

Poultry Meat Science

Edited by R.I. Richardson and G.C. Mead



CABI Publishing

Poultry Meat Science

All rights reserved. No part of this publications may be reproduced in any form or by any means, electronically, mechanically, by photocopying, recording or otherwise, without the prior permission of the copyright owners.

© CAB International

ISBN 81-902320-3-7

First Indian Print 2005

Distributed by
RESEARCHCO BOOK CENTRE
25B/2, New Rohtak Road, Karol Bagh,
New Delhi - 110 005
Tel.: 28712565, 55150445
Fax.: 91-11-28716134
Email - researchco@dishnetdsl.net



Printed at Salasar Imaging System, Lawrence Road Industrial Area, Delhi

CONTENTS

CONTRIBUTORS	vii
PREFACE	ix
ACKNOWLEDGEMENTS	xi
I Biochemical basis of meat quality	1
CHAPTER 1	
Muscle structure, development and growth <i>G. Goldspink and S.Y. Yang</i>	3
CHAPTER 2	
Muscle abnormalities: morphological aspects <i>M. Mahon</i>	19
CHAPTER 3	
Muscle abnormalities: pathophysiological mechanisms <i>M.A. Mitchell</i>	65
CHAPTER 4	
Biochemical basis of meat texture <i>C.E. Lyon and R.J. Euhr</i>	99
CHAPTER 5	
Poultry meat flavour <i>L.J. Farmer</i>	127
CHAPTER 6	
Poultry meat colour <i>D.L. Fletcher</i>	159
II Production and harvesting factors affecting meat quality	177
CHAPTER 7	
Live production factors influencing yield and quality of poultry meat <i>E.T. Moran, Jr</i>	179
CHAPTER 8	
Nutritional effects on meat flavour and stability <i>M. Enser</i>	197
CHAPTER 9	
The influence of ante-mortem handling on poultry meat quality <i>P.D. Warriss, L.J. Wilkins and T.G. Knowles</i>	217

CHAPTER 10		
Effects of stunning and slaughter methods on carcass and meat quality		231
A.B.M. Raj		
III Microbiological quality of poultry meat and meat products		255
CHAPTER 11		
Salmonella infection in poultry: the production environment		257
C. Wray, R.H. Davies and S.J. Evans		
CHAPTER 12		
Hygiene during transport, slaughter and processing		277
R.W.A.W. Mulder		
CHAPTER 13		
The decontamination of carcass meat		285
M.H. Hinton and J.E.L. Corry		
CHAPTER 14		
Strategies for extending the shelf-life of poultry meat and products		297
L.F.J. Woods and P.N. Church		
IV Poultry meat products		313
CHAPTER 15		
On-line assessment of poultry meat quality		315
H.J. Swatland		
CHAPTER 16		
Problems and solutions in deboning poultry meat		347
A. Sams		
CHAPTER 17		
Sensory assessment of poultry meat quality		359
G.R. Nute		
CHAPTER 18		
Functional properties of muscle proteins in processed poultry products		377
A.B. Smyth, E. O'Neill and D.M. Smith		
CHAPTER 19		
The role of processed products in the poultry meat industry		397
R. Mandava and H. Hoogenkamp		
V Abstracts		411
Retail requirements of meat		413
J.C. Hall		
From meat inspection to consumer protection: a long way to go		415
J.H.G. Goebbels		
VI Poster abstracts		417
		437
Index		

CONTRIBUTORS

R.J. Buhr, Poultry Processing & Meat Quality Research Unit, United States Department of Agriculture, Agricultural Research Service, Russell Research Center, Athens, GA 30604, USA

P.N. Church, Food Technology Section, Leatherhead Food Research Association, Randalls Road, Leatherhead, Surrey KT22 7RY, UK

J.E.L. Corry, Division of Food Animal Science, School of Veterinary Science, University of Bristol, Langford, Bristol BS40 5DU, UK

R.H. Davies, Central Veterinary Laboratory, New Haw, Addlestone, Kent KT15 3NB, UK

M. Enser, Division of Food Animal Science, School of Veterinary Science, University of Bristol, Langford, Bristol BS40 5DU, UK

S.J. Evans, Central Veterinary Laboratory, New Haw, Addlestone, Kent KT15 3NB, UK

L.J. Farmer, Food Science Division, Department of Agriculture for Northern Ireland and The Queen's University of Belfast, Newforge Lane, Belfast BT9 5PX, UK

D.L. Fletcher, Department of Poultry Science, University of Georgia, Athens, GA 30602, USA

G. Goldspink, Department of Anatomy and Developmental Biology, The Royal Free Hospital School of Medicine, The University of London, Rowland Hill Street, London NW3 2PF, UK

M.H. Hinton, Division of Food Animal Science, School of Veterinary Science, University of Bristol, Langford, Bristol BS40 5DU, UK

H. Hoogenkamp, Protein Technologies International, Checkerboard Square, St Louis, MO 63164-00011, USA

T.G. Knowles, Division of Food Animal Science, School of Veterinary Science, University of Bristol, Langford, Bristol BS40 5DU, UK

C.E. Lyon, Poultry Processing & Meat Quality Research Unit, United States Department of Agriculture, Agricultural Research Service, Russell Research Center, Athens, GA 30604, USA

M. Mahon, School of Biological Sciences, 1.124 Stopford Building, University of Manchester, Oxford Road, Manchester M13 9PT, UK

