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**GLUCONO- δ -LACTONE - INDUCED GELATION
OF SOME MEAT COMPONENTS AT
CHILLED TEMPERATURES**

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requirements for the degree of Doctor of Philosophy
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ABSTRACT

In this study, 1,5-glucono- δ -lactone, was used to achieve acid-induced gelation of meat, myofibrillar protein and myosin at 4°C. The mechanisms of gelation of myofibrillar protein and myosin were investigated. The effects of addition of sodium chloride and tetrasodium pyrophosphate to myosin and myofibrillar protein, with and without 1,5-glucono- δ -lactone, were also studied. In addition, the presence of other phosphates, orthophosphate, tripolyphosphate and hexametaphosphate, in a myosin system were studied to aid in an understanding of the the observed effects of tetrasodium pyrophosphate on myosin.

At about pH 4.5, it was observed that extraction of the A-band of myofibrillar protein occurred. It was suggested that an impregnated composite system of myosin reinforcing the myofibrillar structure had formed. At about pH 4.0, complete extraction of the A-band occurred. Dissolution of the myofibrillar structure was suggested to result in myosin network formation of weaker Young's Modulus than the impregnated composite system.

Addition of 1,5-glucono- δ -lactone to myosin resulted in the exposure of hydrophobic sites as the pH decreased and it was suggested that acid-induced denaturation had occurred. Gel formation occurred parallel to denaturation. At pH 4.0, the gel became liquid-like and was suggested to be a result of excess repulsive electrostatic interactions. Hydrogen bonding and hydrophobic interactions were shown to be involved in gel formation, whereas sulfhydryl bonding appeared not to be involved in gelation. Sodium chloride was postulated to enhance gel rigidity through its effects on the isoelectric point of myosin. The inclusion of tetrasodium pyrophosphate resulted in network formation prior to acid-induced denaturation and was suggested to enhance hydrogen bonding.

The acid-induced gels appeared to revert to myosin or myofibrillar protein when immersed in quiescent water, a condition where unimpeded diffusion of ions was obtained. However, a slow rate of ion diffusion resulted in the formation of a 'strong', translucent gel which was dense to the point of being effectively impermeable to ion migration. These gels were hypothesized to have formed through the displacement of sodium and potassium ions with protons, enhancing hydrogen bonding. Myosin was observed to have a stronger affinity for sodium than for potassium.

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LIST OF CONTENTS

	Page
ABSTRACT	i
ACKNOWLEDGEMENTS	ii
LIST OF CONTENTS	iii
LIST OF FIGURES	ix
LIST OF TABLES	xiv
ABBREVIATIONS	xvi
CHAPTER 1 INTRODUCTION	1
CHAPTER 2 LITERATURE REVIEW	5
2.1 Meat	5
2.1.1 The composition of muscle	5
2.1.2 The gross structure of muscle	6
2.1.3 The ultrastructural organisation of muscle	6
2.1.4 Myosin	9
2.1.5 The proteolytic subunits of myosin	13
2.1.6 Other major myofibrillar proteins	16
2.2 D-Glucono- δ -lactone	17
2.3 Gelation	18
2.4 Restructuring research	22
2.4.1 Fresh meat restructuring	22
2.4.2 The function of muscle proteins in heat gelation	23
2.4.2.1 Myosin and actin	26
2.4.2.2 Myosin subfragments and subunits	28
2.4.2.3 Other muscle proteins	30
2.4.2.4 Physicochemical changes in myosin molecules during gelation	32
2.4.3 Factors affecting heat-induced gelation of myosin in model systems	40
2.4.3.1 Myosin concentration	40
2.4.3.2 Myosin isoforms	41
2.4.3.3 Ionic strength	42
2.4.3.4 The pH value	44
2.4.3.5 Cations	45

