

**THE EFFECT OF MCT + CHO + L-CARNITINE
SUPPLEMENTATION ON THE PERFORMANCE AND
METABOLIC RESPONSES OF MARATHON
ATHLETES**

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**SUBMITTED TO THE FACULTY OF MEDICINE
DEPARTMENT OF PHYSIOLOGY
UNIVERSITY OF PRETORIA**

*In partial fulfilment of the requirements for the degree Magister
Scientiae (Physiology), Pretoria, South Africa, 1996.*

CONTENTS

Page No.

ACKNOWLEDGMENTS.....	v
ABSTRACT.....	vii
OPSOMMING.....	ix
ABBREVIATIONS.....	xi
LIST OF TABLES.....	xiii
LIST OF FIGURES.....	xiv

CHAPTER 1: BACKGROUND AND STUDY OBJECTIVES

1 INTRODUCTION.....	1
2 MEDIUM-CHAIN TRIGLYCERIDES.....	8
2.1 Properties.....	8
2.2 Clinical use and applications.....	10
2.3 Medium-chain triglyceride metabolism.....	11
2.3.1 Absorption and transport.....	11
2.3.2 Hepatic metabolism.....	14
2.3.3 Extrahepatic metabolism.....	16
2.4 Energy from medium-chain fatty acids.....	16
3 L-CARNITINE.....	18
3.1 Biosynthesis and metabolism.....	18
3.1.1 Chemical composition.....	19
3.1.2 Methylation in the body - the role of magnesium.....	20
3.2 Carnitine absorption and distribution.....	23
3.3 Renal carnitine handling.....	23
3.4 Functions of carnitine.....	25

3.5	The role of carnitine in fatty acid metabolism.....	26
3.5.1	Transport and activation of fatty acids.....	26
3.5.2	The role of carnitine in long-chain fatty acid metabolism.....	27
3.5.3	The role of carnitine in medium-chain fatty acid metabolism.....	29
3.6	The effect of exercise on carnitine.....	31
3.7	The influence of L-carnitine administration on physical exercise.....	34

CHAPTER 2: SUBJECTS, MATERIALS AND METHODS

1	SUBJECTS.....	36
2	PRELIMINARY ANALYSES.....	36
2.1	Nutritional analysis.....	36
2.2	Anthropometric evaluation.....	36
3	EXPERIMENTAL DESIGN.....	37
4	LABORATORY TESTS.....	41
4.1	VO ₂ max exercise test.....	41
4.2	Blood analyses.....	43
4.3	Serum organic acid extractions.....	47
4.4	Plasma carnitine determinations.....	47
5	SUPPLEMENTATION.....	48
5.1	Supplement I - MCT + CHO.....	48
5.2	Supplement II - MCT + CHO + L-carnitine.....	52
6	STATISTICAL ANALYSIS.....	53

CHAPTER 3: RESULTS

1	GENERAL RESULTS.....	54
1.1	Physical characteristics.....	54
1.2	Training distances.....	54
1.3	Dietary analyses.....	55

2	BLOOD ANALYSES.....	59
2.1	Plasma analyses - Technikon Dax system.....	59
2.2	Serum lipid profiles.....	62
2.3	Serum organic acid profiles.....	63
2.3.1	Non-esterified fatty acid and L-lactate.....	63
2.3.2	β -OH-butyric acid.....	72
2.4	Plasma carnitine concentrations.....	74
3	PERFORMANCE.....	78
3.1	Marathon results.....	78
3.2	VO ₂ max exercise test results.....	79
3.2.1	VO ₂ max.....	80
3.2.2	Peak treadmill running speed.....	80
3.2.3	Respiratory exchange ratio.....	84
3.2.4	VCO ₂	84
3.2.5	VO ₂	87
3.2.6	Heart rate.....	87

CHAPTER 4: DISCUSSION

1	DIETARY ANALYSES.....	90
2	BLOOD ANALYSES.....	92
2.1	Nutritional status parameters.....	92
2.2	Serum organic acid profiles: non-esterified fatty acid and L-lactate concentrations.....	94
2.3	Plasma carnitine concentrations.....	99
3	PERFORMANCE.....	102
3.1	Marathon results.....	102
3.2	VO ₂ max.....	103
3.3	Peak treadmill running speed.....	104
3.4	Respiratory exchange ratio.....	104
3.5	VCO ₂	106
3.6	VO ₂ and heart rate.....	107