R. Mandava, Nestle R&D Centre, P.O. Box 520, S-26725 Bjuv, Sweden

G.C. Mead, Department of Farm Animal and Equine Medicine and Surgery,

Index

Note: page numbers in *italics> refer to figures and tables*

- 'A' - 'not A' test 364-366
- acetic acid 288
- acid dips for carcass decontamination 286, 288-289
- actin 381
 - filaments 4, 5, 6, 66
 - genes 9
 - myosin gelation 391-392
- actin-Z-disc 103
- α -actinin 66
- actomyosin 382, 392
- adenosine triphosphate *see* ATP
- adrenaline 217
- Aeromonas* 299, 307
- aflatoxin 171
- age and meat quality 179-180, 181, 182
 - composition of thigh/breast muscle 180, 181
 - flavour 145-147
 - live production factors 179-180, 181, 182
 - taste compounds 147
 - yield 179-180, 181, 182
- ageing
 - cost 350-351
 - cost reduction 354
 - drip loss reduction 350
 - electrical stimulation 352
 - extended after harvesting 353-354
 - post-chill 109
 - temperature and meat texture 111
 - tenderness with deboning 349
- air ionization 304
 - carcass decontamination 286, 291
- air-chilling, electrical stimulation 352
- aldehydes, aliphatic 142
- aldolase 81
- Allo-Kramer shear values 107, 429
- Alphitobius* 267
- amino acids 186-188
 - aroma 139
 - dietary inadequacy 187
 - taste compounds 129, 130-131
- ante-mortem handling 217-218
 - meat texture 226-227
 - muscle glycogen store depletion 223
 - paleness of meat 225-226
- anterior horn cell disorders 35
- antioxidants 83
 - natural in feed 428
 - nutritional effects 197-200
- argon gas stunning 114, 115-116, 234, 236, 240-241
 - toughness prevention 352-353
- arizonosis 257
- aroma
 - precursors 139-140
 - sensory profiles 372, 373
- aroma compounds
 - chemical reactions 136-139
 - flavour 131-133, 133-136, 136-142, 143
 - volatile 131-132
- aroma-forming reactions
 - factors affecting 140-142, 143
 - pH 140, 141
 - precursors 139-140
 - temperature 140-141, 142
- ascites 318
- aspartate aminotransferase (AST) 81, 82
- ATP 4, 6, 7
 - breakdown post-mortem 109
- depletion
 - anoxic stunning 250
 - electrical stunning 112
 - post-mortem 101, 102
 - post-mortem muscle contraction 226
 - post-mortem regeneration 100
 - rigor development 347-348
- ATPase 4, 5, 233

- atrophy of muscle fibre 21–22
 autolysis, myofibrillar 25, 317
 automation, shelf-life extension 310
 avian myopathies 37
- batters 406
 see also meat batters
 Becker muscular dystrophy 31–32
 belt flattener 119, 353
 biopreservatives 301
 biosecurity, *Salmonella* infection 267–268
 birds, wild 267
 bitter taste 129
 blade tenderization 353
 bleed out 236–237
 inadequate 239
 kinetics 425
 blood loss at slaughter 236–239
 delayed neck cutting 238–239
 electrical stunning 237
 gas stunning 237–238
 blowfly larvae 267
 bones, broken 232, 245–246
 boning
 bacterial growth 297
 hot 110, 113
 sarcomere length 110
 time 99, 110
 bouillon 129
 breast meat
 colour and stunning method 246
 fast-food menus 109
 breast muscle
 chilling 110
 defects 184
 fibre types 180
 rigor 101
 tensioning 110–111
 breeding flock, *Salmonella* infection 260
 Breeding Flocks and Hatcheries Order (1993) 270
 broilers
 carcass classification system 163
 handling 218
 housing 419
 meat quality 421
 mortality in transit 218
 skin colour 160, 162, 165
 bruising
 catching/handling 222
 visual defects 169, 170, 171
 yield and quality 179
- calbindin-D-9k 77
 calcium
 cell entry channels 72
 homeostasis in turkey muscle 51
- influx 72
 intracellular 71–72
 intracellular actions 78
 intracellular free concentrations 77–79
 control defect 79–80
 mitochondrial uptake 74–75
 myoplasmic homeostasis 80, 81, 87–88
 overload 86
 dystrophy 83
 post-mortem rigor 102
 pumps 72–73, 73
 regulatory system deficiencies 78–79
 release from sarcoplasmic reticulum 66, 67–69
 toxicity 71
 uptake into intracellular compartments 73–75
 calcium channel 67–68
 disorders 34
 ryanodine receptor 70, 76
 sarcoplasmic reticulum 51
 calcium-ATPase 72, 73
 calcium-based muscle damage in turkeys 51–52
 calcium-binding proteins 75
 high affinity cytosolic 76–77
 storage compartments 75–76
 calcium-induced calcium release (CICR) 68, 69, 81
 calcium-related degeneration of muscle fibre 25
 calmodulin 75
 calmodulin-dependent calcium-ATPase 72
 calpain 317
 calpain–calpastatin system 106
 calreticulin 75–76
 calsequestrin 75, 76
Campylobacter 221, 281, 307
 stress factors 279, 280
 canthaxanthin 428
 capture and handling myopathy 41
 carbon dioxide
 acidosis 241
 gas stunning 114, 115–116, 234, 236, 240–241
 toughness prevention 352–353
 packaging 305
 carcass
 broken bones 232, 245–246
 cross-contamination prevention 279
 damage during handling 222, 241
 defects 232
 downgrading 232
 electric current application 299
 faecal contamination 221, 280
 hygiene with food withdrawal 221
 quality 231–233
 surface heating patterns 427
 trimming 232, 233
 see also ageing; decontamination of