3.2.4.3	Gel preparation	76
3.2.4.4	Rheological investigations	77
3.2.4.5	Measurement of pH	77
3.2.4.6	Fluorescence	77
3.2.4.7	Light microscopy	78
3.2.4.8	Transmission electron microscopy (TEM)	78
3.2.4.9	Van Slyke reaction	79
3.2.5	Dialysis	79
3.2.5.1	Myosin, myofibrillar protein and minced meat dialysis	79
3.2.5.2	Tensile tests	80
3.2.5.3	Measurement of pH	80
3.2.5.4	Inductively coupled plasma (ICP) emission spectrometry	80
CHAPTER 4	GdL-INDUCED GELATION OF MYOFIBRILLAR PROTEINS	81
4.1	Introduction	81
4.2	Results	82
4.2.1	Preparation of myofibrillar proteins	82
4.2.2	Minced meat gelation	83
4.2.3	Myofibrillar protein gelation with hydrochloric acid	83
4.2.4	Myofibrillar protein gelation with GdL	84
4.2.5	The effect of sodium chloride on gelation	89
4.2.6	The effect of TSPP on gelation	91
4.2.7	The effect of addition of NaCl and TSPP	94
4.2.8	Soluble protein measurements	96
4.2.9	Transmission electron microscopy (TEM)	98
4.2.10	Laser diffraction experiments	98
4.3	Discussion	103
4.3.1	Gelation	103
4.3.2	The phenomenon of events over the gelation time course	105
4.3.3	Effects of NaCl and TSPP	114
4.3.3.1	The effect of NaCl	114
4.3.3.2	The effect of TSPP	118
4.3.3.3	The effect of TSPP and NaCl	118
4.3.4	A postulated sequence of events	120

CHAPTER 5	GdL-INDUCED GELATION OF MYOSIN	123
5.1	Introduction	123
5.2	Results	124
5.2.1	Purity of the myosin preparation	124
5.2.2	The effect of addition of glucono- δ -lactone (GdL)	124
5.2.2.1	The rheological effect of addition of GdL to myosin	124
5.2.2.2	The effect of GdL addition on fluorescence	127
5.2.2.3	Microscopy of GdL-induced myosin gels	130
5.2.3	The effect of addition of sodium chloride	130
5.2.3.1	The effect of sodium chloride on the rheological characteristics of myosin gels	130
5.2.3.2	The effect of NaCl addition on fluorescence	137
5.2.3.3	The effect of NaCl on myosin gel structure	137
5.2.4	The effect of addition of tetrasodium pyrophosphate (TSPP)	141
5.2.4.1	The effect of TSPP on the rheological characteristics of myosin gels	141
5.2.4.2	The effect of TSPP addition on fluorescence	143
5.2.4.3	The effect of TSPP addition on gel structure	148
5.2.5	The effect of addition of TSPP and NaCl	148
5.2.5.1	The effect of TSPP and NaCl on the rheological characteristics of myosin gels	148
5.2.5.2	The effect of TSPP and NaCl on fluorescence	154
5.2.5.3	The effect of NaCl and TSPP on the structure of myosin gels	154
5.2.6	The effect of sulfhydryl-blocking agents on the rheological characteristics of myosin gels	154
5.2.7	The effect of sugars on the rheological characteristics of myosin gels	158
5.3	Discussion	164
5.3.1	ANS fluorescence	164
5.3.2	Bohlin rheology	166
5.3.3	True gels or entanglement networks?	169
5.3.4	GdL addition - the phenomenon of events over the pH time course	173
5.3.5	Addition of NaCl and TSPP	176
5.3.5.1	The effect of addition of NaCl	176
5.3.5.2	The effect of addition of TSPP	180
5.3.5.3	The effect of addition of NaCl and TSPP	187
5.3.6	Bonding in gelation	188
5.3.6.1	Hydrogen bonding	189

5.3.6.2	Sulphydryl bond formation	190
5.3.7	A postulated sequence of events	192
5.3.7.1	Discussion of contradictory results	193
5.3.7.2	A postulated sequence of events	198
CHAPTER 6	THE EFFECT OF PHOSPHATES ON GdL-INDUCED MYOSIN GELATION	202
6.1	Introduction	202
6.2	Results	204
6.2.1	The effect of addition of TSPP on myosin gelation	204
6.2.2	The effect of addition of different phosphates on myosin gelation	205
6.2.3	The effect of addition of nitrite	207
6.3	Discussion	209
6.3.1	Theories to explain the effect of phosphates on the functionality of meat proteins	209
6.3.2	The effect of addition of phosphates on GdL-induced gelation of myosin	215
6.3.3	Summary	220
CHAPTER 7	THE REVERSIBILITY OF GdL-INDUCED GELS OF MYOSIN	223
7.1	Introduction	223
7.2	Results	224
7.2.1	Myosin dialysis	224
7.2.2	Analysis of washed and dialysed myosin	227
7.2.3	Dialysis of myofibrillar proteins	232
7.2.4	Dialysis of minced meat	234
7.3	Discussion	234
7.3.1	Myosin gel reversibility	234
7.3.2	Myofibrillar protein and minced meat gel reversibility	239
7.3.3	Summary	240
CHAPTER 8	DISCUSSION	242
8.1	Discussion of results	242
8.2	Future work	255
CHAPTER 9	CONCLUSIONS	258

