

PYRUVATE: A COMPREHENSIVE REVIEW ©1997 - 2007

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INTRODUCTION

Pyruvate is a dietary supplement targeting both sedentary and active individuals. The most popular claims for pyruvate center about its purported ability to: 1) "significantly" increase fat and weight loss; 2) improve exercise endurance capacity; 3) effectively reduce cholesterol, and; 4) serve as a potent antioxidant. However, these contentions are based mainly on faulty extrapolations of preliminary or inconclusive evidence.

Multi-level marketing supplement distributors and internet entrepreneurs, most without any formal training in nutrition, are leading the campaign with reckless abandon and little regard for the accuracy of their claims. Anecdotal testimonials from "satisfied" users permeate everything from internet websites to fitness magazines to television infomercials. While the mere mention of "scientific studies" is enough to impress the lay consumer, a critical review of the original research reveals a very different picture.

WHAT IS PYRUVATE?

Pyruvate is a three-carbon (triose) ketoacid produced in the end stages of glycolysis. It can be reduced to lactate in the cytoplasm or oxidatively decarboxylated to acetyl CoA in the mitochondrion (13). Simply, it is a product of sugar metabolism.

COMPARISON OF POPULAR CLAIMS TO ACTUAL RESEARCH

Claim: "Significantly increase fat loss by 48% and weight loss by 37%!"

Two human studies evaluated pyruvate's role as a fat and weight reductant (11, 12). In both investigations, treatment subjects lost more fat and weight than the control group, but only one found these percentages (11). Considerably smaller changes (23% greater fat loss and 16% greater weight loss) were noted in the other study (12). This claim is particularly misleading to consumers since these "significant" percentages actually amount to only a few pounds. The widely popular 48% translates to a mere 1.3 kg or 2.86 lbs and 37% is really 1.6 kg or 3.52 lbs--hardly the significant losses dieters have come to expect. Furthermore, these percentages have no practical relevance outside the context of a research article (How does a consumer quantify 48 and 37%?). A formal research environment differs from the real world in that the latter presents many confounding variables, so results (or lack thereof) may be attributable to factors unrelated to pyruvate supplementation.

The experimental protocol was extremely exclusive. All subjects were: 1) morbidly obese women; 2) housed in a metabolic ward for 21 days; 3) confined to bed except for walking to the restroom and kitchen; and 4) restricted to a 500 to 1,000 kcal liquid diet. As such, the results of these studies are specific to these criteria and cannot be reliably generalized to the population at large.

The relatively small differences observed in treatment subjects were induced by dosages considerably larger (22 to 28 grams of triose) than those available to consumers. Commercially available preparations provide about 500 mg to 1 gram of pyruvate, usually taken a few times a day for a daily intake of 3 to 5 grams. To date, no studies have been performed with such benign

dosages.

Claim: "Prevents fat regain and eliminates "yo-yo" effect"

This claim is based on a single study (5). Initial weight loss was induced by a 310 kcal diet followed by subsequent hypercaloric refeeding supplemented with large amounts of triose (15 grams of pyruvate and 75 grams of dihydroxyacetone). The treatment group gained 1.8 kg or 3.96 lbs (36%) less weight and 0.8 kg or 1.76 lbs (55%) less fat than the placebo group. However, for a number of reasons, these results cannot be accurately ascribed to the general public.

This study also employed morbidly obese women housed in a metabolic ward for 21 days while refraining from all physical activity. While results were statistically significant, they were physiologically negligible; that is, from an absolute standpoint the changes were relatively inconsequential.

Claim: "Significantly improve exercise endurance by 20%."

Stanko and colleagues found triose-supplemented (75 grams dihydroxyacetone and 25 grams pyruvate) subjects increased time to exhaustion by 20% during arm and leg ergometry protocols (9, 10). Unfortunately, these results are far from conclusive and should be considered, at best, preliminary.

First, both studies employed small numbers of untrained males; no large-scale investigations using trained subjects have been performed. Well-trained athletes present less intra- and inter-subject variability in performance which can increase the statistical power of the trial (2).

Second, the large amounts of pyruvate needed to elicit improvements ranged from 20 to 100 times the amounts found in supplements. Unfortunately, there is no evidence that the minuscule doses available to consumers exert any physiological effect.

Some marketers have generalized that pyruvate supplementation can improve performance across a broad spectrum of activities. However, such quantum leaps are inappropriate since these results are specific to arm and leg ergometry protocols. Different activities impose specific physiological and biochemical demands, and can vary in their motor unit recruitment patterns.

The point is that no one knows what effect it has, if any, on other sports; claims to the contrary are based solely on speculation.

Claim: "Shown to lower cholesterol."

