Contents

Preface to the Technical Series xi
Preface xiii
Contributors xv

1 Processed Cheese and Analogues: An Overview 1
A.Y. Tamime

1.1 Historical background 1
1.2 Diversity of products 2
   1.2.1 Terminology and/or nomenclature 2
   1.2.2 Classification 3
1.3 Patterns of production 3
1.4 Principles of manufacturing stages 5
   1.4.1 Natural cheeses 5
   1.4.2 Formulation of a balanced mix 5
   1.4.3 Emulsifying salts 7
   1.4.4 Addition of miscellaneous additives 7
   1.4.5 Heat treatment 12
   1.4.6 Homogenisation 12
   1.4.7 Filling machines and packaging materials 13
1.5 Conclusions 14
References 14

2 Current Legislation on Processed Cheese and Related Products 25
M. Hickey

2.1 Introduction and background 25
2.2 Definitions and standards of identity 26
   2.2.1 Background and evolution 26
   2.2.2 Legislation in the European Union (EU) 27
   2.2.3 Legislation in the UK 36
   2.2.4 Legislation in the Republic of Ireland 41
   2.2.5 Legislation in Germany 42
   2.2.6 Legislation in the Netherlands 44
   2.2.7 Legislation in France 45
Contents

2.2.8 Legislation in Denmark 46
2.2.9 Legislation in Sweden 46
2.2.10 Legislation in Spain 47
2.2.11 Legislation in Italy 48
2.2.12 Legislation in the Czech Republic 48
2.2.13 Legislation in Hungary 50
2.2.14 Legislation in the USA 51
2.2.15 Legislation in Canada 57
2.2.16 Legislation in Australia and New Zealand 59
2.2.17 Legislation in Japan 59
2.2.18 Legislation in Mercosur/Mercosul 60
2.2.19 Legislation in Chile 62
2.2.20 Legislation in some Middle Eastern countries 63
2.2.21 Codex Alimentarius standards 68
2.3 Summary and conclusions 73
2.4 Acknowledgements 73
References 74

3 Effects of Natural Cheese Characteristics and Processing Conditions on Rheology and Texture: The Functionality of Cheese Components in the Manufacture of Processed Cheese 81

T.P. Guinee

3.1 Definition of processed cheese products: an introduction 81
3.2 Overview of manufacture
  3.2.1 Background 83
  3.2.2 Manufacture 85
3.3 Microstructure of PCPs 86
3.4 Principles of processed cheese manufacture 87
  3.4.1 Destabilisation and dehydration of milk during the manufacture of natural cheese 87
  3.4.2 Characteristics of protein in natural cheeses 88
  3.4.3 Effects of heating/shearing cheese (protein) 90
  3.4.4 The interaction of emulsifying salt with cheese protein during processing 90
3.5 Effects of natural cheese characteristics on PCPs
  3.5.1 Calcium content 92
  3.5.2 pH 93
  3.5.3 Degree of maturity and intact casein content 97
3.6 Effects of processing conditions
  3.6.1 Time 101
  3.6.2 Temperature 103
  3.6.3 Shear 104
3.7 Conclusions 105
References 106
4 Functionality of Ingredients: Emulsifying Salts 110
J.A. Lucey, A. Maurer-Rothmann and S. Kaliappan

4.1 Introduction 110
4.2 Main types of emulsifying salts 111
  4.2.1 Citrate 111
  4.2.2 Phosphate-based 113
  4.2.3 Other types of emulsifying salts 115
4.3 Properties and roles of emulsifying salts used in processed cheese 116
  4.3.1 Calcium binding/ion exchange 116
  4.3.2 pH adjustment, buffering and titration behaviour 118
  4.3.3 Casein dispersion, protein hydration and fat emulsification 120
  4.3.4 Creaming and structure formation during cooling and storage 122
  4.3.5 Antimicrobial activity 124
  4.3.6 Crystal formation and other properties of emulsifying salts 124
4.4 Selection of emulsifying salt 127
4.5 Conclusion 129
References 129

5 Flavours and Flavourants, Colours and Pigment 133
G. Osthoff, E. Slabber, W. Kneifel and K. Dürrschmid

5.1 Introduction 133
5.2 Types of processed cheese 133
5.3 Raw material 134
5.4 Flavour 135
  5.4.1 Natural flavourants 135
  5.4.2 Chemical flavourants 139
  5.4.3 Flavour changes 140
5.5 Colours 141
  5.5.1 Natural colours 141
  5.5.2 Colour decay and changes 142
  5.5.3 Process colours 142
5.6 Sensory attributes of processed cheese 142
5.7 Conclusion 143
References 144

6 Manufacturing Practices of Processed Cheese 148
M. Nogueira de Oliveira, Z. Ustunol and A.Y. Tamime

6.1 Introduction 148
6.2 Some historical background 148
6.3 Processed cheese and products 150
6.4 Key steps in processing 153
  6.4.1 Selection of ingredients 154
  6.4.2 Emulsifying salts 158
## Contents

