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

BY

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CONTENTS

Page No.

CHAPTER 4: DISCUSSION

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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 inneem 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 supplementasie periodes, sonder enige intervensie. Hierdie periode het oor die middel van die winter gestrek. Plasma karnitienvlakke het gedaal, desondanks karnitien supplementasie. 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	-	ß-OH-ß-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

LIST OF FIGURES