- carcass meat
 carcass appearance defects
 handling 222, 241
 plucking 242
 stunning 241–242, 243–244, 244–246
 see also haemorrhage
 β -carotene 428
 carotenoids
 pigment 166, 319
 poultry feed supplementation 428
Cassia occidentalis 43
 catching, bruising damage 222
 category scales 367–373
 graphic 368–369
 line 368–369
 sensory profile methods 369–373
 cathepsins 106
 cell signalling 71, 72
 central core disease 31
 channel proteins 67
 chemesthesis 129
 chemical-spectrophotometric analyses 163–164
 chicken inherited muscular dystrophy 37
 chicken shank colour 162–163
 chicks
 salmonella contamination 262
 sanitization of handling equipment 262–263
 chilling
 colour 168
 convection 232
 drop loss 354
 electrical stimulation 352
 extended for ageing cost reduction 354
 haem pigment leaching 168
 immersion 111, 232
 meat texture 111
 chloride channel disorders 34
 chlorine decontamination of carcass meat 289–290
Clostridium botulinum 303, 307–308
 coated products 405–407
 fat uptake 406–407
 coccidiosis, pigmentation impact 166
 coffee senna 43
 cold shortening of muscle 105, 348
 collagen 106, 180, 317
 colorimetry 164–166, 332
 colour 159–160
 acceptability 160
 chemical-spectrophotometric analyses 163–164
 chicken shank 162–163
 chilling 168
 direct pigment analysis 163–164
 evaluation 161
 fat 319
 instrumentation for measurement 161
 killing method 168
- light scattering techniques 332–337
 measurement 160–161
 meat/muscle 160, 167–169, 318
 myoglobin 164, 168
 on-line monitoring 318–319
 pH of muscle 169
 product uniformity 160
 PSE 169
 reflectance colorimetry 164–166
 skin 166–167
 standards 162
 stress effects 168
 visual defects 169, 170, 171
 visual scoring 164
 comfort foods 404
 compression rheology 320–322, 323, 324–328
 compression tests for meat tenderness 107
 congenital fibre type disproportion (CFTD) 30, 31
 connectin 106
 connective tissue, meat quality 317, 320–322, 323, 324–328
 contamination of consumer-ready products 278
 contractile proteins 66
 contractility of muscle 66
 contraction, eccentric 234
 cooking
 aroma compounds 131
 category scales 368–369
 in-pack 303
 loss
 meat quality 328–332
 stunning method 246–247
 meat tenderness 106
 method 132
 flavour 150, 151
 oxidation 203
 shelf-life extension 302–303
 systems 408
 taste compounds 130–131
 crates
 cleaning/disinfecting 282
 contamination 221
 stocking density 246
 creatine kinase (CK) 24, 81
 dystrophy 32
 isoenzymes 81, 82
 myopathy mechanism 86
 subunits 81
 crop microorganisms 280
 cystatins 106
 cytoskeletal proteins 382
- deboning 347
 appearance 350
 meat yield 350–351
 rigor 347–348

- deboning *continued*
 sensory profiles 370-371
 tenderness 348-349
- decapitation 413
- decontamination of carcass meat 285, 286, 287-292
 acid dips 286, 288-289
 air ions 286, 291
 chlorine 289-290
 cold water washing 287
 deluge 286, 288
 dips 286, 287
 electromagnetic waves 286, 290
 electron accelerators 286, 287
 gamma irradiation 285, 286, 287
 high pressure 286, 291
 microwave 286, 290, 427
 short heating times at high temperature 429-430
 sprays/steam 286, 288
 trisodium phosphate 286, 289, 291, 292
 ultrasonic energy 286, 291
 ultraviolet light 286, 290
 visible light 290
- deep pectoral myopathy (DPM) 38-39, 82-83, 318
- degeneration of muscle fibre 24-25
 calcium-related 25
- degenerative myopathy of turkeys 39
- deluge washing 286, 288
- desmin 317
- developmental regulatory factors 44
- dietary deficiency myopathies 83-84
- dihydropyridine receptors (DHPRs) 67, 69
 dystrophic chicken muscle 83
 inactivation 68
- dips 286, 287
- disinfection, *Salmonella* infection 265-266
- disulphide bonds in myosin 389-390
- DNA vaccines 14
- docosapentaenoic acid (DHA) 198, 199, 200
 raising levels 200-203, 205, 206
- double muscling 37
- drinking behaviour, broiler housing 419
- drip loss
 chilling 354
 reduction 350
- Duchenne muscular dystrophy 31-32, 78-79
- duo-trio test 363-364
- dystrophies 31-32, 37
 calcium overload 83
 chicken inherited muscular dystrophy 37
 hereditary muscular dystrophy of turkeys 41-42
 see also Duchenne muscular dystrophy
- dystrophin 78
 glycoprotein complex 32
 protein 83
- EF-hand protein family 77
- eggs
 salmonella contamination 260
 sanitization 261
 yolk colour 160, 162
- eicosapentanoic acid (EPA) 198, 199, 200
 raising levels 200-203, 205, 206
- electrical impedance 319, 320
 measurement 339-340
- electrical stimulation 304
 amperage 351-352
 meat texture 111, 116-119
 rigor 116
 sarcomere length 117-118
 toughness prevention 351-352
 voltage levels 118-119
- electrical stunning
 blood loss 237
 breast meat colour 246
 broken bones 246
 carcass appearance defects 241-242, 243-244, 244-245
 cooking loss 246-247
 duration and rigor development 239-240
 extended duration 112-113
 haemorrhage 340, 421
 hot boning 113
 irreversible 113-114
 meat quality 421
 meat texture 112-114, 247-248
 method 235-236
 muscle contraction 234-235
 sensory properties of meat 250
- electrocution, meat texture 113-114
- electromagnetic waves 286, 290
- electron accelerators 286, 287
- emulsifying capacity 320
- emulsion theory 378-379
- endocrine system secondary myopathies 34
- energy, dietary 185-186
- enhancer sequences 10
- environment
 flavour 148-149
 quality/yield of meat 188-190
- environmental contamination by salmonella 263-266
- Escherichia coli* 288, 289
 mandatory testing in US 280
- EU Directive 92/117/EEC 268
- evisceration 282
 flavour effects 150
 intestinal breakdage contamination 280
- excitation-contraction (EC) coupling 66-67
- exercise-induced myopathy, subgastrocnemial isohaemic 83
- faecal contamination
 carcass 221

