

L-CITRULLINE MALATE

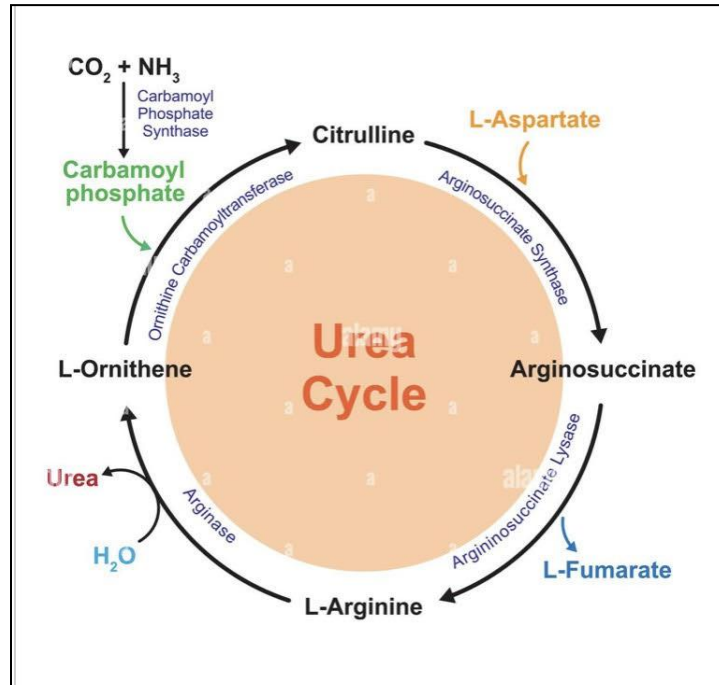
Introduction

Citrulline malate (CM), a combination of L-citrulline and malic acid (malate), is known to provide ergogenic (enhancing physical performance, stamina, or recovery) support regarding resistance training and high-intensity exercise (1). Additionally, Citrulline supplementation should have a positive effect on both mood and cognitive function (9). Citrulline comes from the Latin word *citrullus*, which means watermelon: the first food Citrulline was discovered in, first isolated in 1914 (7). L-Citrulline is a neutral, non-essential alpha-amino acid. L-Citrulline is not only an integral component of the urea cycle in the liver and kidneys, but also one of the pathways in nitric oxide production (2). As you might have guessed, watermelon, namely yellow watermelon (which boasts 3.5 milligrams (mg) per gram for the flesh and 1.5 mg per gram for the rind), is the highest natural source of L-Citrulline. Other notable food sources include cucumbers, pumpkins, and squash (7). Malic acid is an alpha hydroxy acid found in certain fruits like apples, cherries, grapes, or blackberries for instance (3). Malic acid is both sour and acidic, and interestingly, may help to clear away dead skin cells when topically applied. Additionally, its sourness promotes saliva production in people with dry mouth. Most notably, malic acid is involved in the Krebs (citric acid) cycle: an energy-producing pathway (3). The Krebs cycle takes place in the mitochondria, consuming oxygen, producing carbon dioxide and water as waste products, and converting ADP (adenosine diphosphate) into energy-rich ATP (adenosine triphosphate).

