VITAMIN C & THE CAVY

By David Hardesty

Introduction

Early man faced a bleak existence as a hunter/gatherer. Without the benefit of today's modern medicines, the human population, just as any other animal population, was susceptible to the full brunt of his environment. Numerous infectious diseases, viral or bacterial, were constantly weeding out the weakest members of his population. With no way to halt the inevitable result of these diseases, life expectancy could be less than 35 years. Cold winter months could be expected to be a time of death and misery. The healers in these societies early on made a connection between supplementing with a good, nutritious diet, and the chances of a patient recovering from illness. Early healers, through trial and error, concocted potions which they would administer to the sick to bolster the bland and limited diets available during the winter. Patients who were fed a combinations of certain dried leaves, or fruits, when reconstituted with water, were more likely to recover. These early healers would try anything to increase the odds of recovery. They really could care less why it worked the way it did. It would be centuries before empirical scientific research would create an understanding of the mechanisms at work.

Just Why is Vitamin C Such an Important Part of a Cavies Diet Anyway? All animal life is dependent upon an external source of organic matter for normal growth and tissue maintenance. Very often the availability of this supply will fluctuate from feast to famine depending upon various environmental conditions such as rainfall or season. Evolution has equipped organisms to minimize the affects of this fluctuating food supply in a number of ways. Adapting behavior to wait out time of inadequate supply of nutrients by hibernation or encapsulation is one way. During times of plenty, excess carbohydrates and proteins are metabolized within the liver and stored within the adipose tissues as fat for future usage. Vitamins, normally found in minute quantities within the diet, do not enjoy this luxury. Depending upon the physical structure of the particular vitamin molecule, vitamins are retained in varying degrees within the body. Vitamins A, D, E, and K belong to the fat soluble vitamin series and are stored within the adipose or fat tissues. Excessive amounts of these vitamins can be toxic in varying degrees due to their solubility in fat. The remaining vitamins belong to the water soluble series. This series includes the B-complex vitamins, Niacin, Pantothenic acid, Folic acid, Biotin, and Vitamin C. All of these vitamins are characterized by a low retention, or storage capacity, and as such must be constantly replenished from a dietary source.

History of Vitamin C

When man began exploring the New World he would come face to face with scurvy, the disease of Vitamin C deficiency. Long ocean voyages, where the primary source of food was dried meats and grain, were often accompanied by a high death rate. In 1535, Cartier, the French explorer, was taught by native North American Indians, that certain bulbs or roots, as well as a tea made from the tips of pine tree branches, would ward off the disease which had already claimed half of the members of his expedition. In 1756, Dr. James Lind published the results of experimentation which would, for all time, brand the British sailor as "Lime'ys". Up until the time of Lind, the highest singular cause of death in the British Navy, on long ocean voyages, was scurvy. Using British sailors as experimental subjects, Lind conducted research in what is referred to as the first "controlled" experiments in modern nutritional research. In addition to disproving the effectiveness of many popular "cures" of his day, Lind proved conclusively that there was a substance found in fresh limes which would totally prevent scurvy in those sailors which had a daily supplement of the fruit in their diet. The discovery, in 1907, that the cavy also needed an exogenous, or dietary, source of the same substance to remain healthy, gave the scientific community a much more suitable experimental animal for conducting this research. In 1928, the Hungarian research team of Svirbely and Szent-Gyorgyi, isolated what they would call hexuronic acid from lemon juice. In 1932, the American team of Waugh and King positively identified hexuronic acid as the anti-scurvy compound, or more properly, antiscorbutic agent. By 1933, Swiss, German, and British chemists had identified the molecular structure of hexuronic acid and developed low cost methods to manufacture the vitamin. It was in this same year that Haworth gave hexuronic acid the more familiar name of ascorbic acid.

Symptoms of Vitamin C Deficiency

Investigators have found that the cavy, when fed a diet devoid of Vitamin C, but nutritionally sufficient in all other nutrients, will continue to grow normally for about nine or ten days as the animal uses up the Vitamin C already present within its body. Collins & Elvehjem (1958) found that by the 14th day of this scurbogenic (able to induce scurvy) diet that older cavies would begin a rapid weight loss. Younger cavies would have started this rapid weight loss several days earlier at day 9. Odumoso and Wilson (1972) found that it took about 12 days for the rapid weight loss to start. They found that by day 24 on this scurbogenic diet that the weight of their cavies had dropped back to that at the start. By day 27 on the diet, cavies were weighing less than the start, exhibiting classical symptoms of scurvy, and dying spontaneously.

The scurvy symptoms included rough and poor coat condition, unwillingness to move characterized by stiff joints and limbs, “hopping" when prodded into moving, tenderness to touch, extremely poor flesh condition and a stance with the feet tucked under the animal as if unable to support its own body weight.

