (WMS)
- 180. 6.3 - Challenges with NGS methods
- 181. 7 - Molecular techniques for GMOs and transgenic food

182.	7.1 - Existing regulatory laws for GM foods available in market
183.	7.2 - Reference materials, laboratory testing, and method validation for detection of GMOs
184.	7.3 - Categories of molecular detection techniques for GMOs or transgenic food
185.	7.3.1 - Category I: "Screening Target" specific
186.	7.3.2 - Category II: "Gene" specific
187.	7.3.3 - Category III: "Construct" specific
188.	7.3.4 - Category IV: "Event" specific
189.	7.4 - Southern blotting
190.	7.5 - PCR
191.	7.5.1 - Competitive PCR
192.	7.5.2 - Quantitative or real-time PCR
193.	7.5.3 - Multiplex PCR
194.	7.5.4 - New PCR-based methods for GMO
195.	7.6 - Array-based methods
196.	7.7 - Toxicological analysis
197.	7.8 - Next-generation sequencing
198.	8 - Future prospects
199.	Acknowledgments
200.	Declaration of Competing Interest
201.	References
202.	6 - Microfluidic devices: biosensors
203.	1 - Introduction
204.	2 - Biosensors classes and fundamentals
205.	2.1 - Biological recognition elements
206.	2.1.1 - Enzymes
207.	2.1.2 - Immunosensors
208.	2.1.3 - Nucleic acids
209.	2.1.4 - Bacteriophages
210.	2.1.5 - Whole cell biosensors
211.	2.2 - Transduction elements
212.	2.2.1 - Electrochemical transduction
213.	2.2.2 - Optical transduction
214.	2.2.3 - Chemiluminescence and bioluminescence
215.	2.2.4 - Mass sensitive sensors
216.	3 - Nanobiosensors, microfluidics, and lab-on-a-chip
217.	3.1 - Label-based methods
218.	3.2 - Label-free detection methods
219.	3.3 - Micro/nanofluidics integrated with nanobiosensors
220.	4 - Application of new biosensing technologies for food safety
221.	4.1 - Pesticide residues
222.	4.2 - Veterinary drugs and growth promoting agents
223.	4.3 - Pathogenic bacteria and natural toxins
224.	4.4 - Natural toxins
225.	5 - Commercial instrumentation and future perspectives
226.	Acknowledgment

227.	References
228.	7 - Electronic noses and tongues
229.	1 - Background
230.	2 - Electronic nose (E-nose)
231.	3 - Electronic tongue (E-tongue)
232.	4 - Treatment of data
233.	5 - Application of E-nose and E-tongue
234.	5.1 - Meat and fish
235.	5.2 - Dairy products
236.	5.3 - Honey
237.	5.4 - Eggs
238.	5.5 - Fruit and vegetables
239.	5.6 - Beverages
240.	6 - Conclusions and future trends
241.	References
242.	8 - Liquid chromatography in food analysis
243.	1 - Introduction
244.	2 - Liquid chromatography–mass spectrometry in food analysis (target and nontarget compound screen
245.	2.1 - Natural compounds
246.	2.1.1 - Vitamins
247.	2.1.2 - Flavonoids
248.	2.1.3 - Lipids
249.	2.1.4 - Carbohydrates
250.	2.2 - Food Additives
251.	2.2.1 - Preservative
252.	2.2.2 - Artificial sweeteners
253.	2.2.3 - Food coloring
254.	2.3 - Contaminants
255.	2.3.1 - Pesticides
256.	2.3.2 - Carcinogens and natural toxins
257.	2.3.3 - Veterinary and human drugs
258.	3 - Trends in application of liquid chromatography in food analysis
259.	3.1 - Ultra-high-performance liquid chromatography
260.	3.2 - Monolithic column
261.	3.3 - Fused-core particle packed columns
262.	4 - Conclusion and future perspectives
263.	References
264.	9 - Gas chromatography
265.	1 - Introduction
266.	2 - Advances in column technology
267.	3 - New generations of stationary phases
268.	3.1 - Ionic liquid's stationary phases
269.	3.2 - Water compatible stationary phases
270.	4 - Multidimensional gas chromatographic platforms
271.	4.1 - LC–GC systems instrumental configurations

