

Contents

<i>Preface</i>	xi
<i>Acknowledgments</i>	xiii
<i>Authors</i>	xv
<i>List of Abbreviations</i>	xvii

Section I: Fat-soluble vitamins

Chapter 1 Vitamin A and carotenoids	3
1.1 Review	3
1.2 Properties	8
1.2.1 Chemistry	8
1.2.1.1 General properties	8
1.2.1.2 Spectral properties	14
1.2.2 Stability	16
1.2.3 Bioavailability	23
1.3 Methods	23
1.3.1 The Carr-Price colorimetric method	27
1.3.2 Advances in vitamin A and carotenoid analysis	28
1.3.2.1 Spectroscopic methods	28
1.3.2.2 High performance liquid chromatography	28
1.3.3 Method applications	59
1.3.3.1 Vitamin A and other retinoids	59
1.3.3.2 Carotenoids	61
1.4 Method protocols	65
References	68

Chapter 2 Vitamin D	83
2.1 Review	83
2.2 Properties	86
2.2.1 Chemistry	86
2.2.1.1 General properties	86
2.2.1.2 Spectral properties	86
2.2.2 Stability	86
2.2.3 Bioavailability	90

2.3 Methods	90
2.3.1 General approach	90
2.3.2 Regulatory and handbook methods	91
2.3.2.1 AOAC International	94
2.3.2.2 European Committee for Standardization.....	95
2.3.2.3 International Dairy Federation	95
2.3.3 High performance liquid chromatography	95
2.3.3.1 Extraction procedures for analysis of vitamin D by liquid chromatography	95
2.3.3.2 Chromatography parameters	104
2.3.3.3 Internal standards	107
2.4 Method protocols	107
References.....	112
Chapter 3 Vitamin E: tocopherols and tocotrienols	119
3.1 Review	119
3.2 Properties.....	125
3.2.1 Chemistry	125
3.2.1.1 General properties.....	125
3.2.1.2 Nomenclature rules.....	127
3.2.1.3 Spectral properties.....	131
3.2.2 Stability	131
3.2.3 Biological activity	133
3.3 Methods	135
3.3.1 General approach	135
3.3.2 Regulatory and handbook methods	136
3.3.2.1 AOAC International	136
3.3.2.2 American Oil Chemists Society.....	140
3.3.2.3 European Committee for Standardization.....	141
3.3.3 Advances in analysis of the tocopherols and tocotrienols	141
3.3.3.1 Gas chromatography.....	141
3.3.3.2 High-performance liquid chromatography.....	142
3.4 Method protocols	177
References	179
Chapter 4 Vitamin K.....	193
4.1 Review	193
4.2 Properties.....	197
4.2.1 Chemistry	197
4.2.1.1 General properties.....	197
4.2.1.2 Spectral properties.....	198
4.2.2 Stability	200
4.3 Methods	200
4.3.1 General approach	200
4.3.2 Regulatory and handbook methods	202
4.3.3 Advances in analysis of vitamin K.....	205
4.3.3.1 Spectroscopic and electrochemical methods.....	205
4.3.3.2 High performance liquid chromatography.....	205
4.4 Method protocols	218
References	222

Contents

Section II: Water-soluble vitamins

Chapter 5 Ascorbic acid: vitamin C.....	231
5.1 Review	231
5.2 Properties	236
5.2.1 Chemistry	236
5.2.1.1 General properties.....	236
5.2.1.2 Spectral properties.....	239
5.2.2 Stability	239
5.3 Methods	240
5.3.1 Extraction procedures	240
5.3.2 Classical approaches to vitamin C analysis	243
5.3.2.1 Oxidation–reduction methods.....	243
5.3.2.2 Derivatization methods	246
5.3.2.3 Enzymatic methods.....	248
5.3.3 Advances in the analysis of vitamin C	249
5.3.3.1 Spectroscopic and electrochemical detection combined with flow injection and sequential injection analysis .. .	249
5.3.3.2 Capillary electrophoresis	250
5.3.3.3 Liquid chromatography	251
5.4 Status of vitamin C analysis	273
5.5 Method protocols	274
References.....	280
Chapter 6 Thiamin	291
6.1 Review	291
6.2 Properties.....	294
6.2.1 Chemistry	294
6.2.1.1 General properties.....	294
6.2.1.2 Spectral properties.....	295
6.2.2 Stability	297
6.3 Methods	298
6.3.1 Classical approaches to analysis of thiamin.....	298
6.3.1.1 Chemical.....	298
6.3.2.2 Microbiological	303
6.3.2 Advances in the analysis of thiamin	304
6.3.2.1 Spectroscopic, electrochemical, and capillary electrophoretic methods .. .	304
6.3.2.2 Liquid chromatography	304
6.4 Method protocols	316
References.....	318
Chapter 7 Riboflavin	325
7.1 Review	325
7.2 Properties.....	329
7.2.1 Chemistry	329
7.2.1.1 General properties.....	329
7.2.1.2 Spectral properties.....	330
7.2.2 Stability	330