- processing technology 282
- fast food outlets 402
- fasting see feed withdrawal
- fat
 abdominal 182, 316
 binding 377
 chemical oxidation 298
 coated products 406-407
 colour 319
 emulsification 378-379, 380
 high performance feeds 185
 liquefaction 380
 oxidation 298
- fatness, body 188
- fatty acids
 dietary
 n-3 PUFA increase 200-202
 tissue fatty acid composition 198-200
- endogenous 198
- exogenous 198, 199
- flavour 203-207
 metabolic fate 199-200
 odour 203-207
 peroxidation 207
- feathering 188
- feed, natural antioxidants 433
- feed withdrawal 220
Campylobacter 281
 carcass hygiene 221
 pre-slaughter 221, 279, 280
 stress 280
 transport of poultry 219
 weight loss 219, 220
- feeding behaviour, broiler housing 419
- fibreoptic spectrophotometry 318, 336-337
- filleting time 248, 249-250
- fillets
 belt flattened 119, 353
 boning 110
- fish lipids 202
- fish oils, taint 203, 206, 207
- fishy taint 203, 206, 207
 prevention with vitamin E 208
- flattening 119, 353
- flavour 127
 age 145-147
 aroma compounds 131-133, 133-136, 136-142, 143
 assessment 203-204
 compounds 128-131
 cooking method 150, 151
 diet 147-148
 enhancers 129, 130
 environment 148-149
 evisceration effects 150
 fatty acids 203-207
 formation 128-132, 133-136, 136-142, 143
 further-processed poultry products 404
- genotype effect 144-145
- growth rate 144, 145
- intestinal microflora 148
- irradiated chicken 427
- nutritional effects 207
- postslaughter treatment 150
- poultry strain 144-145
- production regime 148-149
- production/processing factor effects 143-150, 151
- sensory profiles 372, 373
- sex 147
- slaughter treatment 150
- stocking density 149
- storage period 150
- vitamin E effects 148
- flesh see meat
- flock health, pigment absorption 166
- Flory-Stockmayer model of gelation 384
- focal myopathy 40, 84-85, 318
- food deprivation see feed withdrawal
- food poisoning 277, 415
- Food Safety Objectives (FSOs) 415-416
- food service market 400, 402
- formaldehyde 265
 vapour 262
- fowl typhoid 257
- freeze-thaw cycling 304
- freezer burn 297
- freezing systems 409
- Fry Shield 406
- furanthiols 142
- further-processed poultry 399-400, 401, 402
 coated products 405-407
 cooking systems 408
 flavours 404
 freezing systems 409
 gourmet sausages 407-408
 innovations 405-409
 products 403-404, 405
 trends 402-404, 405
- Fusarium moniliforme* 171
- gamma irradiation carcass decontamination 285, 286, 287
- gap filaments 106
- gas stunning 234, 236, 240-241
 blood loss 237-238
 breast meat colour 246
 broken bones 246
 carcass appearance defects 243, 244, 246
 cooking loss 246-247
 meat texture 114-116, 248-250
 method 236
 muscle pH 241
 rigor 240-241, 352
 sensory properties of meat 250-251

