

# Contents

<b>Foreword</b>	.....	v
<b>Introduction</b>	.....	xi
<b>References</b>	.....	xiv
<b>I Techniques of Analysis</b>	.....	1
1 Sample Preparation: Isolation and Concentration	.....	1
1.1 Headspace Sampling	.....	3
1.2 Distillation	.....	9
1.3 Extraction	.....	12
1.4 Miscellaneous Procedures	.....	17
References	.....	18
2 Separation and Identification	.....	33
2.1 Preseparation Procedures	.....	33
2.2 Gas Chromatography	.....	35
2.2.1 Column Technology	.....	35
2.2.2 Sample Application	.....	37
2.2.3 Detection	.....	37
2.2.4 Coupled Instrumentation	.....	39
2.2.4.1 Gas Chromatography-Mass Spectrometry (GC-MS)	.....	39
2.2.4.2 Gas Chromatography-Infrared Spectroscopy (GC-IR)	.....	41
2.3 Liquid Chromatography	.....	41
2.3.1 Liquid Chromatography-Mass Spectrometry (LC-MS)	.....	41
2.3.2 Liquid Chromatography-Infrared Spectroscopy (LC-IR)	.....	42
2.4 Other Separation and Identification Techniques	.....	42
2.4.1 Thin-layer Chromatography (TLC)	.....	42
2.4.2 Tandem Mass Spectrometry (MS-MS)	.....	42
2.4.3 Nuclear Magnetic Resonance (NMR) Spectroscopy	.....	43
References	.....	44

II	<b>Biogenetic Pathways</b>	52
1	Formation of Natural and "Secondary" Volatiles	52
1.1	Lipid Metabolites	56
1.1.1	Natural Volatiles Produced via Fatty Acid Metabolism	56
1.1.2	Unsaturated Acyl Lipids as Precursors of "Secondary" Volatiles	62
1.1.2.1	Fatty Acid Peroxidation by Lipoxygenase	64
1.1.2.2	Fatty Acid Hydroperoxide Cleavage	66
1.1.2.3	Formation of Volatile Alcohols	72
1.1.2.4	Lipoxygenase-Catalyzed Co-Oxidation Processes	75
1.2	Amino Acids as Precursors of Volatiles	76
1.2.1	Alcohols and Esters in Banana and Tomato Fruits	76
1.2.2	Sulfur-Containing Volatiles	81
1.2.3	3-Alkyl-2-methoxypyrazines	83
1.3	Volatiles Derived from Phenylpropanoid Metabolism	84
1.3.1	General Phenylpropanoid Metabolism	84
1.3.2	Natural Volatiles Originating from Cinnamic Acids	86
1.3.3	Cinnamoyl-Coenzyme A (CoA) Thioesters	87
1.3.4	Cinnamic Acid Esters	88
1.3.5	Reduction of Cinnamic Acids	88
1.3.6	Degradation of the Side-Chain of Cinnamic Acids	90
1.3.6.1	Biogenesis of Benzoic Acids	90
1.3.6.2	Natural Compounds Derived from Benzoic Acids	92
1.3.7	Biogenesis of Phenylacetic Acids	94
1.3.8	Coumarins	95
1.3.8.1	Simple Coumarins by Conversion of Cinnamic Acids	96
1.3.8.2	Furanocoumarins	97
1.4	Isoprenoids	97
1.4.1	Monoterpene	98
1.4.1.1	Structures and Biogenetic Schemes	99
1.4.1.2	Acyclic Precursors	102
1.4.1.3	Acyclics	104
1.4.1.4	p-Menthanes	105
1.4.1.5	Bornanes	109
1.4.1.6	Pinanes	110
1.4.1.7	Thujanes	111
1.4.1.8	Caranes	113
1.4.1.9	Cyclopentanoids	113

---

1.4.1.10	Irregular Monoterpenes .....	115
1.4.1.11	Transformations and Catabolism .....	118
1.4.2	Sesquiterpenes .....	119
1.4.3	Metabolites from Higher Terpene Precursors.....	120
	References .....	126
2	Post-processing Enzyme Reactions –	
	Volatile s in Vegetables .....	148
2.1	Enzymic Splitting of S-Alkyl- and S-Alkenylcysteine Sulfoxides .....	148
2.2	Volatile s from Glucosinolates .....	151
2.2.1	Structure and Biosynthesis .....	153
2.2.2	Degradation by Myrosinases (Thioglucoside Glucohydrolases).....	154
2.2.3	Formation of Isothiocyanates and Nitriles .....	154
2.2.4	Formation of Thiocyanates and other Degradation Products .....	158
	References .....	159
	Index .....	162