- 272. 4.2 - LC–GC application to mineral oil contamination assessment
- 273. 5 - Comprehensive two-dimensional gas chromatography
- 274. 5.1 - Improving GC × GC separation power and resolution
- 275. 5.2 - Improving GC × GC identification reliability by structured pattern separations
- 276. 5.3 - Benefits and flexibility of thermal modulation
- 277. 5.4 - Potentials of differential-flow modulation for high-throughput profiling and fingerprinting
- 278. 6 - Mass spectrometry and its fundamental role for confident characterization of complex samples
- 279. References
- 280. 10 - Electrophoresis
- 281. 1 - Introduction
- 282. 2 - Separation modes
- 283. 2.1 - Capillary zone electrophoresis (CZE)
- 284. 2.2 - Micellar electrokinetic chromatography (MEKC)
- 285. 2.3 - Capillary electrochromatography (CEC)
- 286. 2.4 - Capillary gel electrophoresis (CGE)
- 287. 2.5 - Capillary isotachopheresis (CITP)
- 288. 2.6 - Capillary isoelectric focusing (CIEF)
- 289. 3 - Detectors and detection modes in capillary electrophoresis
- 290. 3.1 - Optical detectors
- 291. 3.1.1 - UV-vis detection
- 292. 3.1.2 - Fluorescence
- 293. 3.1.3 - Indirect detection
- 294. 3.2 - Capacitively coupled contactless conductivity detection
- 295. 3.3 - Mass spectrometry
- 296. 4 - Sample preparation in capillary electrophoresis
- 297. 5 - Conclusions and future trends
- 298. References
- 299. 11 - Mass spectrometry: principles and instrumentation
- 300. 1 - Introduction to mass spectrometry
- 301. 1.1 - Ionization methods
- 302. 1.2 - Mass analyzers
- 303. 1.2.1 - Quadrupole
- 304. 1.2.2 - Ion trap
- 305. 1.2.3 - Time of flight
- 306. 1.2.4 - Orbitrap-MS and FT-ICR-MS
- 307. 1.3 - Tandem mass spectrometry
- 308. 2 - Real-time analysis mass spectrometry
- 309. 2.1 - DART/DESI source
- 310. 2.2 - PTR-MS/SIFT-MS
- 311. 3 - Isotope ratio mass spectrometry
- 312. 4 - Hyphenated technologies
- 313. 4.1 - Gas chromatography mass spectrometry in food analysis
- 314. 4.2 - Liquid chromatography–tandem mass spectrometry in food analysis

- 315. 4.3 - Gas and liquid chromatography–isotope ratio mass spectrometry in food analysis
- 316. 5 - Nontargeted analysis: metabolomics analysis
- 317. 5.1 - MS-based metabolomics studies in food sciences
- 318. 6 - Conclusions and perspectives
- 319. Acknowledgment
- 320. References
- 321. 12 - Applications of imaging techniques in food science
- 322. 1 - Spectral imaging
- 323. 1.1 - Applications in food science
- 324. 1.1.1 - Assessment of food quality parameters
- 325. 1.1.2 - Determination of toxic contamination
- 326. 1.1.3 - Variety discrimination
- 327. 2 - Magnetic resonance imaging
- 328. 2.1 - Principle of MRI
- 329. 2.2 - Application of MRI
- 330. 2.2.1 - Salt and water distribution during food processing
- 331. 2.2.1.1 - Freezing studies
- 332. 3 - Soft X-ray imaging
- 333. 3.1 - Principle of soft X-ray
- 334. 3.2 - Application of soft X-ray
- 335. 3.2.1 - X-ray imaging of infective damage in fruits
- 336. 3.2.2 - Imaging of microstructure of food product
- 337. 4 - Mass spectrometry imaging
- 338. 4.1 - Principle of MS imaging
- 339. 4.2 - Application of MS imaging
- 340. 4.2.1 - Gamma-aminobutyric acid (GABA) distribution in eggplant sections
- 341. 4.2.2 - Highly detailed distribution of lysophosphatidylcholine in rice seeds
- 342. 4.2.3 - Automatic matrix application enhanced ionization efficiency of food metabolites
- 343. 5 - Fluorescence imaging
- 344. 5.1 - Principle of HSF1
- 345. 5.2 - Applications of HSF1
- 346. 5.2.1 - Contamination of foods and agricultural products
- 347. 5.2.2 - Quality inspection of agricultural products
- 348. 6 - Ultrasound imaging
- 349. 6.1 - Principle of UI
- 350. 6.2 - Applications of UI
- 351. 6.2.1 - Detection of foreign materials in agricultural products
- 352. 6.2.2 - Estimation of body composition of meat and fish
- 353. 7 - Conclusions and future trends
- 354. References
- 355. Part II Applications
- 356. 13 - Food authenticity and fraud
- 357. 1 - Introduction
- 358. 2 - Methods for food authentication and adulteration