- mortality in transit 218–219
 motor units 29
 multicores 31
 muscle
 adaptability 19–20
 aerobic/anaerobic 101
 cell damage indicators 81–82
 cohesion 50
 cold shortening 105
 colour 318
 contractility 66
 contraction 4, 99, 234
 development 3
 differentiation 10–11
 eccentric contraction 234
 fibre type determination 12–13
 filament distribution anomalies 30–31
 form 66
 function 66
 growth 4–6, 7, 9
 control factors 52
 posthatching 13
 potential 8
 rapid 317, 318
 isoelectric point 104
 mass 8
 pathology 19–20, 318
 pH 101, 102, 104
 phenotypic determination 9
 plasticity 19–20
 post-mortem biochemistry 100–106
 regeneration control factors 52
 regulation of mass by GH and IGF 12–13
 rheological properties 322, 323, 324
 structure 4, 5
 variability 19–20
 water-binding ability 104
 muscle abnormalities 37, 82–85
 control factors in growth and regeneration 52–53
 deep pectoral myopathy 82–83
 dietary deficiency myopathies 83–84
 focal myopathy 84–85
 growth factors 52
 pathology 65
 progressive muscular dystrophy 83
 PSE 85
 stress-induced myopathy 85
 toxic myopathies 84
 muscle fibre 4–6
 artefactual abnormalities 29
 atrophy 21–22
 autolysis 25
 challenge response 20–21
 damage response 20–21
 degeneration 24–25
 external membrane defects 27
 fast-contracting 315
 fibrosis 27, 28
 glycogen storage 26
 growth 6
 hyaline 27
 hypertrophy 23–24
 hypotrophy 21–22
 inflammatory response 27–28
 inherent defects 50
 intracellular composition 25–29
 lipid storage 26
 neural elements 28
 number 7–8
 predominance of groupings 26–27
 red 233
 regeneration 25, 26
 responses 20–29
 sarcolemmal accumulations 26, 27
 size 7, 46–47
 splitting 27
 tubular aggregates 27
 types 6–7
 white 233
 muscle proteins
 classification 381
 functional properties 377
 gelation 384–385
 interactions in meat batters 378–380
 see also actin; myosin
 muscular dystrophy see Duchenne muscular dystrophy; dystrophies
 myoblasts 7–8
 MyoD gene family 11, 52
 myofibrillar isoform genes 7
 myofibrils 5–6
 autolysis 317
 birefringence 333
 overlap 348
 proteins 381
 myogenin 11
 myoglobin 24–25
 evaluation 164
 meat colour 168
 reactions 169
 myopathies 29, 30–34
 congenital 30–31
 ion balance 86
 meat quality 87–88
 mechanisms 85–87
 myosin
 actin role in gelation 391–392
 aggregation 388
 amino acid substitutions 382
 ATPase 26
 biochemical properties 381–384
 cross-bridge 4, 5
 denaturation 386–387
 profile 391–392
 disulphide bonds 389–390
 domains 387, 389

- environmental conditions for gelation 391
 filaments 4, 5, 6, 66
 function 383–384
 gel matrix formation 387
 gelation 388–392
 factors influencing 390–392
 heat-induced 381
 properties 385–390
 gene expression 13
 heating 386–387, 389
 heavy and light chains 4
 genes 9
 meat batters 381
 muscle contraction role 381–382
 polymorphism 390
 skeletal muscle 381–384
 structure 382–384
 myosin-actin systems, gel strength 392
 near-infrared (NIR) reflectance spectroscopy 318, 328–332
 apparatus 329, 330
 near-infrared (NIR) transmittance 330–331
 nebulin 106, 317
 neck cutting at slaughter 236–237, 238–239
 neck dislocation 423
 needle fluorometry 320–322, 323, 324–328
 nemaline bodies 26
 neural elements, muscle fibre 28
 neurogenic disease 29
 neuromuscular disorders 29–37
 central 35–36
 dystrophies 31–32, 37
 experimental pathology 30
 inflammatory 32
 ion channel 34
 junctional 36
 metabolic 33
 myopathic muscle disease 29, 30–34
 peripheral nerve lesions 36
 secondary 34–35
 neuromuscular junction 28, 36
 neuronal apoptosis, accelerated 36
 nitrite 298
 nitrogen, gas stunning 114, 115
 nitrosomyoglobin 298, 305
 No Fry 406–407
 nucleotides, taste compounds 129, 131
 nutrition
 flavour effects 197
 high performance feeds 185
 meat stability 197
 quality of meat 185–188
 yield 185–188
 nutritional muscular dystrophy 83–84
 nutritional myopathy 43, 83–84
 odour
 compounds 141
 fatty acids 203–207
 on-line monitoring 319
 odour impact compounds 132, 133–136
 chemical reactions 136–139
 lipid oxidation 136, 137–138
 Maillard reaction 136, 137
 thiamine degradation 136, 137–138
 ohmic heating 303
 oiliness, skin 319
 oleic acid 188
 olfactory receptors 128
 on-frame-ageing and boning time 110
 optoelectrical sorting for turkey PSE 337–341
 Oregon disease see deep pectoral myopathy
 organic acids
 carcass decontamination 288–289
 marinading 302
 packaging film impregnation 307
Salmonella typhimurium reduction 299
 ovens 408
 oxidative stability of meat 205
 oxygen 298
 high-pressure 306
 oxygen scavengers 306
 oxymyoglobin 298, 305
 packaging
 carbon dioxide 305
 edible 307
 film 306–307, 309
 high-oxygen modified-atmosphere 305
 in-pack indicators 307
 modified-atmosphere 305–307, 309
 oxygen scavengers 306
 scavengers 309
 shelf-life extension 304–307, 309
 vacuum 308
 paired comparison test 361–362
 pale, soft, exudative (PSE) 37, 42, 85
 ante-mortem stress 225
 colour 169
 on-line monitoring 319, 320
 optoelectrical sorting 337–341
 post-mortem glycolysis 87
 paleness of meat 350
 ante-mortem handling 225–226
 L* values 225–226
 light scattering techniques 332–337
 palmitic acid 198, 199
 palmitoleic acid 198, 199
 paratyphoid infection 257
 parvalbumin 76–77
 pathogenic microorganisms 277, 278
 pectoralis major muscles 233
Pediococcus cerevisiae 301
 percussive stunning 423

