Index

Note: Italicised f and t refer to figures and tables.

Abi, see abortive infection (Abi) systems
ability to rank samples, 451
abortive infection, 187
abortive infection (Abi) systems, 187
acid-curd cheese manufacture, 287
acid-induced gelation, 13–15
ADSA, see American Dairy Science Association
AMAFE, see Association of Manufacturers of Natural Animal-derived Food Enzymes
American Dairy Science Association, 443
aroma, 222–4
assessor selection, cheese, 450–52
acclimatisation and confirmation, 451–2
initial testing, 451
internal versus external panels, 450
monitoring performance, 452
pre-selection procedure, 450
Association of Manufacturers and Formulators of Enzyme Products (AMFEP), 111
Association of Manufacturers of Natural Animal-derived Food Enzymes, 111
attribute ratings, 460–61t
The Australian grading system, 442
automated laboratory methods, 179–80
bactofugation, 279
Bio-Mathematics and Statistics Scotland, 452
BioSS, see Bio-Mathematics and Statistics Scotland
bovine serum albumin, 6
brevibacteria, 205
brine salting, 342–3
BSA, see bovine serum albumin
Canadian Department of Agriculture, 443
the Canadian grading system, 443
Candida krusei, 199, 200, 204, 206, 208, 210, 216, 218–9, 219 f
casein
milk composition, 3–6
caseinomacropeptide, 111
casein-to-fat (C/F), 333
CCPs, see critical control points
CDA, see Canadian Department of Agriculture
cetrimide fucidin cephalosporin selective, 195
CFCD, see cetrimide fucidin cephalosporin selective
cheese flavour products, 253–5 (see also cheese ripening)
cheesemaking technology
basics, 70–76
fundamentals, 69–70
process, 391–3
reduced-fat versions of traditional background, 88
reduced version of, 88–90
research role, 95–6
ripening/maturation
adventitious microflora in cheese, 87–8
diversity arising from composition, 87
stages
addition of the starter culture, 78–80
coagulation and cutting, 80–81
dry surface salting, 85–6
heat treatment of milk, 78
hooping and salting, 83–4
moisture control, 81–3
pressing, 86
standardisation of milk, 77–8
whey technology
composition of cheese whey, 91
lactose recovery, 95
membrane filtration technology, 91–3
pretreatment, 93–4
476  Index

cheesemaking technology (Cont.)

WPC production, 94–5, 94f
World market, 68–9
cheese manufacture, 386–9
acid-induced gelation, 13–15
with additives, 396
basic technology, 70–76
characteristics
assessment of, 264–6
colorimetry, 268
definition, 264
image analysis, 268–9
rheology and texture, 267–8
sensory tests, 266–7
chemical residues
antibiotics, 43–4
mycotoxins, 44
other residues, 45
cutting, 415–19
applications of, 419–21
characteristics and features of food cutting, 415
dicing, 420–21
parameters affecting cutting performance, 416–17
partitioning and segmentation, 419–20
shredding, 421
slicing, 420
velocity, 417–19
defects, 397–9
defined, 9–10
effect of pretreatment
addition of calcium chloride, 289–90
bactofugation, 279
clarification, 280
cold storage of milk, 271–3
curd-cutting programmes, 291–4
homogenisation, 286–9
milk gelation, 290–91
protein-to-fat ratio standardisation, 280–86
in situ denatured whey protein, 273–9
stirring and cooking, 294–5
thermisation, 273
efficiency, 47–9
end-product testing, 401–4
environmental monitoring, 404–6
enzymatic activity of milk
of bacterial lipases to lipolysis, 42
of lipolysis in the dairy industry, 42–3
lipolytic activity, 40–42
lysoosomal proteinases of somatic cells, 38–9
plasmin proteinase, 37–8
proteinases from psychrotrophic bacteria, 39–40
proteolytic activity, 36–7
ggrading systems, 442–4
Australian, 442
Canadian grading system, 443
International Dairy Federation grading system, 443
New Zealand grading system, 444
UK grading system, 443
US grading system, 443
Grated cheese for manufacture of, 395–6
heat treatment, 389–90
made from unpasteurised milk, 395
major categories, 75–6
tmanufacture principles, 262–4 (see also cheese manufacture)
mean rating for flavour attributes of, 454f
microbiological techniques, 406–8
milk composition
cow nutrition effects, 27–8
effect of milk frequency, 30–31
effect of parity, 30
effect of season, 30
genetic variants of, 29–30
stage of lactation, 28–9
milk composition influence, 269–71
milk for, 386–9
packaging, 421–8
of hard and semi-hard cheeses, 425–8
machinery for, 430–36
machines
tcontrol of, 428–30
materials, 422–5
miscellaneous methods of, 436–7
of soft cheeses, 428
specific requirements, 421–2
various steps of, 429f
tprevention and control, 399–401
processed cheeses, 396
tproperties, 416f
tquality of, see cheese quality
tof reduced-fat cheese, 89–90
with reduced-fat content, 154–6
trennet-induced gelation, 10–13
tscoring system, 468f
tclassification of, 469–70f
tsomatic cell count, 34–6
specialist, 394–6

