Effect of various whey protein supplements on recovery from prolonged endurance exercise in trained cyclists

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ABSTRACT

Background:

Protein-containing recovery beverages are proposed to support an athlete's recovery from exercise through stimulation of insulin release, promoting the restoration of muscle glycogen stores, and stimulation of protein synthesis and muscle protein restoration.

Objective:

The present study aimed to determine, (1) whether there is an insulinotropic effect of whey proteins, when consumed in addition to carbohydrate, which is assumed to enhance muscle glycogen resynthesis and (2) whether a blend of hydrolysate and intact protein, when consumed in addition to carbohydrate, will enhance the athlete's recovery from exercise.

Design:

Twelve trained top level cyclists repeated a protocol on four consecutive weeks, during which either a control beverage (Carb) or three beverages containing whey protein (carbohydrate and intact protein (Carb + I); carbohydrate and protein hydrolysate (Carb + H; carbohydrate and intact protein : protein hydrolysate mix (Carb + M)) were consumed during recovery from exhaustive endurance exercise. The beverages were formulated to supply 1.2 g/kg/hour carbohydrate and 0.4 g/kg/hour protein. Subjects followed a controlled diet two days before each experimental day. On the experimental day the athletes each performed a glycogen-depleting exercise programme, then received the designated dietary beverage every 30 minutes for the first two hours post-exercise. The progress of recovery was monitored via the measurement of cardiovascular recovery, and the appearance and relative concentration of metabolites in blood (15 samples over a four hour period, obtained via an indwelling cannula) and urine samples (13 samples over a seven hour period) collected sequentially during the post-exercise recovery period.

Results:

Plasma albumin concentrations were significantly lower following consumption of beverages containing whey protein (Carb + H, $p<0.01$; Carb + M, $p<0.05$) compared to

that observed with the Carb beverage. Urine output was significantly higher after consumption of the Carb beverage than with any of the three-protein containing beverages (Carb + I, $p<0.01$; Carb + H, $p<0.05$; Carb + M, $p<0.05$) during the period of controlled fluid consumption. Heart rate recovery was found to be significantly greater following consumption of the three protein-containing beverages (Carb + I, $p<0.001$; Carb + M, $p<0.001$, Carb + H, $p<0.01$) than following consumption of the Carb beverage. The Carb + M beverage produced increased heart rate recovery ($p<0.001$) compared to that observed following consumption of the other two protein-containing beverages (Carb + I, Carb + H). Following correction of the data for haematocrit, to account for the hydration status of the athletes, a significant difference ($p<0.05$) in the ratio of plasma insulin to plasma glucose concentrations was found following consumption of any of beverages containing whey protein (Carb + I, Carb + H, Carb + M) compared to that observed for the Carb beverage. Consumption of the Carb + I beverage resulted in significantly higher concentrations of urinary nitrogen excretion as urea ($p<0.05$) and ammonia ($p<0.01$), and significantly higher plasma concentrations of the amino acids Valine, Leucine, Isoleucine, Phenylalanine, Tryptophan, and Tyrosine ($p<0.05$).

Conclusions:

The addition of whey protein to a carbohydrate-containing beverage stimulated enhanced recovery from exercise. A major factor in the improved recovery was increased rehydration following consumption of the protein-containing beverages, mainly due to the high sodium content of these beverages. This increased rehydration was shown to influence results for plasma insulin and plasma glucose concentrations where, after accounting for the hydration status of athletes, a difference between consumption of the Carb beverage and that observed for any of the three protein-containing beverages was observed. The results also allude to a potential benefit of protein hydrolysates over intact protein on protein recovery. Consuming a protein mix (Carb + M) also appears to improve heart rate recovery compared to consuming either intact (Carb + I) or hydrolysed (Carb + H) proteins individually. The results of this study highlight the importance of dietary protein on enhancing recovery from endurance exercise.

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Approval for this research has been obtained from both the Massey University Ethics Committee and the Manawatu-Whanganui Ethics Committee for the experiments described in this thesis.