- peripheral nerve lesions 36
 peroxy compound 265
 pH
 ante-mortem handling 226–227
 aroma-forming reactions 140, 141
 light scattering measurement of
 post-mortem changes 332–333
 muscle after stunning 239, 241
 muscle colour 169
 myosin gelation 391
 phenolic compounds 139
 phosphates
 intracellular 71
 tenderization 353
 phospholamban 74
 phospholipase AU2u 86
 phospholipids 142, 200
 plasmalogen 139
 phosphorus, dietary 188, 189
 physical entrapment theory 379–380
 physical load on muscle 44
 picking, delayed 119
 pigment absorption, flock health 166
 pigment analysis, direct 163–164
 pigment content evaluation 161
 pigmentation 161
 carotenoid 319
 skin 166
 pinking 298
 plasmalogen phospholipids 139
 plucking 242, 282
 polyunsaturated fatty acids (PUFA) 207
 see also n-3 PUFA
 porcine stress syndrome (PSS) 37, 79–80
 postslaughter treatment, flavour 150
 potassium channel disorders 34
 poultry
 production industry 3
 strain variation in flavour 144–145
 world meat production/consumption
 397, 398, 399
 Poultry Breeding Flocks and Hatcheries
 (Testing and Registration) Order
 (1989) 268
 poultry house, standard of cleaning 266
 preservatives, shelf-life extension 300–301
 pro-oxidants 197
 Processed Animal Protein Order (1989) 269
 processed products
 muscle protein functional properties 377
 see also further-processed poultry
 processing
 procedure effects on meat texture 109–119
 standards 413, 414
 technology 282
 product life 413–414
 production regime 148–149
 progressive muscular dystrophy 83
 protein
 gelation 384–385
 myofibrillar 381
 see also muscle protein
 proteolysis, postmortem 106
 n-3 PUFA 207
 increasing meat content 200–203, 205
 tocopherol effects on feed levels 208, 209
 pullorum disease 257
 PureBright process 304
 quality of meat 231–233
 adipose distribution 318
 age 179–180, 181, 182
 biophysical attributes 316
 colour of muscle 318
 conditioning 317
 connective tissue 317, 320–322, 323,
 324–328
 cooking losses 328–332
 defects 232
 electrical stunning 421
 emulsifying capacity 320
 environmental influence 188–190
 fat colour 319
 laser scattering 333–336
 light scattering for paleness and colour
 332–337
 muscle pathology 318
 myopathies 87–88
 nutrition 185–188
 on-line assessment 315–316
 on-line traits 316–320
 PSE 319, 320
 optoelectrical sorting 337–341
 sensory assessment 359–373
 sex 179–180, 181, 182
 taste 319
 toughness 316
 water-holding capacity 328–332
 Z-line degradation 327
 R values 101
 electrical stunning 112–113
 electrocution 114
 Radio-Frequency (RF) cooker 408
 ragged-red fibres 26, 27
 rancidity 138, 298
 oxidative 203, 297
 ranking tests 366
 rear limb necrotizing myopathy 41
 reflectance colorimetry 164–166
 regeneration of muscle fibre 25, 26
 regulatory factor proteins 11
 relative-ischaemia syndrome (RIS) 40
 response elements 10
 retailing 413–414
 retinol 428

- rhabdomyolysis 78
 ribose 137, 138, 139, 142
 ribose-5-phosphate 137
 rigor 100
 ARP post-mortem depletion 101
 carcass temperature 103, 104
 cold shortening 105
 development 239–241, 347–348
 electrical stimulation 116
 gas stunning 240–241, 352
 high-temperature ageing 111
 muscle change 100–102
 muscle contraction 99
 muscle stiffness 338
 onset 101
 pH of muscle 101, 102, 104
 post-mortem shortening 101, 102
 resolution 103
 temperature 348
 tenderness 348–349
 thaw 105–106
 wing flapping during gas stunning 240
 Roche yolk colour fan 162, 163
 rodents 266–267
 ryanodine receptor gene 31, 34
 defect 52
 ryanodine receptor (RyR) 37, 68, 69–71, 79, 80
 avian 80–81
 calcium channel 68, 70, 76
 calcium release 51
 defects 43–44, 50
 DHP association 69
 gene expression 70
 isoforms 70–71, 80
 S100 75
 safety, shelf-life extension 307–308
Salmonella enteritidis 257, 258, 261
 confirmed incidents 271
 contaminated units 265
 control 266
 environmental contamination 263–265
 eradication measures 160
 PT 4 epidemic 271
 rodent spread 266–267
 serological tests 269
 transmission 260
 vaccination 270–271
Salmonella gallinarum 257
Salmonella infection 221, 257–258
 animal feeds 269
 biosecurity 267–268
 birds 267
 breeding flock 260
 chicks 262–263
 confirmed incidents 271
 cycle 259
 detection 269
 disinfection 265–266
 egg contamination 260
 environmental contamination 263–266
 hatchery 260–263
 insects 267
 mandatory testing in US 280
 monitoring 270–271
 origins 259–260
 persistence 264
 rodents 266–267
 sanitization of equipment 262–263
 serological tests 269
 status of flock supplying eggs 261
 statutory controls 268
 stress factors 279, 280
 trans-shell invasion 260
 trisodium phosphate decontamination
 289
 vaccination 270–271
 ventilation system 263
 wildlife 266–267
Salmonella pullorum 257
Salmonella typhimurium 258, 271
 trisodium phosphate spraying of
 carcasses 209
 salmonellosis 257
 saltiness 128
 sample presentation for sensory evaluation
 360
 Saran foil 427
 sarcomere 4, 6
 meat toughness 103
 sarcomere length 316
 boning 110
 determination for meat tenderness 108
 electrical stimulation 117–118
 shortening 103, 348
 sarcoplasmic and endoplasmic reticulum
 Ca²⁺-ATPase see SERCA
 sarcoplasmic reticulum 66, 67
 calcium release 66, 67–69
 ryanodine-sensitive calcium release
 channel (SR-RSCRC) 79, 80
 satellite cells 8, 52–53
 sausages, gourmet 407–408
 scalding in processing stages 282
 scavengers, packaging 409
 second messengers 71
 selective breeding 37
 calcium homeostasis in turkey muscle 51
 selenium
 deficiency 43
 vitamin E 210
Senna occidentalis 84
 sensory assessment of meat quality 359–373
 category scales 367–373
 sample presentation 360
 sensory panels 359–360
 tests 360–367

