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POTENTIAL BENEFITS AND CONTROVERSIES RELATED TO USE OF AMYGDALIN (VITAMIN B17)

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Abstract

Amygdalin, also known as Vitamin B17 is often considered as anticancer remedy and can be found in many plants. Foods rich in vitamin B17 are referred to as nitrilosides, which contain cyanide that is very toxic ingredient. The aim of this article is to highlight some controversies about amygdalin's effects.

Bibliographical searches were performed in available studies and reports using the following terms: "amygdalin", "laetrile", "vitamin B17" and "cancer treatment". Administration of amygdalin may help protect against some cancer types. It also boosts immunity and reduces pain in several diseases. One interesting effect of amygdalin is blood pressure lowering. Besides the beneficial effects, it could be very toxic because the level of cyanide, as very dangerous poison, is very high. This is the reason for failure of many clinical trials linked with anticancer effects of amygdalin in past.

Vitamin B17 is safe for human consumption, but the bottom line is that more research needs to be done to determine safety for both short- and long-term periods of supplementation. There is a greater chance of cyanide toxicity when B17 is taken orally and in high enough amounts, but not when injected. The safest way to get amygdalin at this point is from vitamin B17 whole food sources.

***Key words**: Amygdalin, Food, Vitamin B17, Cancer treatment.*

1. Introduction

Amygdalin (Vitamin B17) was first isolated in 1830 by two French chemists [1, 2]. It was used as an anticancer agent in Russia as early as 1845 [3, 4], while the first recorded use of amygdalin in the United States as a treatment for cancer occurred in the early 1920s [5]. In the 1950s, a purportedly, non-toxic intravenous form of amygdalin was patented as Laetrile [6, 7].

Laetrile has been tested on cultured animal cells, in whole animals, in tumor cells from one species transplanted onto another species, and in humans to determine whether it has specific anticancer properties. Hydrogen cyanide is believed to be the main cancer-killing ingredient in laetrile [8, 9] When laetrile interacts with the enzyme beta-glucosidase or undergoes hydrolyses in the absence of enzymes, hydrogen cyanide, benzaldehyde and glucose are produced [10, 11]. Hydrogen cyanide can also be produced from prunasin, which is a less-than-complete breakdown product of amygdalin [1, 8].

2. Potential benefits and controversies

2.1 Theories of anticancer activity

Proponents of laetrile have proposed four different theories to explain its purported anticancer activity.

The first of these incorporates elements of the trophoblastic theory of cancer. According to the this theory, all cancers arise from primordial germ cells some of

which become dispersed throughout the body during embryonic development and, therefore, are not confined to the testicles or ovaries [12 - 17]. The rationale for laetrile use is the suggestion that malignant cells have higher than normal levels of an enzyme called beta-glucuronidase and that they are deficient in another enzyme called rhodanese (thiosulfate sulfur-transferase). Another suggestion is that laetrile is modified in the liver, and that beta-glucuronidase breaks down the modified compound, ultimately producing cyanide. Rhodanese can convert cyanide into the relatively harmless compound thiocyanate. Thus, it has been proposed that cancer cells are more susceptible to the toxic effects of laetrile than normal cells because of an imbalance in these two enzymes [18 - 20].

The second theory states that cancer cells contain more beta-glucosidase activity than normal cells and, as in the first theory, that they are deficient in rhodanese [18-25]. Again, elevated beta-glucosidase activity in the interstitial regions of some tumors has been experimentally demonstrated [26, 27].

The third theory states that cancer is the result of a vitamin deficient metabolic disorder. Namely, laetrile, or amygdalin/Vitamin B17, is the missing vitamin needed by the body to restore health [18, 28 - 30] Experimental evidence indicates that the level of intake of individual vitamins and/or the vitamin status of an organism can influence the development of cancer, but there is no evidence that laetrile is needed for normal metabolism or that it can function as a vitamin in animals or humans [31, 32].

The fourth theory suggests that the cyanide released by laetrile has a toxic effect beyond its interference with oxygen utilization by cells. According to this theory, cyanide increases the acid content of tumors and leads to the destruction of lysosomes. The injured lysosomes release their contents, which are mainly enzymes, thereby killing the cancer cells and arresting tumor growth or simply by stimulation of the immune system [15].

2.2 From plants to remedy

The term laetrile is derived from the terms laevorotatory and mandelonitrile and is used to describe a purified form of the chemical amygdalin, a cyanogenic glucoside found in the pits of many fruits and raw nuts and in other plants [1, 3, 4, 5, 33, 34]. In body fluids and at physiological pH, hydrogen cyanide dissolves to form the cyanide anion. The term vitamin B-17 was given to laetrile by Krebs E. T. Jr., but it is not an approved designation by the Committee on Nomenclature of the American Institute of Nutrition Vitamins.