4	CONCLUDING REMARKS.....	109
5	FINAL CONCLUSION AND RECOMMENDATIONS.....	114
	APPENDIX A: INFORMED CONSENT FORM.....	115
	APPENDIX B: LOGFORM.....	118
	APPENDIX C: DAILY DIET.....	119
	REFERENCES.....	120

ACKNOWLEDGEMENTS

THIS RESEARCH PROJECT WAS MADE POSSIBLE BY PVM PRODUCTS PTY (LTD)

I wish to acknowledge the following persons and institutions for assistance and support during this research project:

Prof. MC Kruger - Promoter (Department of Physiology, University of Pretoria) - All the valuable time afforded to me, her unstinted guidance and unfailing support and advice at all times. It was an honour to be her student.

Dr. Henry Davis - His assistance, time and interest - especially regarding the evaluation of athletes - not forgetting his support given to me and the athletes during many freezing winter mornings.

Mr. Chic Howell (PVM Products) - His time and meticulous attention to detail in the preparation of the supplements. All his valuable advice, as well as for the editing and proof-reading of the text.

Dr. Jacques Rossouw - Co-promoter (Department of Sport Science, Technikon Pretoria) - For negotiating the use of facilities (i.e. at Potchefstroom University, Technikon Pretoria), the valuable time afforded and advice given during the final phase of the project.

Mr. and Mrs. Rheeder (PVM Products) - For their trust in me by supporting the project and making it possible.

Department of Physiology, University of Pretoria (Prof. DH van Papendorp)

Department of Chemical Pathology, University of Pretoria (Prof. H Vermaak)

Department of Biochemistry, Potchefstroom University (Prof J Minnie)

Ms. Salome Jooste (Department of Biochemistry, Potchefstroom University) - An analyses procedure used in this study was developed and performed by her. I thank her for her valuable time and patience.

Ms. Annetjie vd Merwe (Department of Chemical Pathology, University of Pretoria) - For the efficient manner in which she assisted me with the logistics of several analyses.

Mr. Daan du Toit (Arcadia Athletics Club) - His enthusiasm and assistance with the transport and monitoring of the athletes during the project.

Mr. Wayne Viljoen and Ms. Yolande Burger (Department of Sport Sciences, Technikon Pretoria) - Who spent many an hour conducting the exercise tests.

Ms. Dirkie Pienaar (PVM Products Dietitian) - For her assistance with the dietary analyses.

Dr. Helene Rossouw (Department of Chemical Pathology, University of Pretoria)- For her assistance with the editing of a concept article for publication.

Mr. Justus Dirks - For his assistance with graphical representations.

Mr. Nico Claassen - Who assisted me with statistical analyses.

My Parents - For their prayers, encouragement and support throughout.

The ALMIGHTY without whom nothing is possible.

ABSTRACT

Endurance athletes have long benefited from ingesting carbohydrates prior to, and during endurance events. Fatigue during endurance exercise has repeatedly been associated with the depletion, or reduction, of bodily carbohydrate reserves. The improved endurance capability observed after aerobic training has, however, been attributed to the increased oxidation of fat relative to carbohydrate, thereby having a “carbohydrate sparing” effect and thus delaying the point at which reduced carbohydrate reserves will cause fatigue. This study was therefore designed to investigate the effects of medium-chain triglyceride (MCT) and carbohydrate (CHO) supplementation, on the performance and metabolic parameters of nine male marathon athletes. These results were then statistically compared to the effects of adding L-carnitine to the MCT and CHO supplement, on the same parameters. Metabolic parameters included nutritional status evaluations, serum organic acid profiles (non-esterified fatty acid and L-lactate profiles), and plasma carnitine determinations. Performance was measured in terms of peak treadmill running speed, VO_2 max, respiratory exchange ratios, heart rates, VCO_2 and VO_2 data during progressive treadmill exercise tests. Nutrition and energy intakes were recorded during the study, as well as record kept of the athlete’s training programmes. At the end of each supplementation period, a standard marathon was included in the experimental design, in order to practically validate controlled laboratory results.

