

Modern Methods of Plant Analysis
Volume 20

Analysis of Plant Waste Materials

Edited by
H. F. Linskens and J. F. Jackson



Springer

Contents

Methods of Measurement of Dissolved Organic Carbon of Plant Origin in Soils, Manures, Sludges and Stream Water	N.S. BOLAN, S. BASKARAN, and S. THIAGARAJAN	1
1 Introduction		1
2 Materials and Methods		6
2.1 Soils, Sludges and Stream Water		6
2.2 Extraction of DOC		6
2.3 Amendment of pH		6
2.4 Effect of Drying		7
2.5 Measurement of DOC		7
2.5.1 Spectrophotometric Method		7
2.5.2 Wet Oxidation		7
2.5.3 Dry Combustion		8
2.6 Fractionation of DOC		8
2.6.1 Molecular Weight Fractions		9
2.6.2 Sorption Chromatography		9
3 Results and Discussion		10
3.1 Methods of Measurement of DOC		10
3.1.1 Spectrophotometric Method		10
3.1.2 Dry Combustion		11
3.1.3 Wet Oxidation		12
3.2 Molecular Weight Fractions		13
3.3 Effect of Drying on DOC		14
3.4 Effect of pH on DOC		14
4 Conclusions		16
References		16
Analysis of Papermill Waste Water Treatment Residuals and Process Residues	M.S. ERICH and P. FIRST	21
1 Introduction		21
2 The Pulping Process and the Composition of Papermill Sludge		22
3 Sampling and Chemical Characterization of Papermill Sludge		23

3.1 Sampling	23
3.2 pH and Macronutrients	24
3.3 Trace Elements	25
4 Polychlorinated Dibenzo- <i>p</i> -dioxins and Dibenzofurans in Papermill Sludge	26
4.1 Chemistry and Toxicity of Polychlorinated Dibenzo- <i>p</i> -dioxins and Dibenzofurans	26
4.2 General Analytical Considerations	27
4.3 Safety	28
4.4 Method Performance Tests	29
4.5 Sample Preparation and Analyte Extraction	30
4.6 Cleanup of Sample Extracts	32
4.7 Identification and Quantification of Polychlorinated Dibenzo- <i>p</i> -dioxins and Dibenzofurans by High Resolution Gas Chromatography/High Resolution Mass Spectrometry	34
4.8 Bioassays for Polychlorinated Dibenzo- <i>p</i> -dioxins and Dibenzofurans Equivalents.....	37
5 Conclusions and Future Perspectives	37
References	38

Analysis of Sewage from Anaerobic Purification of Effluent from a Brewery

F. SCHUR	41
1 Introduction	41
2 Anaerobic Effluent Treatment	42
3 Methods of Analysis	45
3.1 Sewage and Sewage Sludge	45
3.1.1 Sampling (EDI 1983)	45
3.1.2 Carbon (EDI 1983)	46
3.1.3 Organic Nitrogen (EDI 1983)	48
3.1.4 Ammonia/Ammonium (EDI 1983)	49
3.1.5 Phosphorus (EDI 1983)	51
3.1.6 Sulphate (EDI 1983)	53
3.1.7 Sulphite (EDI 1983)	54
3.1.8 Sulphide (EDI 1983)	57
3.2 Air and Biogas	59
3.2.1 Hydrocarbons (VDI 1975)	59
3.2.2 Ammonia (VDI 1974)	61
3.2.3 Hydrogen Sulphide (VDI 1982)	64
3.2.4 Mercaptanes (Meier 1975)	67
4 Mass Balances (Schur et al. 1995, 1996)	67
5 Conclusions	73
References	73

**Apple Pomace and Products Derived from Apple Pomace:
Uses, Composition and Analysis**

M. KENNEDY, D. LIST, Y. LU, L.Y. FOO, R.H. NEWMAN, I.M. SIMS, P.J.S. BAIN, B. HAMILTON, and G. FENTON	75
1 Introduction	75
2 What Use Is Apple Pomace?	77
3 The Goal of Apple Pomace Analysis	83
4 The Composition of Apple Pomace	84
5 Analytical Techniques	102
5.1 Routine Methods of Analysis	102
5.2 Water Content/Dry Matter Content	102
5.3 Bulk Density	103
5.4 Crude Protein	104
5.5 Apple Pomace Buffering Capacity	105
5.6 Bioavailable Energy	105
5.7 Polyphenol Components	106
5.8 Antioxidant Analysis	107
5.9 NMR Analysis: A Novel Method of Characterising Apple Pomace	109
6 Discussion	113
References	113