Two studies (7, 8) investigated pyruvate's role as a cholesterol reductant; however, only one showed any change (8). Treatment subjects took (large doses) 36 to 53 grams of pyruvate over the course of six weeks while consuming a high fat (45 to 47%), high cholesterol (560-620 mg) diet. While the results in this study (8) showed small changes in total cholesterol (4%) and LDL cholesterol (5.4%), these effects were negated when subjects consumed a low-fat, low cholesterol diet (7).

It is not valid to state that pyruvate has been conclusively proven to reduce plasma lipids. While popular marketing literature leads consumers to believe that this is an effective treatment for hyperlipidemia, one study does not constitute a substantial body of evidence. No legitimate public health agency would ever make broad recommendations based on such scant evidence.

Claim: "Improves cardiac function and lowers blood pressure."

In one of the cholesterol studies (8), heart rate and diastolic blood pressure decreased by 9 and

6%, respectively; however, these changes were incidental to the research objectives and were not the main focus of the study. These preliminary findings should not be considered conclusive. Rather, they can serve as the impetus for future studies in this capacity. Unfortunately, marketers do not address this in their promotional literature.

Claim: "Pyruvate is a powerful antioxidant!"

The effect of pyruvate as an oral antioxidant has never been investigated. Two studies (1, 3) have shown its potential as an in-vitro antioxidant under tightly controlled experimental conditions; but extrapolating these results to humans is particularly misleading since isolated tissue culture (1) and post-ischemic heart models (3) are not the same as human trials. This is not to discount the relevance of these clinical findings; rather, the practical application of pyruvate as an oral antioxidant remains to be established.

Claim: Pyruvate is a "natural alternative" to Phen/Fen

This claim capitalizes on the American public's fear and distrust of the pharmaceutical industry. To understand why this comparison is invalid, it is necessary to look at how drugs and supplements are evaluated. A regulated drug must undergo extensive testing to evaluate its safety, toxicity, side effects. With the passage of the Dietary Supplement and Health Education Act of 1994, nutrition supplements can be sold to consumers without being tested for safety, efficacy, purity, or potency--although many consumers mistakenly believe that simply because it's available it must be safe and effective.

Even if they were on par with each other, pyruvate has never been clinically tested or proven to be more effective than Phen/Fen (or any other prescription weight loss medication). In light of Phen/Fen's 1997, removal from the market, many marketers are quick to trumpet its "effectiveness" over regulated pharmaceuticals. Clearly, a reliable comparison cannot be made.

FALSE AND MISLEADING CLAIMS

While the most popular claims are supported by limited evidence, there are many more with no basis in fact whatsoever. Some are downright false and others are deceptive half-truths.

Claim: "Shown to be a more potent fat burner than hydroxycitric acid (HCA) and chromium picolinate combined."

This claim is blatantly false since no studies have ever compared pyruvate to HCA and chromium picolinate--chromium and HCA have not been conclusively proven to enhance fat oxidation. There is absolutely no merit for this claim, yet it can be found on promotional literature as "clinically proven."

Claim: "Pyruvate is found naturally in the body and in a variety of foods."

Pyruvate is a normal constituent of human and plant metabolism; however, the term "natural" is ambiguous and therefore confers a deceptive stamp of approval to the unsuspecting consumer. This tactic is grounded in the "if-it's-natural-it-must-be-safe-and-effective" myth. Unfortunately, natural does not mean safe or effective—E. coli and rattlesnake venom are both "natural" but that doesn't mean they promote health and vigor.

Claim: "Pyruvate has been clinically proven safe with no side effects."

In all human trials (5, 7-12), some subjects receiving large doses of pyruvate experienced gastrointestinal distress in the form of diarrhea, borborygmus, and flatulence. It is likely that consumers do not experience these symptoms due to the benign amounts of pyruvate found in supplements rather than manufacturers' formulations.

Claim: "patented 4 times over."

A patent on a product does not mean it works; anyone can patent anything. Wise consumers should dismiss patents as "proof" of efficacy. The only true guarantees are big profits for the companies selling the product.

TESTIMONIALS

Emotional testimonials are often employed by supplement promoters, usually as a way of downplaying one's natural skepticism--the "be like Mike" syndrome. Unfortunately, testimonials have no scientific merit since they do not separate cause and effect from coincidence. Let there be no doubt about it; testimonials are very convincing. One should be skeptical when a product distributor says, "it worked for me, it can work for you." Yes, maybe the promoter experienced some type of change, but there is no way to verify if it was a result of the product. For example, if one takes the pyruvate while reducing calories and engaging in physical activity, there is no way to differentiate whether the weight loss was caused by the diet and exercise or the supplement. Again, there is no separation of cause and effect from coincidence.