7.3	Methods	334
7.3.1	Classical approaches to analysis of riboflavin	334
7.3.1.1	Fluorometric	334
7.3.1.2	Microbiological	339
7.3.2	Advances in the analysis of riboflavin	340
7.3.2.1	Spectroscopic methods	340
7.3.2.2	Capillary electrophoresis	340
7.3.2.3	Liquid chromatography	340
7.4	Method protocols	353
	References	354
Chapter 8	Niacin	361
8.1	Review	361
8.2	Properties	363
8.2.1	Chemistry	363
8.2.1.1	General properties	365
8.2.1.2	Spectral properties	365
8.2.2	Stability	366
8.2.3	Bioavailability	368
8.3	Methods	370
8.3.1	Chemical	370
8.3.1.1	Sample preparation	370
8.3.2	Microbiological	375
8.3.3	Advances in the analysis of niacin	376
8.3.3.1	Capillary electrophoresis, chemiluminescence, and mass spectrometry	376
8.3.3.2	High performance liquid chromatography	376
8.4	Method protocols	386
	References	394
Chapter 9	Vitamin B₆	401
9.1	Review	401
9.2	Properties	403
9.2.1	Chemistry	403
9.2.1.1	General properties	403
9.2.1.2	Spectral properties	408
9.2.2	Stability	408
9.2.3	Bioavailability	409
9.3	Methods	411
9.3.1	Microbiological	411
9.3.2	Advances in the analysis of vitamin B ₆	414
9.3.2.1	Spectroscopic, electrochemical, and capillary electrophoresis methods	414
9.3.2.2	Liquid chromatography	414
9.4	Method protocols	430
	References	435
Chapter 10	Folate and folic acid	443
10.1	Review	443
10.2	Properties	447

Contents

10.2.1	Chemistry	447
10.2.1.1	General properties	447
10.2.1.2	Spectral properties	453
10.2.1.3	Stability	453
10.2.1.4	Bioavailability	456
10.3	The µg dietary folate equivalents	457
10.4	Methods	457
10.4.1	Microbiological	459
10.4.1.1	Folate assay organisms	459
10.4.1.2	Extraction procedures	460
10.4.1.3	Modification of traditional microbiological assays for folate	464
10.4.1.4	Recommendations for the microbiological assay of folate	464
10.4.1.5	AOAC International Official methods	468
10.4.2	Ligand-binding assays	469
10.4.3	Advances in the analysis of folate and folic acid	471
10.4.3.1	High performance liquid chromatography and high performance liquid chromatography-mass spectrometry ..	471
10.4.3.2	Optical biosensor-based immunoassays	490
10.4.3.3	Status of folic acid and folate analysis	491
10.5	Method protocols	491
	References	493
Chapter 11	Vitamin B₁₂.....	507
11.1	Review	507
11.2	Properties	511
11.2.1	Chemistry	511
11.2.1.1	General properties	511
11.2.1.2	Spectral properties	514
11.2.2	Stability	514
11.2.3	Bioavailability	515
11.3	Methods	515
11.3.1	AOAC International methods (<i>Lactobacillus delbrueckii</i>)	515
11.3.2	Radio-ligand binding assays	518
11.3.3	Advances in the analysis of vitamin B ₁₂	520
11.3.3.1	Spectroscopic and chemiluminescence methods	520
11.3.3.2	Capillary electrophoresis	521
11.3.3.3	High performance liquid chromatography and high performance liquid chromatography-mass spectrometry ..	521
11.3.3.4	Optical biosensor protein-binding assay	528
11.4	Method protocols	528
	References	530
Chapter 12	Biotin.....	535
12.1	Review	536
12.2	Properties	536
12.2.1	Chemistry	536
12.2.1.1	General properties	539
12.2.1.2	Spectral properties	540