In the 1970s, laetrile gained popularity as an anticancer agent. By 1978, more than 70,000 individuals in the United States were reported to have been treated with it [5, 28, 35]. Laetrile has been used for cancer treatment both as a single agent and in combination with a metabolic therapy program that consists of a specialized diet, high-dose vitamin supplements, and pancreatic enzymes [10, 36].

Laetrile was legalized in more than 20 states in USA during the 1970s. In 1980, the U. S. Supreme Court acted to uphold a federal ban on interstate shipment of laetrile [5, 37]. As a result, the use of laetrile has greatly diminished, but the compound continues to be manufactured and administered as an anticancer therapy, primarily in Mexico, and in some clinics in the United States.

Although the names Laetrile, vitamin B-17, and amygdalin are often used interchangeably, they are not the same product. The chemical composition of U.S.-patented Laetrile (mandelonitrile-beta-glucuronide), a semisynthetic derivative of amygdalin, is different from the laetrile/amygdalin produced in Mexico (mandelonitrile beta-D-gentiobioside), which is made from crushed apricot pits [6, 7]. Mandelonitrile, which contains a cyanide group, is a structural component of both products [6]. It has been proposed that released (hydrogen) cyanide is the active cancer-killing ingredient in laetrile, but two other breakdown products of amygdalin-prunasin (which is similar in structure to Laetrile) and benzaldehyde, may also be cancer cell inhibitors [8, 9, 38, 39].

Laetrile can be administered orally as a pill, or it can be given by injection. It is commonly given intravenously for a period of time followed by oral maintenance therapy. The incidence of cyanide poisoning is much higher when laetrile is taken orally [2, 24, 40] because intestinal bacteria and some commonly eaten plants contain enzymes (beta-glucosidases) that activate the release of cyanide after laetrile has been ingested [8, 24]. Relatively little breakdown occurs to yield the (hydrogen) cyanide when laetrile is injected [24, 28]. Administration schedules and the length of treatment in humans vary widely.

2.3 Human trials

Laetrile has been used as an anticancer treatment in humans worldwide [37]. Although many reports are available, findings from only two clinical trials [36] have been published.

Case reports have provided little evidence to support laetrile as an anticancer treatment [10, 14, 19, and 20]. The absence of a uniform documentation of cancer diagnosis, the use of conventional hemotherapies in combination with laetrile, and variations in the dose and duration of laetrile therapy complicate evaluation of the data. In a case series published in 1962

[20], findings from ten patients with various types of metastatic cancer were reported. These patients had been treated with a wide range of doses of intravenous Laetrile (total dose range, 9 - 133 g). Pain relief (reduction or elimination) was the primary benefit reported. Some objective responses, such as decreased lymphadenopathy and decreased tumor size, were noted. Information on prior or concurrent therapy was provided; however, patients were not followed up long-term to determine whether the benefits continued after treatment was stopped.

Another case series that was published in 1953 included 44 cancer patients and found no evidence of objective response that could be attributed to laetrile [17]. Most patients with reported cancer regression in this series received recent or concurrent radiation or chemotherapy. Thus, it is impossible to determine which treatment produced the positive results. Benzaldehyde, which is one of laetrile's breakdown products, has also been tested for anticancer activity in humans. Two clinical series reported a number of responses to benzaldehyde in patients with advanced cancer for whom standard therapy had failed [41, 42]. In one series, 19 complete responses and 10 partial responses were reported among 57 patients who had received beta-cyclodextrin benzaldehyde; however, precise response durations were specified for only two of the patients (41].

Another series by the same investigators used 4,6-benzylidene-alpha-D-glucose, which is an intravenous formulation of benzaldehyde [42]. In this series, seven complete responses and 29 partial responses were reported among 65 patients, with response durations ranging from 1.5 to 27 months. No toxicity was associated with either preparation of benzaldehyde, and it was reported that the responses persisted as long as treatment was continued. Almost all of the patients in these two series had been treated previously with chemotherapy or radiation therapy, but the elapsed time before the initiation of benzaldehyde treatment was not disclosed.

In 1978, the National Cancer Institute (NCI) requested case reports from practitioners who believed that their patients had benefitted from laetrile treatment [43). Ninety-three cases were submitted, and 67 were considered evaluable for response. An expert panel concluded that two of the 67 patients had complete responses and that four of the others had partial responses while using laetrile [35]. On the basis of these six responses, the NCI agreed to sponsor the first and the second phase of these clinical trials.

