

Science Review:

Metabolic Effects of Medium-Chain Triglycerides

Introduction

Medium-chain triglycerides (MCT) are lipid molecules composed of a glycerol backbone and three medium-chain fatty acids (MCFA) whose chain lengths are between 6 and 12 carbon atoms.¹ Long-chain triglycerides (LCT), on the other hand, contain long-chain fatty acids (LCFA) whose chain lengths are 14 or more carbon atoms.¹ Because the digestion and absorption of MCT involve fewer biological steps than LCT (see mechanisms of action), MCT are easily absorbed and more rapidly transported to target organs for utilization, and little are stored in adipose tissue.¹⁻⁴ These characteristics have made MCT a valuable dietary ingredient in enteral and parenteral formula for patients suffering from impaired digestion of LCT since the 1950s.⁵

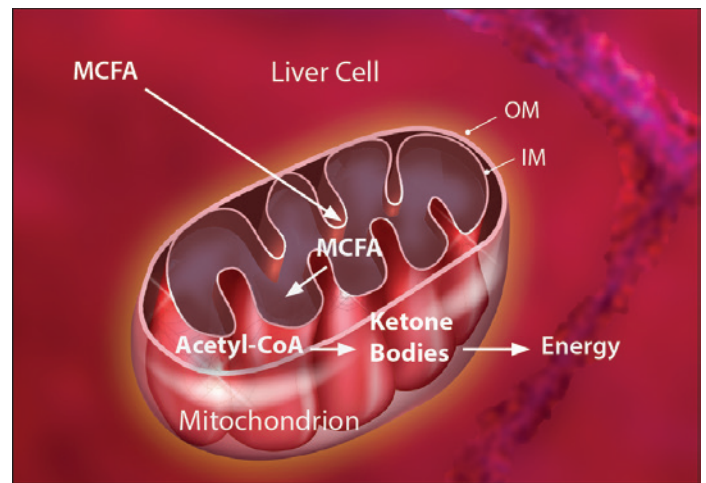
Because MCT are rapidly oxidized to acetyl-CoA, and higher concentrations of acetyl-CoA are conducive to ketone body formation,³ MCT were introduced as an alternative to fat in a ketogenic diet in the 1970s for the management of intractable childhood epilepsy.⁶ Recently, research has been interested in whether MCT may have other clinical applications for metabolic health.

Research Highlights

- ✓ Healthy subjects consuming 20-30 g/day MCT for 4 weeks showed enhanced ketogenic response, with plasma β -hydroxybutyrate increased 2.2-fold and acetoacetate increased 3.1-fold compared to baseline⁷
- ✓ A meta-analysis of 13 randomized controlled trials longer than 3 weeks found that replacement of LCT with MCT in the diet significantly decreased body weight, waist circumference, hip circumference, body fat, subcutaneous fat, and visceral fat⁸
- ✓ In men who were overweight, fat oxidation was enhanced postprandially following a MCT-rich diet compared to a LCT-rich diet⁹

Mechanisms of action

- Once ingested, MCT are rapidly digested in the small intestine to glycerol and MCFA.¹⁰ Unlike LCFA, MCFA can be swiftly transported in circulation to the liver without incorporation into chylomicrons¹
- MCFA can cross the mitochondrial membrane independent of the carnitine palmitoyltransferase (CPT) system.² Contrarily, CPT system is required for the transport of LCFA, therefore limiting the concentration of LCFA in mitochondria³
- These properties allow MCT to be rapidly oxidized to acetyl-CoA, and higher concentrations of acetyl-CoA are conducive to ketone body formation³
- MCT are oxidized to a greater extent than LCT, resulting in less opportunity for MCT deposition into adipose tissue⁴



MCFAs = medium-chain fatty acids, OM = outer membrane, IM = inner membrane
Image adapted from: Bach AC et al. *Am J Clin Nutr.* 1982;36(5):950-962.

Clinical research of MCT

Effect on ketone body production

- In healthy men, 35 g MCT given at lunch significantly increased plasma levels of β -hydroxybutyrate for 5 hours, with a peak at 60 minutes¹¹
- In healthy elderly subjects, a meal delivering 20 g MCT significantly increased circulating levels of β -hydroxybutyrate for 180 minutes¹²
- Healthy adult subjects consuming 20-30 g/day MCT for 4 weeks showed enhanced ketogenic response, with plasma β -hydroxybutyrate increased 2.2-fold and acetoacetate increased 3.1-fold compared to baseline⁷

Effect on individuals with increased BMI

- In healthy men who were overweight, an MCT-enriched diet (~21.5 g/meal MCT) for 4 weeks led to greater reductions in upper body adipose tissue compared with an LCT-enriched diet¹³
- In adult subjects who were overweight, a diet enriched with 18-24 g/day MCT oil for 16 weeks led to a greater reduction in body weight compared to the same diet enriched with olive oil⁴
- A meta-analysis of 13 randomized controlled trials longer than 3 weeks found that replacement of LCT with MCT in the diet significantly decreased body weight, waist circumference, hip circumference, body fat, subcutaneous fat, and visceral fat⁸

Effect on satiety and food intake

- In healthy men, including 35 g MCT oil at lunch significantly reduced food intake at dinner, compared with including LCT oil at lunch¹¹
- In men who were overweight, supplementation with 20 g MCT at breakfast and 10 g MCT during a pre-lunch snack significantly reduced next-meal food intake compared to LCT¹⁴
- In female subjects with obesity, a very low-calorie diet supplemented with 9 g/day MCT for 4 weeks increased postmeal satiety and reduced premeal and postmeal hunger and appetite scores compared with the same diet supplemented with LCT¹⁵

Effect on fat oxidation

- In a study in which healthy females (with normal weight or obesity) ingested either 30 g of LCT or 30 g of LCT-MCT mix, substitution of LCT with MCT resulted in more rapid and more complete lipid oxidation¹⁶
- In men who were overweight, fat oxidation was enhanced postprandially following a MCT-rich diet compared to a LCT-rich diet⁹

References:

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Conclusion

Unlike LCT, MCT are rapidly digested into MCFA, which do not require chylomicrons for transport and carnitine shuttle for entry into mitochondria.¹⁻⁴ These properties allow MCT to be rapidly metabolized to ketone bodies.³ MCT may help temporarily increase satiety and reduce food intake.^{11,14,15} Incorporating MCT into meals may be beneficial for the management of body weight and body composition.^{4,8,13}

