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Is Vitamin B17 Quackery or a Cancer Cure? An Extensive Analysis

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Abstract

Cancer remains a major worldwide health concern that requires the investigation of new treatment approaches. Naturally present in large quantities in the seeds of many different fruits, amygdalin is a cyanogenic glycoside that has attracted a lot of interest as a possible anticancer drug. The article starts by summarising the history of amygdalin's use as a conventional cancer treatment and explores its contentious standing in the medical community. It looks into the chemical pathways that have been suggested to underlie amygdalin's anticancer actions, such as its transformation into hydrogen cyanide and consequent cytotoxicity, in addition to its ability to trigger apoptosis, impede angiogenesis, and alter immunological responses. A thorough discussion of the cellular and molecular pathways that amygdalin influences is provided, illuminating the complex manner in which it functions within cancer cells. Amygdalin's interactions with important molecular targets in cancer cells, including the Bcl-2 family of proteins. A critical evaluation of amygdalin's safety profile and efficacy from a clinical standpoint is also conducted. Although preliminary research suggested encouraging outcomes, a lack of thorough clinical trials and uneven methodology have led to mistrust. Furthermore, more research is necessary to fully understand the questionable metabolism of amygdalin and its propensity to release hazardous cyanide chemicals. To sum up, this thorough analysis offers a fair synthesis of the most recent research on amygdalin's possible use as an anticancer medication. The development of amygdalin into a therapeutically effective therapy option requires thorough research into its mechanisms, potential toxicity, and synergistic interactions with existing medications, even though preclinical data points to its potential. This review provides valuable insights into the complex molecular mechanisms and clinical difficulties surrounding amygdalin, which will help guide future investigations into how to use this drug to treat cancer.

***Keywords**: Amygdalin, Laetrile, Vitamin B17, Cancer, Cyanogenic Glycoside, Apoptosis*

INTRODUCTION

One of the biggest issues facing both industrialized and emerging nations is the spread of diseases linked to modern civilization. The advancement of technology and the consequent contamination of the environment have been linked to a rise in diseases like diabetes, cancer, osteoporosis, obesity, cardiovascular disease, neurological disorders, and autoimmune diseases [1]. A group of illnesses collectively known as cancer is defined by the unchecked proliferation and body-wide spread of cancerous cells. One of the main causes of death from the 20th to the 21st centuries was cancer. Globally, cancer sufferers still encounter numerous obstacles on their path to recuperation [2]. Generally speaking, hereditary abnormalities account for 5–10% of cancer cases, but smoking, diet, obesity, physical inactivity, excessive alcohol use, sun exposure, and pollution account for 90–95% of cases [3]. Stress and other lifestyle and environmental factors, like infectious diseases, are to blame. Globally, the number of people dying from cancer is still rising, even though it is generally acknowledged to be a preventable disease [4]. The World Health Organisation (WHO) is increasing research, early detection, and prevention-focused initiatives to find lifestyle modifications and medicinal treatments that can be utilized to cure cancer. The World Health Organisation (WHO) estimates that 9.6 million people died from cancer-related causes in 2018 [5], making it the world's leading cause of morbidity and mortality. Cancer patients and their families endure a great deal of physical and psychological suffering, which frequently necessitates a multidisciplinary approach to care and treatment. Patients in lower middle-income nations face an even greater burden because access to high-quality cancer treatment is still uneven among regions, despite advances in medical research and technology [7].

Global cancer patients receive comprehensive care from organizations such as the National Comprehensive Cancer Network (NCCN) and the Union for International Cancer Control (UICC), which are dedicated to addressing these inequities and promoting early identification [8]. There are numerous well-established cancer treatment options available, such as surgery, chemotherapy, and radiation. However, it is anticipated that herbal medications will be used as cancer treatments in the future due to their low cost, high pharmacological effects, and lack of adverse effects. A prospective source for the creation of chemopreventive and chemotherapeutic drugs is natural products. In the previous 30 years, the FDA has authorized about 80% of all medications that are derived from natural sources [9-10].