- 359. 2.1 - Chromatographic techniques
- 360. 2.1.1 - Gas chromatography
- 361. 2.1.2 - High-performance liquid chromatography
- 362. 2.2 - Spectroscopic techniques
- 363. 2.2.1 - Ultraviolet–visible spectrometry
- 364. 2.2.2 - Fluorescence spectroscopy
- 365. 2.2.3 - Infrared spectroscopy
- 366. 2.2.4 - Electronic nose
- 367. 2.2.5 - Nuclear magnetic resonance spectroscopy
- 368. 2.2.6 - Stable isotope analysis
- 369. 2.3 - Enzymes in food authentication
- 370. 2.4 - DNA-based methods in food authentication
- 371. 2.5 - Differential scanning calorimetry
- 372. 3 - Conclusions
- 373. References
- 374. 14 - Biologically active and health promoting food components of nuts, oilseeds, fruits, vegetables
 - 375. 1 - Nuts and oilseeds
 - 376. 1.1 - Phytosterols
 - 377. 1.2 - Fatty acids
 - 378. 2 - Fruits and vegetables
 - 379. 2.1 - Polyphenols
 - 380. 2.2 - Carotenoids
 - 381. 2.3 - Glucosinolates
 - 382. 3 - Cereals and legumes
 - 383. 3.1 - Dietary fiber
 - 384. 3.2 - Isoflavones
 - 385. 3.3 - Lignans
 - 386. Acknowledgments
 - 387. References
- 388. 15 - Foodomics evaluation of genetically modified organisms
- 389. 1 - Introduction
- 390. 2 - Controversial issues and legislation on GMOs
- 391. 3 - Strategies used for the analysis of GMOs
- 392. 3.1 - Target-based strategies
- 393. 3.1.1 - Screening methods for GMOs detection in food
- 394. 3.1.2 - Quantification of GMOs in food
- 395. 3.2 - Profiling and untargeted strategies
- 396. 3.2.1 - Transcriptomics
- 397. 3.2.2 - Proteomics
- 398. 3.2.3 - Metabolomics
- 399. 4 - Conclusions and future outlooks
- 400. Acknowledgment
- 401. References
- 402. 16 - Flavors and odors analysis
- 403. 1 - Introduction

- 404. 2 - Sample preparation for food flavor evaluation
- 405. 3 - Advanced analytical techniques for food flavor and odor analysis
- 406. 3.1 - Gas chromatography in food flavor research
- 407. 3.2 - Gas chromatography coupled to mass spectrometry
- 408. 3.3 - Gas chromatography olfactometry applied to odor evaluation
- 409. 3.4 - Multidimensional gas chromatography
- 410. 4 - Conclusions and future trends
- 411. References
- 412. 17 - Emerging contaminants and toxins
- 413. 1 - Introduction
- 414. 2 - The global scheme to analyze emerging contaminants
- 415. 3 - New substances appearing as emerging contaminants
- 416. 4 - Contaminants whose tested methodologies have improved
- 417. 5 - Emerging concerns on well-known contaminants
- 418. 6 - Conclusions
- 419. Acknowledgments
- 420. References
- 421. 18 - Natural toxins analysis
- 422. 1 - Introduction
- 423. 2 - Characterization of filamentous fungi
- 424. 3 - Mycotoxins—secondary fungal metabolites
- 425. 4 - Masked mycotoxins
- 426. 5 - The most popular mycotoxin identification techniques
- 427. 5.1 - HPLC
- 428. 5.2 - LC/MS/MS
- 429. 5.3 - Others
- 430. 6 - Conclusions
- 431. References
- 432. 19 - Advances in MS methods for food allergens detection
- 433. 1 - Introduction
- 434. 2 - MS methods for food allergens detection
- 435. 2.1 - Top-down approach in the detection of food allergens
- 436. 2.2 - Bottom-up approach in the detection of food allergens
- 437. 2.2.1 - High resolution MS approaches
- 438. 2.2.2 - Low resolution MS platforms
- 439. 3 - Concluding remarks
- 440. References
- 441. 20 - Review on metal speciation and their applications since 2010
- 442. 1 - Introduction
- 443. 2 - Sample preparation for the speciation analysis
- 444. 2.1 - Sample collection, storage, and pretreatment
- 445. 2.2 - Extraction methods for the sample analysis
- 446. 3 - Speciation analysis of metal ions
- 447. 3.1 - Arsenic
- 448. 3.2 - Antimony
- 449. 3.3 - Cobalt

450.	3.4 - Chromium
451.	3.5 - Cadmium
452.	3.6 - Iron
453.	3.7 - Lead
454.	3.8 - Mercury
455.	3.9 - Manganese
456.	3.10 - Selenium
457.	3.11 - Tin
458.	4 - Conclusions
459.	References
460.	Index
461.	Back cover