types used in illustrative example, 453
yield estimation, 1

cheese products, 394–6

cheese-ripening
for accelerated and controlled
   genetically modified LAB, 249–52
   non-starter adjunct cultures, 248–9
   commercial drive, 239
   commercial opportunities created by, 240–41
   methods for accelerated
      attenuated starter cultures, 246–8
      elevated storage temperatures, 241–4
      enzyme additions, 245–6
   rules and regulations for GMOs in foods, 252–3
   ultra-high-pressure technology, 244
   quality prediction, 260–62

cheese sensory processing
   distribution of, 470
   integration versus selection of, 441–2
   three dimensions of, 440–41
   chymosin, 102, 103
   citrate metabolism in cheese, 238–9
   clustered regularly interspaced short palindromic repeats, 187

CMP, see caseinomacropeptide

coagulants
   analysis, 107–10
   application
      handling and use of, 116
      trades in use, 115–16
      cheese ripening, 123–4
   cheese yield difference, 122
   choice, 124–5
   controlling and curd fitness, 119
   heat liability, 123
   kinetics of milk, 112–15
   legislation and approval, 110–11
   milk quality, 116–19
   molecular aspects
      aspartic proteinases, 101–2
      specific types, 102–3
      performance of different types, 119–23
      stability and destabilisation of the casein micelles, 111–12
   types
      animal origin, 99–100
      fermentation-produced chymosin, 100–101
      microbial coagulants, 100
      vegetable coagulants, 101
   typical dosage difference between, 121
   commercial cheese sensory character, 467–8
   development of flavour lexicons, 469–71
   discrimination amongst cheese types, 468–9
   maturity declaration on cheese packaging with sensory panel ratings, 467–8
   Comté-type cheese, 376
   confocal scanning laser microscopy, 133, 339
   consumer, cheese making, 444–6
   cheesemaking – grading link, 446
   link between cheesemaking, grading and the consumer, 444–5
   link between grading and consumer, 445–6
   continuous quality improvement, 305, 306
   coryneforms, 205
   CQI, see continuous quality improvement
   CRISPR, see clustered regularly interspaced short palindromic repeats
   critical control points, 307
   CSLM, see confocal scanning laser microscopy
   ‘culture-cheese’ (Kulturkaese), 212
   culture strain selection, 177