The phase I study was designed to test the doses, routes of administration, and the schedule of administration judged representative of those used by laetrile practitioners [36]. The study involved six cancer patients. The investigators found that intravenous and oral amygdalin showed minimal toxicity under the conditions evaluated; however, two patients who ate raw almonds while undergoing oral treatment developed symptoms of cyanide poisoning.

The phase II study was conducted in 1982 and was designed to test the types of cancer that might benefit from laetrile treatment [3, 4]. Most patients had colon, lung and breast cancer. To be eligible for the trial, patients had to be in good general condition, and they must not have received any other cancer therapy for at least 1 month before treatment with laetrile. Laetrile, evaluated for potency and purity by the NCI, [44 - 46] was administered intravenously for 21 days, followed by oral therapy, utilizing doses and procedures similar to those evaluated in the phase I study. Other vitamins and pancreatic enzymes were also administered as part of a metabolic therapy program that included dietary changes to restrict the use of: caffeine, sugar, meats, dairy products, eggs, and alcohol. A small subset of patients received higher-dose amygdalin therapy and higher doses of some vitamins as part of the trial. Patients were followed up until there was definite evidence of cancer progression, elevated blood cyanide levels, or severe clinical deterioration. Among 175 evaluable patients, only one patient met the criteria for response. This patient, who had gastric carcinoma with regional and cervical lymph node metastases, experienced a partial response that was maintained for 10 weeks while on laetrile therapy. Fifty-four percent of the patients had measurable disease progression at the end of the intravenous course of treatment, and all of the patients had disease progression 7 months after completing intravenous therapy. Seven percent of the patients reported an improvement in performance status at some time during therapy, and 20 percent claimed symptomatic relief. In most patients, these benefits did not persist. Blood cyanide levels were not elevated after intravenous laetrile treatment; however, they were elevated after oral therapy [36].

Variations in commercial preparations of laetrile from Mexico, the primary supplier, have been documented [46, 47]. Incorrect product labels have been found, and samples contaminated with bacteria and other substances have been identified [46, 47]. When a comparison was made of products manufactured in the United States and Canada, differences in chemical composition were noted, and neither product was effective in killing cultured human cancer cells [16].

2.4 Vitamin B17's potentially big benefits

2.4 1. May help protect against cancer

Overall, study results investigating the anti-cancer effects of vitamin B17 are mixed. Some show that vitamin B17 is beneficial in avoiding cancer and keeping

the spread of existing cancer cells to a minimum, while others show no effects of vitamin B17 on cancerous cells. While many practitioners believe that vitamin B17 laetrile is a very good cancer treatment, most agree that it shouldn't be the primary cancer treatment for any patient - instead, they recommend that it be used as an effective add-on supplement. Vitamin B17, specifically in the form of D-amygdalin, may help with the regression and growth of cancerous cells and tumors because it exhibits selective killing effects on mutated cells, also called apoptosis. Apoptosis is a mechanism of "programmed cell death" and considered an important part of cancer treatment. Vitamin B17 compounds have the important ability to kill cancer cells more readily than killing normal, healthy cells. In a study by the Department of Physiology at Kyung Hee University in South Korea, when amygdalin extract was combined with cancerous human prostate cells, the extract helped significantly induce apoptosis in the prostate cancer cells. The researchers conclude that amygdalin may offer a valuable, natural option for prostate cancer treatment [48]. Other animal studies show that vitamin B17 amygdalin is effective at killing cancerous bladder and brain cells under certain conditions, especially when combined with other antibody-enzyme complexes [49]. On the other hand, other studies using human lung and breast cancer cells show no effects of vitamin B17 on stunting tumor growth. Therefore, in the medical community, there still isn't agreement at this time as to whether vitamin B17 should be used as an anti-cancer treatment.

2.4.2 Boosts immunity

Vitamin B17 contains special properties that slow down the spread of illness throughout the body by killing harmful cells, but the exact way that vitamin B17 does this isn't well-understood. A study published in the International Journal of Radiation and Biology found that vitamin B17 amygdalin stimulated the immune system by causing a statistically significant increase in the ability of a patient's white blood cells to attack harmful cells [49]. One theory of vitamin B17's effects suggests that transformation of normal cells into dangerous cells that can cause disease is normally prevented by beneficial enzymes produced within the pancreas. So vitamin B17 may help increase the production of pancreatic enzymes that destroy harmful properties within the body. Vitamin B17 is also thought to help the body experience enhanced detox effects by supporting liver function. This boosts immune function by ridding the body of toxins, malignant cells and other potentially harmful substances before they cause illness or serious chronic diseases. Another explanation of vitamin B17 mechanisms is that when vitamin B17 releases cyanide, it increases the acid content of tumors and leads to the destruction of harmful cells within the tumors, arresting their growth.