REFERENCES	262
APPENDIX 1	292
APPENDIX 2	297
APPENDIX 3	298

LIST OF FIGURES

	Page
2.1 Hierarchies of muscle structure	7
2.2 A sketch and a section of a muscle	8
2.3 The components of the sarcomere	11
2.4 The myosin molecule	12
2.5 Schematic explanation for the appearance of three light chain bands, instead of two, in polyacrylamide gels of myosin purified from adult rabbit skeletal muscle.	14
2.6 The proteolytic subunits of myosin	15
3.1 A typical SDS-PAGE gel	75
4.1 Time development of Young's Modulus	85
4.2 Time development of springiness	85
4.3 Gels of myofibrillar protein in the presence and absence of GdL, NaCl and TSPP	87
4.4 Time development of Young's Modulus with addition of 2.3% NaCl	90
4.5 Time development of springiness with addition of 2.3% NaCl	90
4.6 Development of Young's Modulus with increasing NaCl concentration	92
4.7 Development of springiness with increasing NaCl concentration	92
4.8 Time development of Young's Modulus with addition of 0.3% TSPP	93
4.9 Time development of springiness with addition of 0.3% TSPP	93
4.10 Time development of Young's Modulus with addition of 2.3% NaCl and 0.3% TSPP	95

4.11	Time development of springiness with addition of 2.3% NaCl and 0.3% TSPP	95
4.12	Immediate soluble protein content of myofibrillar gels	97
4.13	Soluble protein content of myofibrillar gels at 24 h	97
4.14	Transmission electron micrographs of myofibrillar protein (pH 5.8)	99
4.15	Transmission electron micrographs of myofibrillar protein with 3.6% GdL added (pH 3.8)	100
4.16	Transmission electron micrographs of myofibrillar protein with 2.3% NaCl added (pH 5.6)	101
4.17	Transmission electron micrographs of myofibrillar protein with 2.3% NaCl and 3.6% GdL added (pH 3.8)	102
4.18	Transmission electron micrographs of raw muscle (pH 5.54)	110
4.19	Transmission electron micrographs of acidified raw muscle (pH 4.48)	111
4.20	Transmission electron micrographs of acidified raw muscle (pH 3.92)	112
5.1	The development of the G' of myosin gels at 0.70% GdL	126
5.2	The development of G' of myosin gels at varied GdL concentrations	126
5.3	Fluorescence development of myosin solutions at 0.025% GdL	128
5.4	Fluorescence and pH development of myosin solutions at 0.025% GdL	128
5.5	Fluorescence development of myosin solutions at varied GdL concentrations	129
5.6	Comparison of rheological and fluorescence data	129
5.7	Transmission electron micrographs of myosin (pH 6.8)	131
5.8	Transmission electron micrographs of myosin with GdL (pH 4.3)	132
5.9	The development of G' of myosin gels at 0.70% GdL and 2.50% NaCl	135
5.10	The development of G' of myosin gels at 2.50% NaCl and varied GdL concentrations	135
5.11	The development of G' of myosin gels at 0.70% GdL and varied NaCl concentrations	136