curd
   controlling factors
      cutting time, 151
      pH, 149–50
      rennet concentration, 149
      temperature, 150–51
      washing of the curd, 151
   effect of milk composition
      β-Lactoglobulin, 142
      casein micelle size, 141
      genetic polymorphism of milk proteins, 141–2
      glycosylation, 141–2
      lactational variation and somatic cell count, 142–3
      variations in main components, 140–41
   effects of milk pre-treatment
      combined with heat treatment, 148
      cooling, 143–4
      high heat treatment, 144–6
      homogenisation, 147
      pH adjustment by carbon dioxide injection, 146–7
      phospholipase addition, 147–8
   factors affecting aggregation
      casein concentration, 131
      ions, 132–3
      pH, 131–2
curd (Cont.)
rennet concentration, 130–31
temperature, 132
formation of a gel, 133–5
on-line measurement of
curd setting, 152
gelation and cutting time controlling,
152–3
of syneresis, 153–4
rheological properties of rennet gels
calcium chloride and sodium chloride, 137
interactions between technological
parameters, 137–8
pH, 137
rennet concentration, 136
renneting skimmed milk, 135 f
temperature, 136
syneresis
calcium chloride, 140
dimensions of the gel or curd grains, 139
modelling of, 138–9
pH, 139–40
rennet concentration, 139
temperature, 140
curd-cutting programmes, 291–4
commercial practice, 293–4
role in stirring in syneresis, 291–3
traditional method, 293
curd forming properties, 288–9
curd maturation, 393–4
D. hansenii, 204
data capture and analysis of the
sensory-profiling protocol
(DDASPP), 452
defect-orientated, 442
Derjaguin theory, 112
descriptive ability, 451
direct salting, 343–4
direct-to-vat inoculation (DVI), 167
direct vat set (DVS), 167
DVS culture use, 175–7
end-product testing, 401–4
enzyme-modified cheese (EMC), 253–5, 254 f
enzymes production technology
description, 103–6
formulation, standardisation and quality
control, 106–7
general background, 103
EPS, see exopolysaccharide
exopolysaccharide, 351
eye formation, 363–6
cheese cohesion, 366
cheese structure and, 372–7
changes during ripening, 374–5
eye formation and slit development, 376–7
mechanical properties, 372–4
definition, 363
description, 365–6
and gas production, 364
gas production – a sign of quality, 363–5
measurements applied to, 372 f
mechanical properties, 372–4
fat-filled protein particle, 287
fat-in-dry matter, 194 f, 281, 333
FDM, see fat-in-dry matter
‘fermentation-produced chymosin’, 99, 109
FFPP, see fat-filled protein particle
FFS, see form-fill-and-seal
flavour lexicons, 469–71, 471 t
Food and Agriculture Organisation (FAO), 360
form-fill-and-seal
description, 429, 434, 436 f
machines
description, 432–3
transformation, 434–6
FPC, see ‘fermentation-produced chymosin’
fresh cheese manufacture, 287
Generalised Procrustes Analysis (GPA), 458–9
genetically modified organism (GMO), 99, 178
good manufacturing practice (GMP), 399
HACCP, see hazard analysis critical control
points
hazard analysis critical control points, 95, 211, 307
high-pressure liquid chromatography (HPLC),
341
high-throughput screening methods, 166
homogenisation
effects on curd forming properties, 288–9
fresh, acid-curd cheese manufacture, 287
rennet-curd cheese manufacture, 287–8
HTS methods, see high-throughput screening
methods
in-process control (IPC), 305, 306 f, 307
integrated design and analysis, cheese, 452–66
of assessors’ performance, 461–6
Generalised Procrustes Analysis (GPA), 458–9
interpretation of sensory dimensions, 456–8
multivariate prediction, 459–61
PCA, 455–6
preliminary treatment, 453–4
of sensory-profiling protocol, 452–3
sensory space maps, 454–5, 459
The International Dairy Federation grading system, 443
International Dairy Federation (IDF), 107
Jameson effect, 400
κ-casein hydrolysis, 113–14
‘key compositional parameters’ (KCPs), 299
key performance indicators, 305, 306f
key quality indices, 308
Kluyveromyces lactis, 204
Kluyveromyces marxianus, 99f, 105–6, 199, 204, 206–9, 216, 218–9, 219f
KPIs, see key performance indicators
KQIs, see key quality indices
LAB, see lactic acid bacteria
lactic acid bacteria, 166, 199
bacteriophage of
phage control during culture preparation, 184
phage control in the dairy, 184–5
phage monitoring, 185–6
on propionibacteria, 370–71
proteolysis by
aminoacid catabolism, 183
peptidases of, 182
proteases, 181–2
taxonomy
identification, 172–3
species, 173–4
lactic cheese starter cultures
acidification by, 180–81
background, 166–7
composition of, 188–9
modern approaches
automated laboratory methods, 179–80
food-grade GMOs for the dairy industry, 178–9
traditional bacterial genetics, 177–8
phage-resistant starters, 186
abortive infection, 187
additional routes to bacteriophage resistance, 187–8
conjugal transfer of phage resistance plasmids, 186
inhibition of phage adsorption, 187
isolation, 186
prevention of phage DNA injection, 187
restriction and modification systems, 187
probiotic, 170–72
production, 167–9
proteolysis by, 181–3
taxonomy, 172–4
types
culture strain selection, 177
development of mesophilic cultures, 174–5
DVS culture use, 175–7
Lactobacillus casei, 174, 241, 370
Lactobacillus delbrueckii, 75f, 169, 170, 208f, 219f, 334, 370
Lactobacillus helveticus, 9, 76f, 169, 170, 236, 334, 370
Lactobacillus plantarum, 174, 215, 241
lactocepin (PrtP), 181
Lactococcus lactis, 75f, 168, 169, 179, 181f, 235, 312, 334, 996
lactose metabolism in cheese, 238–9
Landau theory, 112
Leuconostoc mesenteroides, 169, 174
lipoprotein lipase, 8
LPL, see lipoprotein lipase
microfiltration (MF), 92, 333–4
milk
authenticity, 23
composition
casein, 3–6
cow nutrition effects, 27–8
in different parameters, 19–22
effect of milk frequency, 30–31
effect of parity, 30
effect of season, 30
gelation characteristics, 2r
generic variants of, 29–30
lipids, 8–9
mineral, 7–8
optimising manufacturing procedures, 18–19
protein, 6–7
stage of lactation, 28–9
definition, 15–16
Index