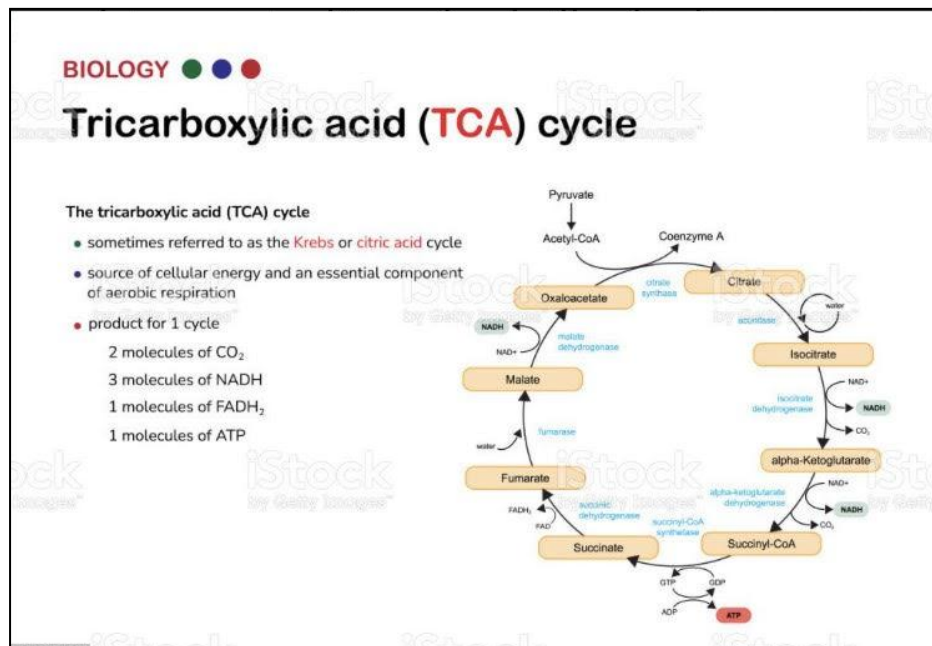
Mechanisms

L-citrulline is a precursor to L-arginine, and hence nitric oxide (NO). NO is a vasodilator, which improves the delivery of blood and oxygen to and from the muscles during exercise. It has long been believed that this mechanism of improved blood flow is responsible for Citrulline malate's beneficial effect on performance. Albeit, recent evidence suggests that enhanced blood flow is not the active mechanism responsible for CM's ergogenic effects. The ergogenic effects of CM are currently believed to be attributed to citrulline's ability to assist ammonia elimination during high-intensity exercise, malate's ability to increase ATP production, an increase in gene expression, or increased efficiency of the malate-aspartate shuttle (1).

Urea Cycle and Cit-NO Cycle (8)



The Krebs (Citric acid) cycle (5)



Bioavailability

The first pass effect is a phenomenon whereby the concentration of a compound, specifically when administered orally, is greatly reduced before it reaches the systemic circulation. It is the fraction of the compound that's lost during the absorption process, generally

via the liver and gut wall (6). L-citrulline has a lower first pass metabolism (presystemic metabolism) than L-arginine, meaning less of it gets metabolized before it can reach tissues to have an effect. Further, arginase is an enzyme that degrades L-arginine in the stomach and intestines (4). Arginase acts to form ornithine and urea from L-arginine, hence posing no benefit towards the conversion of L-arginine into nitric oxide. L-arginine supplementation triggers the action of arginase, hence diminishing L-arginine levels. Supplementing with L-arginine may elevate nitric oxide levels, but only for a relatively transient period (4). L- Citrulline on the other hand, promotes sustained elevation of L-arginine and nitric oxide levels.

Dosage:

Preliminary research suggests that 8 grams of CM ingested one hour before exercise enhances muscular endurance (repetitions to failure) in both men and women (1). Most research to date has used an acute dose of 8 grams of CM one hour before exercise at a 2:1 ratio of L- citrulline to malic acid respectively. While taking 8 grams of CM is proven to be effective when taken one hour before exercise, some evidence suggests that larger doses of up to 15 grams may confer additional benefit (1). Super U provides 8 grams of L-Citrulline Malate (2:1), with 45% improved absorption per the inclusion of AstraGin. This represents the equivalent of 11.6 grams in effect; a dosage strongly likely to provide ergogenic & potentially cognitive benefit.

Safety & Side Effects:

Ingestion of a range of CM doses (2–15 grams) has been demonstrated to have no adverse effects on hematological markers (1). Most health professionals agree that it's safe to take L-citrulline every day in the recommended dosage amounts (11). There are no reported side effects of L-citrulline. However, the supplement may affect the way certain drugs work in your body. Do not take this supplement if you are taking nitrates for heart disease, or ED drugs such as sildenafil (Revatio, Viagra), tadalafil (Cialis), or vardenafil (Levitra, Staxyn) (10). Discuss with your doctor if you are taking any medications or have any health conditions.

*These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, cure, or prevent any disease.

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