6.4.3 Preservatives 163  
6.4.4 Formulation of the cheese blend 167  
6.4.5 Grinding/shredding 167  
6.4.6 Heating/cooking 167  
6.4.7 Miscellaneous processing steps 170  
6.4.8 Packaging 170  
6.4.9 Rate of cooling and storage 170  
6.5 Changes in processed cheese during its shelf-life 171  
6.6 Conclusions 173  
References 173

### 7 Processed Cheese Plants and Equipment: A Practical Overview 179
S. Dixon

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Introduction</td>
<td>179</td>
</tr>
<tr>
<td>7.2 Unit operations</td>
<td>180</td>
</tr>
<tr>
<td>7.2.1 Weighing the ingredients to be processed</td>
<td>180</td>
</tr>
<tr>
<td>7.2.2 Initial size reduction</td>
<td>181</td>
</tr>
<tr>
<td>7.2.3 Grinding</td>
<td>182</td>
</tr>
<tr>
<td>7.2.4 Blending the ingredients to form a standardised cheese mix or blend</td>
<td>184</td>
</tr>
<tr>
<td>7.2.5 Transferring the standardised cheese blend to a cooking system</td>
<td>185</td>
</tr>
<tr>
<td>7.2.6 Direct steam injection into the cooking systems</td>
<td>187</td>
</tr>
<tr>
<td>7.2.7 Filtering the molten cheese</td>
<td>194</td>
</tr>
<tr>
<td>7.3 Processing plant for the manufacture of processed cheese slices</td>
<td>195</td>
</tr>
<tr>
<td>7.4 Conclusions</td>
<td>198</td>
</tr>
</tbody>
</table>

### 8 Packaging Materials and Equipment 199
E.M. Buys and J.F. Mostert

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 Introduction</td>
<td>199</td>
</tr>
<tr>
<td>8.2 Packaging materials</td>
<td>200</td>
</tr>
<tr>
<td>8.2.1 General specifications</td>
<td>200</td>
</tr>
<tr>
<td>8.2.2 Functions of a package</td>
<td>200</td>
</tr>
<tr>
<td>8.2.3 Types of packaging materials</td>
<td>201</td>
</tr>
<tr>
<td>8.2.4 Hygiene of packaging material</td>
<td>201</td>
</tr>
<tr>
<td>8.2.5 Shelf-life and interactions with packaging materials</td>
<td>202</td>
</tr>
<tr>
<td>8.3 Packaging equipment</td>
<td>204</td>
</tr>
<tr>
<td>8.3.1 Background</td>
<td>204</td>
</tr>
<tr>
<td>8.3.2 Portions/wedges</td>
<td>205</td>
</tr>
<tr>
<td>8.3.3 Blocks</td>
<td>208</td>
</tr>
<tr>
<td>8.3.4 Sausage shape</td>
<td>210</td>
</tr>
<tr>
<td>8.3.5 Metal cans</td>
<td>211</td>
</tr>
<tr>
<td>8.3.6 Tubs, jars, cups and plastic containers</td>
<td>211</td>
</tr>
<tr>
<td>8.3.7 Collapsible tubes</td>
<td>213</td>
</tr>
</tbody>
</table>
Contents

10.3.6 Miscellaneous additives 269
10.3.7 Water/steam 269
10.3.8 Sampling for quality appraisal of the retail product 269
10.4 Analysis of chemical composition 270
10.5 Microbiological quality and safety of the product 271
  10.5.1 Introduction and microbiological techniques 271
  10.5.2 Microbiological safety of the product 271
  10.5.3 Preliminary treatment of natural cheese milk and effect
        of certain additives 277
  10.5.4 Hygienic production/facility: HACCP 278
  10.5.5 Bacteriological examination 279
10.6 Assessment of physical characteristics 279
  10.6.1 Unmelted characteristics 279
  10.6.2 Melting characteristics 281
10.7 Assessment of the microstructure 283
  10.7.1 Background 283
  10.7.2 Some aspects affecting microstructure formation 283
  10.7.3 Cryo-SEM description of processed cheese microstructure 291
  10.7.4 Faults in processed cheese products 295
  10.7.5 Product development 297
  10.7.6 Application of confocal scanning laser microscopy
        as a quality control tool in processed cheese manufacture 303
10.8 Sensory profiling of processed cheese 311
  10.8.1 Elements of sensory assessment 311
  10.8.2 Assessor selection 312
  10.8.3 Acclimatisation and confirmation 313
  10.8.4 Sensory vocabulary 314
  10.8.5 Tasting protocol 315
  10.8.6 Analysis and interpretation of data 316
10.9 Conclusions 319
10.10 Acknowledgements 320
References 320
Appendix: Example of a product quality information as a result of
  using a HACCP system 339

Index 341

A colour plate section appears between pages 302 and 303