5.12	Fluorescence development of myosin solutions at 0.025% NaCl and varied GdL	136
5.13	Fluorescence and pH development of myosin solutions at 0.025% GdL and 0.025% NaCl	138
5.14	Fluorescence development of myosin solutions	138
5.15	Fluorescence development of myosin solutions at 0.025% GdL and varied NaCl	139
5.16	Comparison of rheological and fluorescence data	139
5.17	Transmission electron micrographs of myosin with 2.50% NaCl and 0.70% GdL added (pH 4.0)	140
5.18	The development of G' of myosin gels at 0.70% GdL and 0.25% TSPP	144
5.19	The development of G' of myosin gels at varied GdL concentrations and 0.25% TSPP	144
5.20	The development of G' of myosin gels at 0.7% GdL and varied TSPP concentrations	145
5.21	Fluorescence development of myosin solutions at 0.002% TSPP and varied GdL concentrations	145
5.22	Fluorescence and pH development of myosin solutions at 0.025% GdL and 0.002% TSPP	146
5.23	Fluorescence development of myosin solutions at 0.025% GdL and varied TSPP concentrations	146
5.24	Comparison of rheological and fluorescence data	147
5.25	Transmission electron micrographs of myosin with 0.25% TSPP (pH 7.8)	149
5.26	Transmission electron micrographs of myosin with 0.25% TSPP 0.70% GdL added	150
5.27	Development of G' of myosin gels at varied GdL concentrations with 0.25% TSPP and 2.50% NaCl	152
5.28	Development of G' of myosin gels at 0.70% GdL and 2.5% NaCl or 0.25% TSPP	152
5.29	Development of G' of myosin gels at 1.40% GdL with 2.50% NaCl and 0.25% TSPP	153

5.30	Fluorescence and pH development of myosin solutions at 0.025% GdL, 0.025% NaCl and 0.002% TSPP	155
5.31	Comparison of fluorescence data of myosin solutions and G' data of myosin gels	155
5.32	Transmission electron micrographs of myosin with 2.50% NaCl, 0.25% TSPP and 0.70% GdL added (pH 4.2)	156
5.33	Development of G' of myosin gels at 0.70% GdL and 2.5% NaCl	159
5.34	Development of G' of myosin gels at 0.70 GdL and 0.25% TSPP	159
5.35	Development of G' of myosin gels at 0.70% GdL, 2.50% NaCl and 0.25% TSPP	160
5.36	Development of G' of myosin gels at 0.70% GdL and 0.25% TSPP	160
5.37	Development of G' of myosin gels at 0.70% GdL	162
5.38	Development of G' of myosin gels at 0.70% GdL and 0.25% TSPP	162
5.39	Development of G' of myosin gels at 0.70% GdL and 2.50% NaCl	163
5.40	Mechanical spectra of a gel, a weak gel and an entanglement network.	170
5.41	Strain dependence of the shear modulus for a weak gel, an entanglement network and a strong gel	171
6.1	The development of G' of myosin gels with added phosphates	209
6.2	Time development of G' of myosin gels with added phosphates	209
7.1	Transmission electron micrographs of myosin gels with 0.70% GdL, after dialysis (pH 5.7)	228
7.2	Transmission electron micrographs of myosin after dialysis (pH 5.7)	229
7.3	Transmission electron micrographs of myosin gels with 0.70% GdL and 2.50% NaCl, after dialysis	230
8.1	The sequence of events of GdL-induced myofibrillar gelation	244
8.2	The sequence of events in GdL-induced myosin gelation	247
8.3	The sequence of events in GdL-induced myosin gelation with added TSPP	250

A1.1	A light micrograph of myosin at 100x magnification and using NDIC	293
A1.2	A light micrograph of myosin with added 0.70% GdL at 100x magnification and using NDIC	293
A1.3	A light micrograph of myosin with added 2.50% NaCl at 100x magnification and using NDIC	294
A1.4	A light micrograph of myosin with added 0.70% GdL and 2.50% NaCl at 100x magnification and using NDIC	294
A1.5	A light micrograph of myosin with added 0.25% TSPP at 100x magnification and using NDIC	295
A1.6	A light micrograph of myosin with added 0.70% GdL and 0.25% TSPP at 100x magnification and using NDIC	295
A1.7	A light micrograph of myosin with added 0.70% GdL, 2.50% NaCl and 0.25% TSPP at 100x magnification and using NDIC	296

