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WHEY PROTEIN AND SATIETY IN HUMANS

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

in

Nutritional Sciences

at Massey University, Manawatu campus, Palmerston North, New Zealand.

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2013



Abstract

Protein is the most satiating macronutrient and there is an effect of dietary protein source, with dairy whey protein being particularly effective in promoting satiety in adult humans. The underlying cause for this remains to be elucidated. The objectives were to confirm that whey protein is more satiating than maltodextrin carbohydrate in adult humans, to understand the potential mediating factors and to investigate which characteristic of whey protein gives rise to its satiating effect. *Ad libitum* food intake at a subsequent test meal after administration of a preload, subjective feelings of appetite (using visual analogue scales) and plasma concentrations of satiety-related hormones and metabolites were determined. Preload diets enriched with whey protein induced a greater reduction in subsequent food intake and suppression in rated feelings of appetite compared with maltodextrin carbohydrate ($p < 0.05$). The time of consumption of the whey protein preload did not influence the satiety response. Plasma concentrations of pancreatic polypeptide hormone, total amino acids, and the branched-chain amino acids appear to play an important role in mediating the satiating effect of whey protein (sustained increases from 15 to 120 min following preload consumption, $p < 0.05$). To determine the underlying characteristic of whey protein causing the satiating effect, the effects on satiety of whey protein components (glycomacropeptide, alpha-lactalbumin, or beta-lactoglobulin) and a free amino acid mixture simulating the amino acid composition of the whey protein were compared with that of the intact whey protein. The amino acid composition of whey protein *per se* appears to be important in the regulation of food intake and the induction of satiety. The individual constituent proteins or whey protein itself did not promote higher satiety than that found based on providing the free amino acids. The absorbed amino acid profile would appear to play an important role in mediating the satiating effect of whey protein.

Acknowledgements

This PhD was undertaken at the Riddet Institute (formerly Riddet Centre) and the Institute of Food, Nutrition and Human Health (IFNHH), at Palmerston North, New Zealand.

I extend my sincerest gratitude to my supervision team: Distinguished Professor Paul J. Moughan, for welcoming me on his nutrition team and all his guidance as my chief supervisor, Dr Sharon J. Henare for taking over the role of supervision from Dr. Ajay Awati and for her encouragement and the helpful discussions, and Dr Siva Ganesh (AgResearch Grasslands Research Centre) for his statistical input and inspiring me to look at my data in a different manner.

I would like to gratefully acknowledge the Massey University Human Ethics Committee for approval of my human trials (Protocol no. 06/59, 08/38 and 11/47). I would like to thank Dr Mark Williams and Mrs Rosalind Timms (Massey Medical Centre), Mrs Maria-Tine Biersteker and Mrs Chris Booth (IFNHH) for their assistance with my human trials. I am thankful for Ying Jin, Christina Streicher, Jacinta Lee, Heleen van Dijke, Chanapha (Nok) Sawatdeenaruenat, Natascha Strobinger, Mehak Dhillon, and Sumon Saha for their technical support with my human trials. I would also like to thank Professor Marlena Kruger (IFNHH) for the use of the Human Nutrition Research Unit for my human trials. A special thanks to the men and women who volunteered to take part in the studies, I am sincerely grateful.

I am extremely grateful to Dr Barbara Rolls (Pennsylvania State University, US) for her advice in the design and conduct of my first study (Chapter 2). I also express my deep sense of gratitude to Associate Professor Hugh R. Morton (School of Sports and Exercise, Massey University) for his valuable advice on statistical analysis and support in the publication of my first journal article (Chapter 2, *Physiology & Behavior*, 2009, 96, 162–8).

I am thankful to the Massey University Animal Ethics Committee for approval for my rat trial (Protocol no. 12/07). I would like to extend my thanks to Associate Professor Craig Johnson (Institute of Veterinary, Animal and Biomedical Sciences, Massey University) for his valuable support in receiving approval. I am thankful to Dr Carlos Montoya, Dr Jason Hindmarsh and Mr Trent Olson for their assistance.