**Kiwifruit Waste and Novel Products Made from Kiwifruit Waste:
Uses, Composition and Analysis**

M. KENNEDY, D. LIST, Y. LU, L.Y. FOO, A. ROBERTSON, R.H. NEWMAN, and G. FENTON	121
1 Introduction	121
2 What Use Is Kiwifruit?	121
3 The Composition of Kiwifruit	126
4 Analytical Techniques	126
4.1 Dry Material	138
4.2 Enzyme Activity Measurement	139
4.2.1 Protease	140
4.2.2 Carbohydrate Modifying Enzymes	141
4.2.3 Oxo-Reductases	141
4.3 Polyphenol Components	142
4.4 Antioxidant Analysis	143
4.5 NMR Analysis	144
5 Discussion	147
References	147

Analysis of Tree Leaf Decomposition in Arid Soils	
J.C. TARAFDAR	153
1 Introduction	153
2 Important Trees in Arid Soils	154
3 Methodological Approaches for the Decomposition Process	154
3.1 The Perfusion Method	154
3.1.1 Perfusion Apparatus of Lefroy et al. (1995) and Its Components	155
3.1.2 Management of the Perfusion Apparatus	158
3.1.3 CO ₂ Measurement	158
3.1.4 Nutrient Analysis	159
3.2 The Litterbag Technique	159
3.3 Tracer Technique	160
3.4 Measurement of Soil Respiration	161
4 Analysis of Leaf Material Before and After Decomposition	161
4.1 Determination of Cell Wall Constituents in Leaf Samples	161
4.1.1 Reagent and Apparatus	162
4.1.2 Procedures	162
4.1.3 Filtration	163
4.1.4 Cleaning of Crucibles	163
4.2 Estimation of Crude Fibre (Acid Detergent Fibre ADF)	164
4.2.1 Reagent and Apparatus	164
4.2.2 Procedure	164
4.3 Determination of Cellulose, Lignin and Insoluble Ash	164
4.3.1 Reagents	164
4.3.2 Procedure	165
4.4 Determination of Cell Contents and Hemicellulose	166
4.5 Direct Estimation of Cellulose, Hemicellulose and Lignin	166
4.6 Fibre Degrading Enzymes	166
4.6.1 Carboxymethyl Cellulose (Endo-1,4- β -Glucanase, EC 3.2.1.4)	166
4.6.2 α -Amylase (1,4- α -D-Glucanohydrolase, EC 3.2.1.1)	168
4.6.3 Xylanase (1,4- β -Xylan Xylano Hydrolase; Endo-1,4- β -Xylanase, EC 3.2.1.8)	169
4.6.4 β -Glucosidase (β -D-Glucoside Glucohydrolase, EC 3.2.1.21)	169
4.6.5 α -Glucosidase (EC 3.2.1.21)	170
4.6.6 β -Xylosidase (1,4- β -D Xylan Xylohydrolase: Exo-1,4- β -D Xylosidase, EC 3.2.1.37)	171
4.7 Protein-Degrading Enzymes	171
4.7.1 Urease (Urea Amidohydrolase, EC 3.5.1.5)	171
4.7.2 Proteases	172
4.7.3 Transaminases	173
4.7.4 Glutamate Dehydrogenase (GDH)(L-Glutamate: NADP + Oxidoreductase EC 1.4.1.4)	174

4.8 Determination of Gross Energy (GE)	175
4.8.1 Principle	175
4.8.2 Things Required	176
4.8.3 Chemicals and Reagents	176
4.8.4 Procedure	176
5 Conclusion	178
References	178
 Measurement of Leaf Litter Decomposition	
S.R. GUPTA and V. MALIK	181
1 Introduction	181
2 Plant Litter Sampling and Preparation	182
3 Characterization of Resource Quality of Litter	182
3.1 Physical Properties of Leaves	182
3.2 Chemical Composition of Litter	184
3.2.1 Soluble Carbohydrates and Amino Acids	184
3.2.2 Analysis of Cellulose, Hemicellulose and Lignin	185
3.2.3 Polyphenols	186
3.2.4 Plant Nutrient Analysis	187
4 Lignocellulose Transformation	187
5 Methods for in Situ Litter Decomposition Rates	188
5.1 The Litterbag Technique	188
5.2 Litter Basket Technique	190
5.3 ^{13}C Nuclear Magnetic Resonance (NMR)	191
5.4 Tracer Techniques	193
5.4.1 Tagging Technique	193
5.4.2 ^{14}C Technique	193
5.4.3 ^{13}C Stable Isotope Technique	193
6 Analysis of Decomposition Data	195
7 Laboratory Methods	196
7.1 Respirometric Techniques	196
7.2 ^{14}C -CO ₂ Evolution Rates	197
7.3 Measurement of Enzymatic Activity	198
7.4 Nitrogen Mineralization from Decomposing Litter	198
8 Conclusions	201
References	201
 Subject Index	209

Subject Index

Department of Natural Products Processing, Industrial Research Ltd, P.O. Box 31-310, Lower Hutt, New Zealand

Department of Natural Products Processing, Industrial Research Ltd, P.O. Box 31-310, Lower Hutt, New Zealand