2.4.3 Reduces pain

In a case series published in 1962, when patients were treated with a wide range of doses of intravenous vitamin B17 laetrile, pain relief was the primary benefit reported [20]. Some of the patients' responses included decreased adenopathy (swollen lymph nodes) and decreased tumor size. However, patients weren't followed long term to determine whether or not the benefits continued after treatment stopped, so it's hard to tell whether vitamin B17 could act as a natural pain reliever for other conditions, such as arthritis [3, 4].

2.4.4 Lowers high blood pressure

Vitamin B17 may cause a low blood pressure reaction due to formation of thiocyanate, a powerful blood-pressure-lowering agent [3, 49]. However, it's unknown if this is an effective treatment long-term or if the effects are mostly temporary. Once metabolized, vitamin B17 causes enzyme beta-glucosidase production that interacts with intestinal bacteria to detox the body and lower blood pressure [50]. This normally isn't a danger for most people and may be beneficial for some, but it's important not to use vitamin B17 in this way if you already take blood pressure-lowering medication [21].

2.5 Vitamin B17 foods

What are some vitamin B17 foods? Quite a few, but many might not be what people would normally eat, particularly seeds. Fruit seeds have the highest concentration of B17 of any food, yet most people avoid eating them. There is some controversy surrounding Vitamin B17 because it has cyanide molecules in it. In high doses cyanide is lethal, but the amounts found in food are required for proper health. Vitamin B17 in foods is the best and only way to get the vitamin into our body [51, 52].

The best sources of amygdalin come from a variety of: seeds, fruits, vegetables, sprouts, and nuts, and the very best source is found in apricot seeds. Soil and climate play a large role in how much vitamin B17 is in a particular food, so it can be difficult to determine the exact levels in each food. Some foods that are good sources of vitamin B17 are:

2.5.1 Fruit

Many types of berries are a good source of this vitamin. Look for: strawberries, huckleberries, cranberries and blueberries. One serving (one cup) of: gooseberries, blackberries, boysenberries, raspberries and elderberries have 500 milligrams of vitamin B17. Other fruits that are good sources of the vitamin are: peaches, plums, nectarines, cherries, and prunes, but remember, the pits in these fruits are the true sources of amygdalin.

2.5.2 Nuts

Bitter almonds have the most B17, with cashews and macadamia nuts following.

2.5.3 Leaves/Leafy greens, grasses

Many leaves and grasses are a good source, but few people add them to their diet or have even heard of them. Johnson grass, Tunis grass, and arrow grass are good grasses to eat if you can find them. Alfalfa and eucalyptus leaves are better sources of B17; spinach, beet greens, and watercress all have moderate amounts.

2.5.4 Sprouts

Bamboo sprouts are the best sprouts to eat, but alfalfa, mung, and garbanzo sprouts are also decent sources.

2.5.5 Seeds

Apricot seeds are the best vitamin B17 source of any food. Other good seeds sources include: apples, grapes, berries, buckwheat, cherry, squash, and millet. Seeds can be added to salads and yogurt.

2.5.6 Tubers

Sweet potatoes and yams are much easier to come by at the grocery store. Plus, they're affordable!

3. Conclusions

- It is important to note that laetrile is not always the best treatment in every situation. For example, with fast-spreading cancers, laetrile may not be strong enough to defeat cancer even if the patient is on a superb raw food diet. Unless using high doses of a quality source of laetrile under a doctor's supervision, one should not depend on laetrile as the core treatment in a cancer treatment program. Laetrile is a supplemental treatment or a remission treatment, it is safe and effective, but it should be part of an integrative oncology program.

- Whether we call it laetrile or amygdalin or Vitamin B17, this natural substance has been shown to be an effective weapon against cancer. Laetrile is primarily found in apricot kernels, as well as in thousands of nuts, fruits, and other sources. But it is not without controversy. Critics say it is at best ineffective and at worst potentially toxic. Advocates point to years of positive results and no known cases of cyanide toxicity.

Laetrile has been banned in the U.S., but it is administered legally in several clinics in Mexico as well as in - Germany and parts of Asia, usually intravenously in high doses. What's more, apricot kernels and apricot-based pills can be purchased in the U.S. and taken as a nutritional supplement by cancer sufferers and by others hoping to prevent cancer. As with all medical treatments, it is important to talk it over with the doctor or other health professional.

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