- sensory characters of meat tenderness 107-108
- sensory evaluation of irradiated chicken 427
- sensory panels 359-360
- sensory profile
descriptive of deboned poultry 429
methods 369-373
- sensory properties of meat, stunning method 250-251
- sensory tests 360-367
'A' - 'not A' test 364-366
duo-trio test 363-364
paired comparison 361-362
ranking tests 366
triangular 362-363
two from five test 366-367
- SERCA 73-74
- serine 139
- sex
flavour 147
live production factors 179-180, 181, 182
quality of meat 179-180, 181, 182
yield 179-180, 181, 182
- shear resistance of cooked meat 106
- shear tests for meat tenderness 107
- shear values
electrical stimulation 116, 117, 118
electrical stunning 113
electrocution 114
post-mortem 102
sensory profiles 371-372
deboned poultry 429
tenderness 409
wing restraint 111
- shelf-life extension 297-298
airborne transfer of microorganisms 299-300
automation 310
cooking/heating 302-303
high pressure 304
hygiene 308, 309
marinading 301-302, 308
microbial contamination 309
microwaves 303
packaging 304-307, 309
physical approaches 302-304
preservatives 300-301
raw meat 299-300
safety implications 307-308
spray-chilling 309
strategies 308-310
temperature 300, 308
- skin
appearance with heat-based decontamination 425-426
body fat 182
damage and litter conditions 190
oiliness 319
skin colour 166-167
- assessment 160, 162
guide 163
- skinless products 167
- slaughter
blood loss 236-239
hygiene 282
muscle contraction 234
treatment effects on flavour 150
- slaughterhouse, microbial input 279
- smell sense, flavour 127
- sodium, overload 86
- sodium channel disorders 34
- sodium-calcium ion exchanger 72, 73
- somatic gene transfer 3, 14
- sonication 304
- sour taste 129
- sous vide 303
- spectrophotometry *see* fiberoptic spectrophotometry
- spray-chilling 299
- sprays 286, 288
- SR-RSCRC, myopathy 86
- stabilizers, packaging film impregnation 306-307
- Staphylococcus aureus* 290
- statutory controls, *Salmonella* infection 268
- steam
decontamination of carcass meat 286, 288
under vacuum 304
- stearic acid 199
- stocking density
crates 246
flavour 149
meat influence 190
transport of poultry 219
- storage period, flavour 150
- stress
ante-mortem 225
factors 279-280
meat colour 168
pre-slaughter 227
- stress-induced muscle injury 86-87
- stress-induced myopathy 85
- stunning
ATP-depletion in muscle 250
batch in transport crates 246
carcass appearance defects 241-242, 243-244, 244-246
filleting time 248, 249-250
methods 235-236
muscle contraction 234
muscle pH 239, 241
novel system 423
percussive 423
sensory profiles 370
water bath 425
wing flapping 241
see also electrical stunning; gas stunning

- subjective panel evaluation of meat tenderness 107-108
- sudden death syndrome of chickens 51, 85
- sugars
Maillard reaction precursors 137
taste compounds 128-129, 130-131
- supercontact freezing 309
- surface heating patterns, carcass 427
- sweetness 128-129
- T-tubule membrane 66, 67
depolarization 68, 69
- tar-oil mixture spray 265
- taste
aroma-forming reaction precursors 139-140
on-line monitoring 319
receptors 128
sense 127
- taste compounds 128-131
age 147
cooking 130-131
temperature, ageing 111
- temperature, body
aroma-forming reactions 140-141, 142
holding conditions of lairage 223-224, 225
myosin gelation 391
odour compounds 141
rigor 105, 348
shelf-life extension 300
weight loss during marketing 219
- temperature, environmental 43-44
meat influence 188, 190
shelf-life extension 308
- tenderization 317
belt flattener 119, 353
blade 353
mechanical 119
methods 353
polyphosphate/NaCl combination 353
tension-induced 111
- tenderness 100
deboning 348-349
rigor 348-349
shear value 409, 435
- tenderness of meat
cooking 106
gap filaments 106
glycolysis 104
instrumental measures 107
pH change 104
post-chill ageing time 109
post-mortem proteolysis 106
rigor onset 102
sarcomere length 103, 108, 316
sensory characters 107-108
subjective panel evaluation 107-108
- tensile tests, meat tenderness 107
- texture of meat 99-100
ageing temperature 111
ante-mortem handling 226-227
breast muscle tensioning 110-111
chilling 111
electrical stimulation 111, 116-119
electrical stunning 112-114
electrocution 113-114
filleting time 248, 249-250
gas stunning 114-116
measurement 106-108
mechanical tenderization 119
on-frame-ageing and boning time 110
post-mortem muscle biochemistry 100-106
processing procedures 109-119
stunning method 247-250
wing restraint 111
- texture profile analysis (TPA) 107
- thaw rigor 105-106
- thermal stress *see* heat stress
- thiamine degradation 136, 137-138
- thigh muscles, fibre types 180
- thiobarbituric acid (TBA) number 204-205, 206, 207, 209
- thyroid hormone (T3) 10
- α -tocopherol
poultry feed supplementation 207-208, 428
see also vitamin E
- toughness 316
prevention
electrical stimulation 351-352
gas stunning 352-353
- toxic myopathies 43, 84
mitochondrial 84
- transgene technology 13-14
- transgenic biology 3
- transport myopathy *see* turkey leg oedema
- transport of poultry
bruising in cages 222
Campylobacter contamination 281
food withdrawal 219
hygiene 281
mortality in transit 218-219
stocking density 219
temperature 219
thermal stress 218
trauma 218
water withdrawal 219
weight loss during marketing 219-220
- triacylglycerols 138, 200
- triadin 69
- triangular test 362-363
- trigeminal response 129
- trisodium phosphate
decontamination of carcass meat 286, 289, 291, 292