milk (Cont.)
microbiology of, 22–3
  contamination from outside mammary gland, 32–3
  contamination from within mammary gland, 31–2
  hygienic milk production on-farm, 31
  storage conditions, 33
in pizza cheese, 332–4
protein level, 281–6
safety/public, 16–18
sensory, 23
milk frequency, 30–31
milk gelation, 290–91
milk lipids
  in cheese, 237–8
  as milk composition, 7–8
milk pasteurisation
  effects on coagulation and cheesemaking characteristics, 274–6
  inactivation of pathogens, 273–4
  interactions between whey proteins and casein micelles, 276–9
milk protein breakdown
  amino acid catabolism, 235–7
  milk lipids in cheese, 237–8
  proteolytic systems, 231–5
mineral
  as milk composition, 7–8
  moisture in non-fat substances (MNFS), 281, 283
moulding
  effect on chemical composition, 340
  effect on microstructure, 339–40
  thermal effect, 340–42
N-acetylgalactosamine (GalNAc), 5
N-acetylneuraminic (sialic) acid, 5
NANA, see N-acetylneuraminic (sialic) acid
Nanofiltration (NF), 92
NDM, see non-fat dry milk
the New Zealand grading system, 444
non-fat dry milk, 333
non-starter lactic acid bacteria, 387
NSLAB, see non-starter lactic acid bacteria
Overbeek theory, 112
PAB, see propionic acid bacteria
PCA, see principal component analysis
PDO, see protected designation of origin
Penicillium album, 200, 204
Penicillium camemberti, 193, 194 f., 237, 393
Penicillium glaucum, 200
PEP-PTS, see phosphoenol pyruvate-dependent phosphotransferase system
phage infection protein, 187
phage-resistant starters
  abortive infection, 187
  additional routes to bacteriophage resistance, 187–8
  conjugal transfer of phage resistance
  plasmids, 186
  inhibition of phage adsorption, 187
  isolation, 186
  prevention of phage DNA injection, 187
  restriction and modification systems, 187
PHE, see plate heat exchange
phosphoenol pyruvate-dependent phosphotransferase system, 181
phosphotungstic-acid soluble nitrogen, 374
Pip, see phage infection protein
pizza cheese, 330–32
  functional properties
    background, 330–31
    measurement of functionality, 331–2
    manufacture, 332–5
    brining/salting, 342–4
    coagulant, 337–8
    cooking and cheddaring, 338–9
    factors affecting cheese yield, 345
    process control in, 344–5
    starter culture, 334–7
    stretching and moulding, 339–42
    treatment of milk, 332–4
  microbial properties
    concept, 345–6
    functionality changes during storage, 349
    physicochemical properties, 347–9
    proteolytic properties, 347
  non-traditional methods of manufacture, 349–52
    cheese blends, 350
    direct acidification, 349–50
    imitation (analogue) pizza cheese, 351–52
    low-fat pizza cheese, 350–51
    processed pizza cheese, 352
  plate heat exchange, 93
  principal component analysis, 452
principal component regression (PCR), 459
principal component regression (PCR), 459
principle of cutting, 416f
propionic acid bacteria, 366
propionic fermentation, 366–72
influence of LAB on propionibacteria, 370–71
metabolism of PAB, 368–9
relationship between flavour development and, 371–2
Swiss-type cheeses, 366–7
taxonomy, ecology and presence of PAB in cheese, 367–8
protected designation of origin, 428
protein-to-fat (P/F), 333
description, 280–81
milk protein level, 281–6
protein-to-fat ratio (PFR), 280
proteolysis, 374–5
PTASN, see phosphotungstic-acid soluble nitrogen
quality milk production, 45–7
recombined fat globule membrane, 287
REML, see residual maximum likelihood
rennet application
handling and use of, 116
trades in use, 115–16
approximate conversion, 108f