I would like to thank everyone at the Riddet Institute for their support during my PhD, in particular Dr Shane Rutherford for his scientific advice on amino acid determination and input for the manuscript, Dr Derek Haisman and Mr Vikas Mittal for their guidance with product formulation, Miss Maggie Zou for her valuable assistance in performing the determination of amino acid in plasma samples and Dr Prabhu Balan for his kind support in preparing the ELISA assays and providing me with his dissertation. I am also thankful to all based at the Institute of Food Nutrition and Human Health for their help, especially Mrs Fliss Jackson, Miss Leiza Turnbull and Mrs Elizabeth Maforimbo for chemical analysis and Mr Garry Radford and Mr Warwick Johnson for the use of the food laboratories.

I am extremely thankful to New Zealand Starch Ltd. for providing me with free samples of maltodextrins, Fonterra Co-operative Group Ltd. for supplying me with free samples of whey protein isolates, Davisco Foods International Inc. for providing free samples of glycomacropeptide, alpha-lactalbumin and beta-lactoglobulin and Evonik Industries AG for the enormous donation of individual pure free amino acids.

I am truly thankful to the Riddet Institute for the financial support through a PhD Riddet Scholarship award and funding for my PhD research as part of the Centre of Research Excellence projects. I also thank the Riddet Institute and New Zealand Nutrition Society for their assistance with conference attendance.

I would not have completed my PhD without the love and blessings from my family and friends. I am extremely thankful to my parents Joseph and Elie

Chung Chun Lam for their constant love and support, to my siblings: Cathy, Juliana and Bryan for their encouragement and to my parents-in-law Ross and Suzanne Lawrence for their motivation and support during this PhD journey. My greatest thanks go to my husband, James Lawrence who gave me the strength and encouragement to complete this PhD research. I am dedicating my PhD dissertation to my son, Wesley Lawrence. Thank You.

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List of Abbreviations

~	Approximately
α	Alpha
α -la	Alpha-lactalbumin
β	Beta
β -lg	Beta-lactoglobulin
γ	Gamma
κ	Kappa
5-HT	Serotonin
A-LA	Alpha-lactalbumin
AA	Amino acid
ADA	American Diabetes Association
AgRP	Agouti-related peptide
AMPK	Adenosine monophosphate-activated protein kinase
ANOVA	Analysis of variance
AOAC	Association of Official Chemists
ARN	Arcuate nucleus
ATP	Adenosine triphosphate
AUC	Area under the curve
B-LG	Beta-lactoglobulin
BCAA	Branched-chain amino acid
BMI	Body mass index
BSA	Bovine serum albumin
C	Carbohydrate
Carb	Carbohydrate

CART	Cocaine- and amphetamine-regulated transcript
CCK	Cholecystokinin
CMP	Caseinomacropeptide
CNS	Central nervous system
CRF	Corticotrophin releasing factor
DIT	Diet-induced thermogenesis
DPP-IV	Dipeptidyl-peptidase-IV
E	Energy
EAA	Essential amino acid
EDTA	Ethylenediaminetetraacetic acid
EFSA	European Food Safety Authority
ELISA	Enzyme-linked immunosorbent assay
F	Fat
FAO	Food and Agricultural Organisation
FFA	Free fatty acids
GE	Gross energy
GIP	Glucose-dependent insulinotropic polypeptide
GLP-1	Glucagon-like peptide-1
GMP	Glycomacropeptide
HC	High-Carbohydrate
HF	High-Fat
HP	High-Protein
HPLC	High-performance liquid chromatography
iAUC	incremental area under the curve
IFNHH	Institute of Food, Nutrition and Human Health
Ig	Immunoglobulin
J	joule

kcal	kilocalorie
kJ	kilojoule
MC	Melanocortin
ME	Metabolisable energy
MJ	megajoules
mTOR	rapamycin
NP	Normal-Protein
NPY	Neuropeptide Y
NTS	Nucleus tractus solitaries
NW	Normal-weight
OPA	o-phthalaldehyde
OW	Overweight
P	Protein
PKU	Phenylketonuria
POMC	Pro-opiomelanocortin
PP	Pancreatic polypeptide
Pro	Protein
PYY	Peptide tyrosine-tyrosine
SE	Standard error of mean
sem	Standard error of mean
T/LNAA	Tryptophan Large neutral amino acids ratio
UNU	United Nations University
VAS	Visual analogue scales
WHO	World Health Organisation
WP	Whey protein
WPI	Whey protein isolate