Collins and Elvehjem reported that in post-mortem examinations, that the adrenal glands were enlarged and bleeding. Hemorrhaging, or bleeding, was present in the fore and hind joints, the intestine, and the muscles between the ribs.

How Much Vitamin C is Necessary to Prevent Scurvy?

Waugh and King (1932) found that .5mg of Vitamin C per 100 grams (3.5 oz) of bodyweight was sufficient when the criteria selected was the growth rate of certain body tissues. Dawborn (1945) reported a recommended Minimum Daily Requirement (MDR) of .4mg per 100 grams body weight. Crampton, in 1944, had earlier reported a MDR of 2 mg per day using a natural diet. Reid and Briggs, in 1953, developed a purified scurbogenic diet, nutritionally complete otherwise, which enabled investigators to study the effects of Vitamin C deficiency alone, uncomplicated by other nutritional deficiencies. Using this purified diet, mixed with various predetermined amounts of Vitamin C, Collins and Elvehjem, in 1958, re-established more conclusively a MDR of .5mg per 100 grams of body weight. But this was the level necessary to prevent scurvy. Investigators today are inclined to believe that a MDR closer to twice that amount, or 1mg per 100 grams bodyweight is necessary for optimum growth. Research has also indicated that this MDR varies with both the age and sex of the cavy. Odumoso and Wilson, in 1973, reported a higher survival rate among some female cavies fed a scurbogenic diet than among male cavies on the same diet. Some females were reported to have survived up to 60 days as to the normal survival time of 21 to 27 days. Yet in the same issue as the Odumosa and Wilson study was published, Jones, Hurley, and Hughes reported a 100% mortality on a scurbogenic diet, regardless of sex. What this successfully demonstrates is that there are individual differences in the MDR from cavy to cavy, that is, each cavy is biochemically individual in their requirement for Vitamin C. Commercially prepared diets which may have a sufficient MDR for one cavy, may be insufficient for another, and may manifest itself in subclinical symptoms, such as weak flesh condition or low reproductive rates. Kutsky, in 1973, reported that "the existence of subclinical vitamin deficiencies is extremely difficult to prove without adequate statistical data, but, undoubtedly, if we accept the principle of biochemical individuality, they do exist."

Can There Be Too Much of a Good Thing?

Much debate was created, in 1974, when Dr. Linus Pauling published his theory that massive doses of Vitamin C would reduce the incidence of colds and various other mild maladies. His theories were whole-heartedly embraced by the health food community and created mixed reactions from his colleagues. His theories flew into the face of evidence presented by Gordonoff, in 1960, that cavies given a four week regimen at an estimated 500 mgs Vitamin C per day, would develop scurvy much more rapidly, than did control animals, when Vitamin C was deprived from both groups of cavies.

Catabolism is the process by which complex organic molecules are converted by living cells into more simple organic molecules. This destructive process is irreversible and occurs within an organism either as a prelude to some eventual reformation into a newly synthesized molecule, or as a prelude to its eventual elimination from the body. Complete catabolism results in the reduction of the original organic molecule down to carbon dioxide and water, the primary waste products of all animal life.

Cochrane (1965) observed that two offspring, out of a female cavy which had been receiving 1 gram of Vitamin C per day (1000 x MDR) during pregnancy, had succumbed to scurvy when given only a normal maintenance dose of the vitamin. He postulated that these offspring had been conditioned in utero to a higher than normal rate of Vitamin C catabolism.

Sorrensen (1974) fed an experimental group of cavies a diet which contained 86 grams Vitamin C/kg of diet for 275 days. The growth rate of the experimental animals was significantly retarded as compared to the growth rate of the control group, receiving only 2 grams Vitamin C/kg of diet. Radioactive Vitamin C was administered to these animals at the end of the study and the rate of catabolism, as measured by the amount of radioactive carbon dioxide, was significantly higher. When both groups were put on a scurbogenic diet, the experimental animals were depleted of Vitamin C at a much faster rate than the control group. Due to the presence of these catabolic enzymes, progressively larger and larger doses of Vitamin C were necessary just to maintain these artificially high levels in the blood stream. When these conditioned animals were subjected to a sudden removal of dietary Vitamin C, these catabolic enzymes were so abundant that existing systemic Vitamin C was very quickly wiped out, with the resultant scurvy symptoms. Reducing the conditioning overload level of Vitamin C had little affect on this rapid depletion by these catabolizing enzymes post overload. Therefore dosing cavies with high levels of Vitamin C over long periods of time does little good, and will actually condition the cavy to develop scurvy more rapidly in times of reduced Vitamin C.

References:

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