LIST OF TABLES

	Page
2.1 The amino acid composition of myosin (moles/10 ⁵ g)	10
2.2 Selected properties of the proteolytic subunits of myosin	16
2.3 Structural bonding found in proteins and protein gels	21
2.4 Research related to the bind of restructured meat products	24
2.5 Transition temperatures of myosin	33
4.1 Qualitative characteristics and final pH measurements of myofibril gels	86
5.1 Results obtained from the rheological study of GdL-induced myosin gels	125
5.2 Results obtained from the rheological study of GdL-induced myosin gels in the presence of NaCl	133
5.3 Results obtained from the rheological study of GdL-induced myosin gels in the presence of TSPP	142
5.4 Results obtained from the rheological study of GdL-induced myosin gels in the presence of TSPP and NaCl	151
5.5 Rheological data obtained from GdL-induced myosin gels with added PCMB	157
5.6 Rheological data obtained from GdL-induced myosin gels with added DTT	158
5.7 Rheological data obtained from GdL-induced myosin gels with added sugars	161
6.1 A summary of rheological data of myosin gels formed with added phosphates	206
6.2 The degree of dissociation of phosphates	218
6.3 Characteristics of the phosphates used and calculated data relating to the phosphates	218

7.1 Results of tensile tests of GdL-induced myosin gels	226
7.2 ICP analysis of dialysates of washed and unwashed dialysed myosin and myosin with 0.7% GdL addition	232
7.3 Tensile test of dialysed myofibrillar gels	233

ABBREVIATIONS

Abbreviations of units

A	amps
C	coulombs
°C	degrees Celsius
Da	daltons
g	gram(s)
h	hour(s)
Hz	hertz
J	joules
l	litre(s)
m	metre
M	molar
min	minute(s)
mol	mole(s)
N	Newtons
Pa	pascals
rad	radians
rpm	revolutions per minute
s	second(s)
v	volume
V	volts
w	weight
W	watts

Other Abbreviations

A1	alkali light chain one
A2	alkali light chain two
ADP	adenosine diphosphate
ANS	8-anilino-1-naphthalenesulfonic acid
AR	analytical reagent grade
ATP	adenosine triphosphate
bis	N,N'-methylene-bis-acrylamide
BSA	bovine serum albumin
CD	circular dichroism
CPA	<i>cis</i> -parinaric acid
DSC	differential scanning calorimetry
DTNB	5,5'-dithiobis(2-nitrobenzoic acid)
DTT	dithiothreitol
e.d.	external diameter
EDTA	ethylenediaminetetraacetic acid

EGTA	ethylene glycol-bis(β -aminoethyl ether) N,N,N',N'-tetraacetic acid
G'	storage modulus
G''	loss modulus
G*	complex modulus
GdL	glucono- δ -lactone
HMM	heavy meromyosin
HMP	hexametaphosphate
i	imaginary number = $(-1)^{1/2}$
i.d.	internal diameter
ICP	inductively coupled plasma
IEP	isoelectric point
LMM	light meromyosin
MHC	myosin heavy chain(s)
MW	molecular weight
N	total number of monomers
NDIC	Nomarski differential interference contrast
OP	sodium dihydrogen orthophosphate
OR	optical rotary dispersion
Pc	number density of crosslinkers at the point of incipient gelation
PCMB	p-hydroxy-mercuribenzoic acid
PD	denatured protein
PN	native protein
PPase	pyrophosphatase
PVC	polyvinyl chloride
PVDC	polyvinylidene chloride
q	charge
r	distance separating q
RFI	relative fluorescence intensity
S-1	fragment of HMM containing the head portion
S-2	fragment of HMM between the head and LMM
SDS	sodium dodecyl sulfate
SDS-PAGE	sodium dodecyl sulfate - polyacrylamide gel electrophoresis
SEM	scanning electron microscopy
t	time
TEM	transmission electron microscopy
TEMED	N,N,N',N'-tetramethylethylenediamine
T _m	transition temperature
TPP	tripolyphosphate
Tris	tris(hydroxymethyl)aminomethane
TSPP	tetrasodium pyrophosphate
UV	ultra-violet
Vc	number of crosslinked or branched monomers
WHC	water holding capacity
x	number of protein molecules
Xn	weight average degrees of polymerisation

δ	phase angle
γ	shear strain
γ_0	strain amplitude
$\dot{\gamma}$	strain rate
τ	shear stress
τ_0	stress amplitude
ω	angular frequency