commonly used, 99f
tooling and curd fitness, 119
milk quality, 116–19
molecular aspects
aspartic proteinases, 101–2
specific types, 102–3
performance of different types, 119–23
types
animal origin, 99–100
fermentation-produced chymosin, 100–101
microbial coagulants, 100
vegetable coagulants, 101
typical dosage difference between, 121f
rennet-curd cheese manufacture, 287–8
rennet-induced gelation, 10–13
rennin units (RU), 107
residual maximum likelihood, 453
reverse osmosis (RO), 92
RFGM, see recombined fat globule membrane
Rod-to-cocci ratio, 336–7
sample preparation and presentation, 448–50
environment, 448–9
isolation, 449
presentation order, 449–50
rating of samples, 449
scanning electron microscopy, 207, 339
secondary cheese starter cultures, see Surface-ripened cheeses
aroma, 222–4
classification of
coryneforms, 202–3
moulds and yeasts, 200–201
Penicillium camemberti, 201f
staphylococci, 201–2
commercially available
brevibacteria, 205
coryneforms, 205
mixed starter cultures, 205
moulds, 203–4
staphylococci, 205
yeasts, 204–5
development of
for acid curd cheeses (yellow type), 218–20
application, 220–21
colour development, 220
for semisoft solids, 216–17
for smeared soft cheeses, 208f, 217–18
proteolysis and lipolysis, 221–2
secondary fermentation, 377
SEM, see scanning electron microscopy
sense of smell, 451
sense of taste, 451
sensory-profiling protocol, 452–3
sensory space maps, 454–5, 458f, 466f
sensory vocabulary, 447–8
evolution of vocabulary, 448
working vocabulary for cheese, 448
slicer operating principle, 420f
SQC, see statistical quality control
standard operating procedure (SOP), 305, 306f
Staphylococcus aureus, 32, 39, 201, 211, 214–5, 388, 391–2, 400, 405–6
Staphylococcus thermophilus, 14, 75f, 79, 169f, 170, 174, 176, 179, 182–5, 187–8, 218, 219f, 334, 341, 346, 370
starter culture, 1, 9–10, 12, 14f, 19, 43, 74, 78–9, 116, 166–7, 175, 334–7, 396
addition of, 78
approaches for development, 177
starter culture (Cont.)  
future perspectives, 188–9  
lab methods, 179–80  
LAB range, 169–72  
probiotic, 170–72  
process flow chart, 168  
production of, 167  
role, 335–6  
statistical quality control, 305, 306f  
stretching  
effect on chemical composition, 340  
effect on microstructure, 339–40  
thermal effect, 340–42  
surface-ripened cheeses  
anti-listeria starter cultures, 214–15  
control of, 199–200  
examples, 194f  
food safety, 211  
L. monocytogenes, 213  
mould spoilage, 213–14  
old–young smearing, 212, 212f, 216f  
origin and ripened times of, 195t  
popular varieties, 198–9  
smear bacteria (coryneforms), 209–11  
smear ripened, 192, 196r, 197  
strategies, 206–7  
yeast, 75r–76r, 85, 88, 105–6, 167, 193–5, 196r–197r, 198, 200, 204–5, 209, 216, 218  
Swiss-type cheeses, 366–7  
main features of, 362t  
typical compression profiles obtained with  
Swiss-type cheeses, 373f  
thermal effects, 340–42  
thermoforming fill-and-seal machine, 434f  
total bacterial count (TBC), 386  
trichloroacetic acid (TCA), 341  
UK grading system, 443  
US grading system, 443  
UW melt profiler, 331  
Verwey theory, 112  
violet red bile dextrose (VRBD), 195  
whey protein  
denaturation, 277t  
as milk composition, 6–7  
whey protein concentrate (WPC), 92  
whey technology  
composition of cheese whey, 91, 91t  
lactose recovery, 95  
membrane filtration technology, 91–3  
pre-treatment, 93–4  
WPC production, 94–5  
World Trade Organisation (WTO), 408  
WPC production, 94t, 94–5  
yeast, 75r–76r, 85, 88, 105–6, 167, 193–5, 196r–197r, 198, 200, 204–5, 209, 216, 218