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LIST OF ABBREVIATIONS

Carb	Carbohydrate Only
Carb + H	Carbohydrate + Whey Protein Hydrolysate
Carb + I	Carbohydrate + Intact Whey Protein
Carb + M	Carbohydrate + 50% Whey Protein Hydrolysate + 50% Intact Whey Protein
ACSM	American College of Sports Medicine
ADA	American Dietetic Association
ANP	Atrial Natriuretic Peptide
BWT	Body Weight
DEB	Dietary Electrolyte Balance
DM	Dry Matter
DOC	Dietitians of Canada
GLUT	Glucose Transporter Carrier Proteins
FAO	Food and Agriculture Organization of the United Nations
ISAK	International Society for the Advancement of Kinanthropometry
TCA	Tricarboxylic Acid
UNU	United Nations University
VO_{2peak}	Peak Oxygen Uptake
W_{max}	Maximum Power Output
WHO	World Health Organisation

GENERAL INTRODUCTION

Athletes around the world continually strive for that elusive edge that will give them victory over their fellow competitors. This search for the perfect performance is epitomised by the foundations of the modern Olympic Games and Olympism. The International Olympic Committee defines Olympism as…

> *"... a philosophy of life, exalting and combining in a balanced whole the qualities of body, will and mind. Blending sport with culture and education, Olympism seeks to create a way of life based on the joy found in effort, the educational value of good example and respect for universal fundamental ethical principles." (International Olympic Committee, 2004, p.9)*

An athlete's performance is influenced by a multitude of factors, ranging from their genetic makeup and their physical fitness, through to motivational levels and the desire to succeed. Nutrition is another such factor which, while a relatively new science in terms of sports nutrition, now has a strong focus within the sport science research community. With the commercialism of sport, athletes have a lot to gain from the spoils of victory, ranging from the personal satisfaction gained years of training and effort, through to financial rewards. This has led to the development of a 'win at all costs' attitude, which has often taken athletes down the path of performance enhancing ergogenic aids, many of which are banned by the International Olympic Committee and the World Anti-Doping Agency. With nutrition, however, there are many dietary factors that have the potential to provide the athlete with an ergogenic, or performance-enhancing effect. Dietary protein definitely falls into this category, and its potential has recently been further enhanced through the development of manufacturing processes which produce protein forms that are well suited to an athletes physiological needs. While protein intake is traditionally associated with strength-based athletes, it is now evident that the protein requirement of endurance athletes is also increased due to a combination of exercise-induced muscle damage and the use of protein as a fuel source.

Throughout history, athletes have trialled nutritional strategies, focused on dietary protein, that have resulted in both in enhancement and detriment of athletic performance. One of the most famous accounts of food consumption relates to Milos, a five-time Olympic Cretan wrestler champion (552-516 B.C.), who had a reported daily meat intake of 10kg per day (Maughan & Burke, 2000). Following the 1936 Berlin Olympics, it was stated that athletes frequently focused on the intake of meat and on average took in nearly half a kilogram of meat per day, with pre-event meals consisting of steak and eggs, supplemented with meat-juice (Schenk, 1936, cited in McArdle, Katch & Katch, 1999). This large consumption of protein by athletes, in the form of meat, has more recently been replaced with specially formulated protein supplements, which provide the athlete with a more convenient and healthier option.

Dietary protein supplementation is now common place both amongst athletes and the wider population, with a focus related to both exercise and weight loss. It also represents a major part of a world-wide, multi-million dollar supplement industry. In relation to athletes, there is a common belief that protein consumption has significant benefits on both performance and recovery from exercise. Yet uncertainty still remains with regard to the best form of dietary protein to use and when is the optimal time for its consumption (generally related to an exercise session). To date, nutritional research has been focused around both pre-exercise and during exercise nutritional strategies for maximising performance. However, due to the demands of modern sport, nutritional strategies focused on maximising recovery from exercise are of increased importance. It is during this post-exercise recovery period that the true benefits of protein consumption are becoming more evident. The potential benefit of protein to the recovering athlete relates to achieving maximal training adaptations, in addition to ensuring that exercise performance is not impaired due to any lingering effects from a previous exercise session.

There is still a lot to learn about the true extent that dietary protein intake may have on the recovering athlete. This study looks to extend the current knowledge related to the effect of dietary protein in exercise recovery, with a focus on the use of different forms of whey protein (intact and hydrolysed) on post-exercise recovery of endurance athletes.