There is no way to verify the validity of testimonials. A consumer would not be able to confirm if the people are, in fact, real, or they've been paid for their endorsement. In the case of pyruvate, conflicts of interest abound. A pro-pyruvate article appeared in Muscle and Fitness Magazine (4) and quickly became a highly prized marketing tool for promoters. However, the numerous testimonials listed in the article are questionable. According to the article:

"Terry Newsome, a 38-year old executive from Westlake California, has battled obesity for two decades, touts the effects of pyruvate. I've lost 39 pounds in less than 40 days. Other than the 5 grams of pyruvate, my eating and exercise habits have remained the same and I feel better than I ever dreamed possible....."

Ironically, Terry Newsome, at the time the article appeared on news stands, was president of Med-Pro industries, the company that holds four patents on pyruvate. Since he has direct involvement in the company, this testimonial cannot be considered objective. Even if he did lose 39 pounds in less than 40 days, there is no way to be certain the entire composition was fat.

The First Law of Thermodynamics (Conservation of Energy) holds that energy cannot be created or destroyed, only transformed from one form to another. So it is unrealistic to believe he could have expended an additional 3,500 kcal (1 lb of fat = 3500 kcal) above and beyond his daily caloric requirements, especially since he did not change his eating and exercise habits. And 5 gram doses of pyruvate have never been used in any published clinical research.

Famous athletes double as popular marketing tools for ergogenic aids, the obvious implication being that average consumers will perform at elite levels. The article states: "Of note, Olympic gold-medal gymnast Shannon Miller and her coach, Steve Nunno, are expected to endorse pyruvate because of the increased energy Miller experienced with the product. Though not part of a scientific study, Miller says that pyruvate helped energize her just days before the 1996 Olympics." This passage is misleading to consumers for a number of reasons.

First, the terms "increased energy" and "energize" are ambiguous and can be subjectively defined many different ways (for some, "energy" is just getting out of bed; for others it might be running 15 miles).

Second, elite athletes operate at such high physiological levels of performance that there is very little room for improvement. Untrained individuals, on the other hand, have sufficient room for improvement, with or without supplements. Third, the women gymnasts earned their gold medals as a team. Clearly Ms. Miller contributed her part, but there is no way to know if pyruvate had

any effect on the final results.

Lastly, gymnastics differs markedly from steady-state endurance exercise--the motor unit recruitment patterns and metabolic demands of gymnastics are not the same as arm and leg ergometry protocols (9, 10). So there is no way to tell how much pyruvate contributed to each activity, if at all.

COMMON MARKETING PLOYS

Pyruvate promoters have accessed every available media outlet. By far, the internet is the preferred marketing method, allowing pyruvate to be marketed quickly and inexpensively. People are inculcated by internet message boards, news groups, list-serves, and chat rooms, most of which lead to unsolicited junk e-mail. Unfortunately, consumers have absolutely no way of verifying what's legitimate since anyone can exploit the internet.

Print advertisements line the pages of magazines, newsletters, daily and weekly newspapers, and many supplement industry catalogs. Eye-catching, glossy ads featuring slender, tan bodies are often paired with the usual grandiose claims.

Infomercials trumpet pyruvate's benefits via the late night airwaves. As with any paid endorsement, their content should be viewed with skepticism. Promotional audio tapes are also making the rounds. Essentially, they mirror print advertisements, but are a convenient way to target the non-reader.

COST

Pyruvate does not come cheap. Firms sell pyruvate supplements for anywhere from \$50 to \$65 per bottle of 120 capsules. Usually for a nominal fee, anyone can become a multi-level marketing distributor which would further lower the price even more. No matter how you look at it, this is an expensive price to pay for a product that hasn't been conclusively proven to do anything.

THE BOTTOM LINE

A number of irrefutable certainties exist: 1) The minuscule doses available in commercial supplements have not been proven effective in any available research. No dose-response relationship has been established so there is no way of knowing the minimum effective dose; 2) Existing research does not conclusively support marketers' claims, many of which are based on faulty extrapolations from inconclusive, preliminary findings; and 3) Most studies were conducted by Ronald Stanko and have not been replicated by other researchers in other laboratories under various conditions in various sample populations. But don't expect marketers to readily embrace these facts. Whether pyruvate works or not seems to be unimportant to marketers. Customers will continue to be exploited for profit as long as the existing volume of misinformation surrounding pyruvate persists.

Perhaps all the attention stirred by promoters will spark the interest of other researchers and may eventually answer some of the questions presented in this article. Existing research is valuable in that it can serve as a preliminary foundation to guide future investigations. Nevertheless, at this point in time, pyruvate should be dismissed as nothing more than a too-good-to-be-true supplement.

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