- trisodium phosphate *continued*
 spraying of carcasses against *Salmonella typhimurium* 299
- tropomyosin 9, 66
 troponin C (TnC) 76
 troponins 9, 66
 turkey leg oedema 40
 turkey muscle, leg 51
 turkey muscle abnormalities
 calcium-based muscle damage 51–52
 commercial breeding 45–46
 growth-induced myopathy 48–49
 hyaline fibres 49, 50
 hypercontracted fibres 50
 inherent muscle fibre defects 50
 muscle cohesion 50
 muscle fibre size 46–47
 normal (wild) turkeys 45
 rapid growth 45–50
 rapid postnatal growth 44–51
 selection 44–51
 turkey muscle diseases 38–51
 capture and handling myopathy 41
 deep pectoral myopathy 38–39
 degenerative myopathy 39
 experimental pathologies 43–44
 focal myopathy 40
 hereditary muscular dystrophy 41–42
 ionophore-induced myopathy 42–43
 leg oedema 40
 nutritional myopathy 43
 rear limb necrotizing myopathy 41
 relative-ischaemia syndrome 40
 toxic myopathy 43
 see also pale, soft, exudative (PSE)
 two from five test 356–357
- ulcerative dermatitis 190
 ultrasonic energy meat decontamination 286, 291
 ultraviolet light meat decontamination 286, 290
 unami 127, 128, 129
 uncooked-chilled segments 400
 USDA/Food Safety Inspection Service
 Pathogen Reduction Programme 280
- vaccination, *Salmonella* infection 270–271
 vasculitides 32
 ventilation system 263
 vinculin 317
 visual defects, colour 169, 170, 171
 visual standards for meat defects 163
- vitamin B₁₂ *see* thiamine
 vitamin C 197
 vitamin E 43, 83, 207
 dietary 207–208, 433
 fishy taint prevention 208
 flavour effects 148
 selenium 210
 tissue membrane deposition 207
- warmed-over flavour 138, 288, 428
 Warner-Bratzler shear values 107, 429
 washing
 cold water of carcasses 287
 deluge 286, 288
 water, re-use 282
 water bath stunning
 bleed out kinetics 425
 physical recovery 425
 water binding 377
 water withdrawal
 transport of poultry 219
 weight loss 219, 220
 water-holding capacity 223
 ante-mortem handling 226–227
 meat quality 328–332
 white muscle disease 43
 wildlife, *Salmonella* infection 266–267
 wing flapping
 gas stunning 240
 muscle haemorrhage 245
 stunning 241
 wing restraint 111
 wingtips, red 241, 421
- xanthophyll 162, 167
- Yersinia enterocolitica* 307
 yield
 age 179–180, 181, 182
 deboning 350–351
 environmental influence 188–190
 genetic improvement 182
 nutrition 185–188
 sex 179–180, 181, 182
 yolk colour rotor 162–163
- †
 Z-disc
 degradation 106
 rigor 103–104
 Z-line 317
 zein 307
 zero-tolerance measures, hygiene 280

Poultry Meat Science

Edited by R.I. Richardson, Division of Food Animal Science, university of Bristol, UK
and G.C Mead, Department of Farm Animal and Equine Medicine and Surgery,
The Royal Veterinary College, UK

This book is the result of the 25th Poultry Science Symposium held at the University of Bristol in September 1997. Each symposium in this series is devoted to a specific topic within the field of poultry science. Meat science has not been dealt with in great detail since Symposium 15, Meat Quality in Poultry and Game Birds. In a still expanding industry whose end product is quality meat, revisiting this field is timely.

This authoritative volume reviews its subject in style which is comprehensible to the non-specialist. Contributions are all invited and are written by leading authorities in their fields, from Europe and north America. Specific topics in avian meat science are treated in turn. Basic knowledge is restated succinctly and details of the latest research in those areas is then provided. This combination makes the book suitable for both advanced students and lecturers in meat science, and others such as graduate students of avian and comparative physiology. It will also be of interest to technical managers in the poultry industry.

Cover illustration with permission from the
Burrell Collection, Glasgow Museums

Distributed by
RESEARCHCO BOOK CENTRE
25B/2, New Rohtak Road, Karol Bagh,
New Delhi - 110 005
Tel.: 28712565, 55150445
Fax.: 91-11-28716134
Email - researchco@dishnetdsl.net

ISBN 81-902320-3-7



9 788190 232036