

NADH: Biological Rocket Fuel

By George D. Birkmayer, M.D., Ph.D.

All we need is energy. Every living cell needs energy to stay alive. But exactly how is this energy for life produced? Hydrogen and oxygen react to form water and energy. The biological form of hydrogen is NADH, the abbreviation of nicotinamide-adenine-dinucleotide hydride. The oxygen comes from the air we breathe and is present in every living cell.

Rocket fuels are using the same principle. Hydrogen and oxygen in a liquid state react and cause an explosion which lifts the rocket from the ground. Hence, NADH can be regarded as biological rocket fuel with the smart difference that the energy is not wasted by an explosion but stored in chemical compounds such as ATP (adenosine triphosphate).

NADH was discovered in 1905 and found to be one of the most important coenzymes -- hence it is named coenzyme I.

How NADH Is Produced In Vivo

NADH consists of nicotinamide (also known as vitamin B3) and ADP (adenosine diphosphate). Nicotinamide is a precursor of NADH from which it is formed in the body when food is digested and degraded to sugar, amino acids and lipids. The hydrogen derived from the degradation of the substances is transferred to NADH in a metabolic pathway called citric acid cycle.

It is important to note that even high dosages of nicotinamide can not substitute for NADH. Vitamin B3 does not show any of the beneficial effects observed with NADH.

NADH is described extensively in all biochemistry textbooks. Commercially, it was used only for diagnostic purpose in blood tests. In the mid-1980s my late father and I tried NADH for the first time therapeutically by administering intravenous infusions in Parkinsonian patients. The beneficial effect was remarkable: patients who were unable to get out of their seats could do so in an hour or two after IV application.

As a biological form of hydrogen, NADH is a very sensitive substance which reacts not only with oxygen but with many other chemical compounds even in state. Because of this, NADH was never considered for therapeutic application. After extensive year-long research we succeeded in developing a formulation in which NADH could be stabilized and made absorbable for the intestinal tract, and have received more than 30 worldwide patents. It is not only the composition but also the production process that renders NADH stable. Just blending NADH together with some fillers and excipients does not lead to a stable product; the substance will degrade rapidly in weeks.

Commercially available NADH is produced from yeast which is very rich in NAD (nicotinamidadenine-dinucleotide) the oxydized form of NADH. This NAD is reduced either chemically or biochemically to form NADH which is purified by several crystallization procedures. The final product contains



between 93 to 98 percent NADH with no traces of yeast.

Functions/Applications of NADH

NADH is the cofactor of more than 1000 enzymes in our bodies, however the most important biological functions that can be ascribed to this substance are:

- Cellular fuel for energy production;
- Key role in DNA repair and cell regeneration;
- Enhancer of the cellular immune system;
- One of the most potent antioxidants;
- Stimulator of dopamine, adrenaline and norepinephrine biosynthesis.

The more NADH a cell has available, the more energy it can produce. The heart and the brain are the organs that need the most energy. Hence, NADH shows the greatest benefit to these organs.

Studies at the University in Berlin have found that one particular brand of NADH is absorbed by the intestinal mucosa undegraded. It also reaches the brain by passing the blood brain barrier. After oral application of NADH we found an increase of the NADH in the brain cortex of rats. The more energy a cell produces the better it functions and the longer it can survive. This points to the enormous potential of NADH as cell protector and anti-aging potion.

Furthermore, NADH is essential for enzymes which do repair damaged DNA, rendering the tissue resistant to modifications which can lead to cancer and other degenerative diseases. The more NADH a cell has available, the better the body is protected from developing these types of diseases.

The cellular immune system also needs NADH for full func-

Science Backgrounder

tionality. In collaboration with a research center at the University of Berlin, we found that NADH stimulates the production of Interleukin-6 (IL-6) in human white blood cells in a dosage dependent manner up to fifteen thousand fold. IL-6 has been shown to be a neuroprotective factor. Hence by increasing IL-6 in the body the nerve cells are better protected and the chances of the developing Alzheimer's or Parkinson's disease are lower than in people with a cellular NADH deficiency.