The main findings of this study included the identification of two athletes as “fat burners”. Non-esterified fatty acid (NEFA) profiles indicated that they predominantly relied on fatty acid oxidation during exercise, after MCT supplementation. The latter presumably because of adaptive changes in their metabolism, enabling them to benefit from MCT supplementation. In spite of the majority of athletes relying on carbohydrate metabolism during exercise, the addition of L-carnitine to the MCT and CHO supplement, induced a shift towards lipid metabolism; evident from RER and VCO_2 data, as well as the majority of athletes improving their performance. The observed shift was slight; the latter

being ascribed to the relatively small dose of L-carnitine (compared to previous studies) included in the supplement. However, L-carnitine was incorporated into a palatable, liquid MCT and CHO supplement, and not merely administered in the form of a pharmacological dose.

A major, and extremely unexpected finding, was the presumed effect that the winter, and continuous cold exposure, had on plasma carnitine levels. Plasma carnitine levels decreased significantly, without any intervention, prior to the start of the second trial period, which stretched over the middle of winter. Despite carnitine supplementation, plasma carnitine levels still decreased. This occurrence most certainly influenced results; the shift towards lipid metabolism would presumably have been more pronounced, had the "winter factor" not come into play.

OPSOMMING

Menige langafstand atleet baat reeds dekades by die inname van koolhidrate voor- en gedurende wedlope. Die uitputting van die liggaam se glukogeenstore, word algemeen geassosieer met die intree van moegheid. Daarteenoor, word die verbetering in uithouvermoë a.g.v. aerobiese inoefening geassosieer met 'n verhoging in vetoksidasie, met 'n gevolglike "glukogeensparende" effek. Die punt waarby moegheid sou intree a.g.v. onvoldoende glukogeenreserwes, word dus uitgestel. Hierdie studie het derhalwe die effek van gekombineerde medium-ketting trigliseried en koolhidraatsupplementasie op die prestasie en metaboliese parameters van manlike maraton atlete ondersoek. Hierdie resultate is vervolgens statisties vergelyk met die effek verkry op dieselfde parameters, na die byvoeging van L-karnitien by dieselfde medium-ketting trigliseried en koolhidraat supplement. Metaboliese parameters het nutritionele status evaluasies, serum organiese suur profiele (vry vetsuur- en laktaat profiele), en plasma karnitien vlakke ingesluit. Prestasie is gemeet in terme van piek trapmeul hardloopspoed, VO_2 maks, respiratoriese kwosient waardes, harttempos, VCO_2 en VO_2 data. Dieetanalises is uitgevoer gedurende die studie, en daar is rekord gehou van die atlete se oefenprogramme. In 'n poging om gekontroleerde laboratorium resultate te verifieer, is 'n standaard maraton aan die einde van elke supplementasie periode in die studie ontwerp ingesluit.

Die hoofbevindinge van hierdie studie het die identifisering van twee atlete as "vet verbranders" ingesluit. Vry vetsuur profiele het aangetoon dat hierdie atlete na medium-ketting trigliseried supplementasie grootliks afhanklik was van vetsuur oksidasie gedurende oefening. Laasgenoemde was waarskynlik die gevolg van sekere adaptiewe metaboliese veranderinge, derhalwe kon hulle baat by die medium-ketting trigliseried supplementasie. Hoewel die meerderheid atlete steeds grootliks koolhidrate gedurende oefening verbruik het, het die byvoeging van L-karnitien (tot dieselfde medium-ketting trigliseried en koolhidraat supplement) gelei tot 'n verskuiwing na vetmetabolisme. Laasgenoemde blyk uit respiratoriese kwosient en VCO_2 data. Die meerderheid atlete se prestasie het ook verbeter na

die byvoeging van L-karnitien. Die verskuiwing na vetmetabolisme was gering, en dit is toegeskryf aan die relatiewe klein dosis karnitien wat in die supplement ingesluit is. Wat egter belangrik is, is dat L-karnitien geïnkorporeer is in 'n smaaklike, vloeistofvorm, medium-ketting trigliseried en koolhidraatsupplement, en nie bloot in die vorm van 'n farmakologiese dosis nie.

Die effek van die winter en voortdurende blootstelling aan koue op plasma karnitien vlakke, was 'n belangrike en onverwagte bevinding. Plasma karnitien vlakke het betekenisvol verskil na die vyf weke uitwasperiode tussen die twee suplementasie periodes, sonder enige intervensie. Hierdie periode het oor die middel van die winter gestrek. Plasma karnitienvlakke het gedaal, desondanks karnitien suplementasie. Hierdie verskynsel het resultate ongetwyfeld beïnvloed; die verskuiwing na vetmetabolisme sou waarskynlik meer duidelik gewees het, was dit nie vir die "winter effek" nie.

