



# Nitric Oxide Boosters

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Literature Education Series On Dietary Supplements

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One of the latest categories of dietary supplements for athletes is nitric oxide (NO) boosters. In short, the concept is that nitric oxide helps regulate and direct muscle physiology by stimulating vasodilatation, which results in increased blood flow to working muscles. In turn, this leads to increased oxygen transport, delivery of nutrients to skeletal muscle, a reduction in blood pressure, helping to promote the repair of muscle fibers, and improvements in lactic acid clearance. So how does one boost NO levels?

## **Arginine, A-ARG & A-KIC**

The amino acid l-arginine is the answer. The main importance of l-arginine is considered to be its role as a precursor (building material) for the synthesis of NO.<sup>1</sup> Supplemental sources of l-arginine are thought to augment nitric oxide production<sup>2</sup>, with the result being a measurable increase in blood flow<sup>3</sup> (i.e., vasodilatation). The idea is that the beneficial results of this vasodilatation for athletes include increased oxygen transport, delivery of nutrients to skeletal muscle, muscle fiber repair, and improved endurance.

Thus far, dietary supplement products that are touted to boost NO generally include arginine alpha-ketoglutarate (A-ARG) and/or arginine-ketoisocaproate (A-KIC) as sources of l-arginine. Furthermore, these products are generally marketed to bodybuilders. This gives rise to the question, “Do these NO products really have any benefit for bodybuilders?”

## **Does it work?**

Honestly, I don't know. At least I haven't seen any studies conducted on bodybuilders (or any athletes) using l-arginine, A-ARG & A-KIC to boost NO levels, and promote muscle repair or endurance. However, the model upon which these products are based makes metabolic sense. Furthermore, if it does work then the primary benefit may turn out to be improved lactic acid clearance.

Any athlete can tell you that when lactic acid levels reach a critical level, muscle failure sets in, cutting your exercise session short and/or reducing your performance. Now consider that increased levels of lactic acid are present when oxygen delivery and arterial and venous oxygen contents are low.<sup>4</sup> Furthermore, consider that improvements in NO metabolism resulted in improved lactic acid clearance.<sup>5</sup> Of course this makes sense since NO improves blood flow, and improve blood flow brings fresh oxygen to augment lactic acid clearance. Theoretically an NO boosting supplement may help to do just that. As any athlete will acknowledge, an improvement in lactic acid clearance means an improvement in endurance.

## **ARG & KIC**

In any case, ARG and KIC each have benefits independent of l-arginine and NO boosting. For example, in animal research ARG has been shown to significantly improve endurance.<sup>6</sup> Also, human research has shown that KIC has nitrogen sparing effects<sup>7</sup>, helping to inhibit the breakdown of muscle protein.<sup>8,9</sup> This anti-catabolic effect may mean that less muscle tissue is damaged, allowing for a longer exercise session and quicker recovery. Furthermore, research has also indicated that ARG decreases lactic acid in cell mitochondria by increasing levels of oxygen uptake.<sup>10</sup>

## **Limitation**

Of course NO boosters are formulated to be used prior to exercise, which makes sense since increased blood flow during exercise is likely to provide performance enhancing results. However, there is one serious limitation. The key time for muscular repair is during sleep, and NO levels decline at night.

This means that NO's potential benefits of helping to promote muscle repair will not take place at the time when muscle is primarily repaired.

Now you may think, "No problem, I'll just take my NOX2 before I go to bed too." The problem with doing this is that by supplementing with just arginine a second time during the day, you may cause a decline in endogenously (in the human body) produced arginine. This would really be counterproductive to the goal of increasing NO. This is a potential limitation of NO boosters. However, there may be a solution to this limitation.

### Citrulline

The solution may be to use the amino acid citrulline in addition to A-AKG and A-KIC. Citrulline is actually a precursor to arginine. It is found primarily in the liver and is a major component of the urea cycle. Therapeutically it is used for the detoxification of ammonia, a byproduct of protein breakdown, and in the treatment of fatigue. In addition, at least one study has shown that citrulline significantly improved aerobic performance in athletes.<sup>11</sup>

The cool thing is that citrulline has the ability to increase plasma levels of arginine endogenously (in the human body).<sup>12</sup> And what is really so exciting about citrulline is that it seems to *increase plasma arginine levels better than taking the amino acid arginine itself*.<sup>13</sup> This is the basis to the use of citrulline for increasing NO.

By including citrulline, the benefits of NO may be extended into the night, which means a potential improvement in muscle repair and subsequent muscle growth---and this can occur without causing a decline in endogenously produced arginine.

### Conclusion

Although the NO promoting effects of A-AKG, A-KIC and citrulline supplements require research to firmly verify their benefits, there is great potential for bodybuilders and endurance athletes. That potential includes increased blood flow, increased oxygen transport, delivery of nutrients to skeletal muscle, helping to generate growth of new muscle fiber, and improvements in lactic acid clearance.

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