NADH is the most powerful antioxidant. This can be measured objectively by the so called redox potential. The more negative this potential is the greater the antioxidative capacity. As described in many biochemistry textbooks, NADH and its twin NADPH have the highest redox potential of all biological substances. Conversely, coenzyme Q-10 has a positive redox potential, and therefore is not an antioxidant at all. It can become an antioxidant in the body if it is reduced. This reduction is achieved only in the cell and only by NADH.

This fact implies two consequences: the intake of commercially available CoQ10 is not very meaningful unless the organism has sufficient amounts of cellular NADH available to reduce CoQ10 and make it an antioxidant. Even highly conditioned athletes have a measurable NADH deficit. If you take commercially available CoQ10 without an equivalent dose of NADH, you may deplete the cell from NADH and thereby make the cell energy deficient and prone to degeneration.

Numerous studies have demonstrated that NADH stimulates dopamine and adrenaline production. More adrenaline means more alertness, vigor, ability to concentrate and reduced appetite. NADH may help individuals to lose weight -- studies are in progress to confirm the numerous anecdotal cases.

The following are some additional benefits of NADH:

Athletic performance: In 1995 a study was conducted among competitive-level cyclists and long-distance runners. A significant range of performance improvements was recorded such as increased oxygen capacity, decreased reaction time and greater mental acuity. This study was repeated in a double blind placebo controlled cross-over study at the University of Freiburg, Germany, with the new sublingual NADH formulation.

Highly conditioned Olympic athletes were given 30 mg. NADH for one month. Their performance was measured by spiroergometry at base-line and after the one month treatment period. An average increase in muscular energy of seven percent was found. Lactate levels were significantly lower in the athletes taking NADH than in those taking placebo. The safety blood parameters for the liver, kidney and other organs did not change during the treatment period, indicating that 30 mg. of

NADH is a safe dose. All the other effects observed in the previous study could be confirmed.

Jet lag: Jet lag occurs when travelers cross time zones too quickly for their natural circadian rhythm to keep up. It disrupts the normal day/night pattern and causes sleepiness, malaise, fatigue, impaired cognitive and psychomotoric functioning. Some consumers reported beneficial effects of taking an NADH product when they flew against more than three time zones. Based on these anecdotal reports, the following study was performed: Participants traveled on "red eye" flights from San Diego, CA arriving in Washington, DC at 6 am. In San Diego and in Washington subjects had to perform a number of standardized computer tests. One group received 20 mg. of the NADH product, and the other group took a placebo one hour before the computer test in Washington, DC. This first real-time jet lag study yielded two important results. Jet lag causes deterioration in decision-making abilities, communications and memory by 30 to 70 percent. Alertness, vigilance, visual spatial perception reaction time and multi tasking ability all decrease in cases of jet lag. Slowed reaction by even 0.6 seconds can impact real-life occurrences such as the ability to drive a car and respond quickly to traffic conditions. The NADH product improved mental alertness, visual spatial perception, reaction time and multi tasking abilities significantly.

Sleep deprivation: Jet lag represents just a form of sleep deprivation. Hence, a double-blind placebo controlled study was conducted to determine the effectiveness of NADH in healthy individuals who are sleep deprived. The research was done at the Sleep-Wake Disorder Center New York Presbyterian Hospital under Margaret Moline, Ph.D., as principal investigator. Participants of the study were kept awake for a full night. Computer tests had to be performed by the subjects in the evening and in the morning after the sleepless night. Subjects were randomly given 20 mg. NADH or identical placebo tablets one hour before the morning test. Partial evaluation of the numerous data confirm the results of the jet lag study. Faster reaction time, better multitasking ability, higher alertness and vigilance were seen. The impact of this beneficial effect of the NADH product on sleep deprived people such as shift workers, truck drivers, medical staff and air line crews is more than obvious.

It is obvious that NADH has the potential to help a broad range of consumers. **SIE**

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