ABBREVIATIONS

ALP	-	Alkaline phosphatase
ALT	-	Alanine aminotransferase
AMP	-	Adenosine monophosphate
AST	-	Aspartate aminotransferase
ATP	-	Adenosine triphosphate
B1	-	Baseline 1
B2	-	Baseline 2
BCG	-	Bromcresol green
BMI	-	Basal metabolic index
BSA	-	Body surface area
BSTFA	-	Bis(trimethylsilyl) trifluoroacetamide
CHO	-	Carbohydrate
CoA	-	Coenzyme A
CPT	-	Carnitine palmitoyltransferase
ECG	-	Electro-cardiogram
EDTA	-	Disodium ethylenediamine-tetraacetic acid
FFA	-	Free fatty acid
GPO	-	Glycerol phosphate oxidase
GGT	-	Gamma-glutamyltransferase
HCL	-	Hydrochloric acid
HDL	-	High density lipoprotein
HMG-CoA	-	β -OH- β -methylglutaryl-CoA
HR	-	Heart rate
LCFA	-	Long-chain fatty acid
LCT	-	Long-chain triglyceride
LDH	-	Lactate dehydrogenase

LDL	-	Low density lipoprotein
MAT	-	Methionine adenosyltransferase
MCFA	-	Medium-chain fatty acid
MCT	-	Medium-chain triglyceride
MRC	-	Medical Research Council
NAD	-	Nicotinamide-adenine dinucleotide
NEFA	-	Non-esterified fatty acid
PEPC	-	Phosphoenolpyruvate carboxylase
PVM	-	Protein Vitamins Minerals
RER	-	Respiratory exchange ratio
SI	-	Supplement one
SII	-	Supplement two
SAM	-	S-adenosylmethionine
sd	-	Standard deviation
TMCS	-	Trimethyl-chlorosilane
UV	-	Ultra violet
VLDL	-	Very low density lipoprotein
Vit	-	Vitamin
6W1	-	Six week one
6W2	-	Six week two

LIST OF TABLES

Table		Page No.
1	Nutritional information PVM ENERGO.....	49
2	Nutritional information Supplement I.....	50
3	Bergabest MCT-oil composition.....	51
4	Chemical and physical data-Dimodan PV.....	52
5	Nutritional information Supplement II.....	53
6	Physical characteristics of athletes.....	54
7	Training distances of athletes.....	55
8	Dietary analyses of individual athletes.....	57
9	Plasma analysis - Technikon Dax system.....	60
10	Serum lipid profiles.....	62
11	β -OH-butyric acid concentrations.....	72
12	Plasma carnitine concentrations.....	74
13	Marathon results.....	78

LIST OF FIGURES

Figure	Page No.
1	Digestion and absorption of dietary lipid..... 12
2	The transport of medium-and long-chain triglycerides..... 13
3	A pathway illustrating the production and fate of ketone bodies..... 17
4	The structural formula of L-carnitine..... 19
5	The methylation pathway..... 22
6	The role of carnitine in the transport of fatty acids..... 28
7	Schematic presentation of experimental design..... 38
8a	VO ₂ max of individual athletes indicating baseline 1 and baseline 2 values..... 82
8b	VO ₂ max of individual athletes comparing trial period 1 and trial period 2..... 82
9a	Peak treadmill running speed of individual athletes indicating baseline 1 and baseline 2 values..... 83
9b	Peak treadmill running speed of individual athletes comparing trial period 1 and trial period 2..... 83
10a	Respiratory exchange ratios of individual athletes indicating baseline 1 and baseline 2 values..... 85
10b	Respiratory exchange ratios of individual athletes comparing trial period 1 and trial period 2..... 85
11a	VCO ₂ of individual athletes indicating baseline 1 and baseline 2 values..... 86
11b	VCO ₂ of individual athletes comparing trial period 1 and trial period 2..... 86



12a	VO ₂ of individual athletes indicating baseline 1 and baseline 2 values.....	88
12b	VO ₂ of individual athletes comparing trial period 1 and trial period 2.....	88
13a	Heart rates of individual athletes indicating baseline 1 and baseline 2 values.....	89
13b	Heart rates of individual athletes comparing trial period 1 and trial period 2.....	89