Surgery is the most widely used medical strategy to treat cancer. Chemotherapy, radiation therapy, and other techniques are

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frequently combined to produce synergy. Modified treatments like diet, acupuncture, hypnosis, bioenergetic therapy, and natural energy therapy are among the most popular alternative methods. Numerous adverse effects, such as nausea, vomiting, exhaustion, hair loss, anaemia, and immune system suppression, are associated with chemotherapy. The quality of life of a patient may be considerably impacted by these adverse effects. Chemotherapy medications also target cells that divide quickly, including cancer cells. They can, however, also harm good cells that divide quickly, which can result in harm to the digestive system, bone marrow, and other tissues. Moreover, chemotherapy medications might harm healthy cells and tissues since they have a systemic effect on the body as a whole. Complications and adverse effects are a result of this lack of selectivity. Over time, cancer cells may become resistant to the medications used in chemotherapy, which would lower the treatment's efficacy and necessitate the use of different strategies [11].

The foundation of herbal medicine is the use of plants and substances derived from plants to support healing and well-being. Bioactive substances found in many plants may have anti-cancer properties. Herbal medicine has the potential to reduce the severe side effects that are frequently connected to traditional cancer therapies like radiation and chemotherapy, which is one of its main benefits. These treatments aim to target cancer cells while avoiding healthy ones, potentially providing a more benign approach. Herbal remedies have the potential to improve a patient's general state of health by easing discomfort, lowering symptoms, and promoting the body's own healing mechanisms. This may result in a higher standard of living both during and following cancer therapy.

To increase the effectiveness and lessen the negative effects of conventional cancer treatments, herbal medicine may be used in addition to them. The use of this integrated method is growing among medical professionals.

Herbal remedies can also be customised for each patient according to their unique genetic profile, general health, and kind of cancer. This customised strategy could result in improved results [11]. Research into possible cures and prevention strategies is still ongoing since cancer is still a serious health concern. During this search, vitamin B17—also known as laetrile or amygdalin—has drawn interest as a possible anti-cancer drug. Nonetheless, there are differing opinions regarding the safety and efficacy of using vitamin B17 in the treatment of cancer, making its usage a contentious practice. Since vitamin B17 is linked to apricot kernels, which have an ingredient called amygdalin, it has become more well-known. Supporters of vitamin B17 assert that when this molecule is consumed, it releases cyanide, a deadly toxin that is said to target and kill cancer cells while sparing healthy ones. Due to this technique, which is sometimes referred to as "targeted chemotherapy," vitamin B17 is becoming increasingly popular as a holistic and natural substitute for traditional cancer treatments [12].

Amygdalin is a disaccharide that is mostly present in the fruit kernels of bitter almonds, apricots, and peaches. These fruits have been used for a variety of medical conditions since ancient times [13]. Amygdalin is broken down by betaglucosidase, an enzyme found in the human small intestine and plant cell compartments, into prunasin, glucose, benzaldehyde, and hydrocyanic acid. Benzaldehyde, prunasin, hydrogen cyanide (HCN), and mandelonitrile can all be absorbed via the lymphatic and portal circulations. It is thought that amygdalin's anticancer properties stem from the cytotoxic properties of unhydrolyzed cyanoglycosides and HCN that are produced through enzymes [14-16]. Laetrile, which is derived from amygdalin, has been used for more than 30 years as an alternative and complementary natural medicine for the treatment of cancer. Amygdalin has been demonstrated to have anti-cancer properties on a variety of cancer cell lines, and US Food and Drug Administration patient studies from the late 1970s corroborated these findings [17].

Exploring the Cyanogenic Glycosides

Amygdalin is a member of the cyanoglycosides (CG) class of chemical compounds, which is made up of glycones and sugars with a 1-cyanobenzyl component. The hemiacetal OH group at the sugar moiety's anomeric carbon atom is where the 1-cyanobenzyl moiety is connected. Cyanogenic glycosides' main purpose is to shield plants from huge animals and insects. Generally speaking, amygdalin levels rise during fruit enlargement and stay constant or slightly lower during ripening. The endocarp of peach seeds has a greater amount of amygdalin than the mesocarp. What makes almond grains bitter depends on how much cyanogenic amygdalin diglucosides are present [18]. Amygdalin was discovered in 1830 by French chemists Pierre-Jean Robiquet and Antoine-François Boutron-Charlard. Dr. Ernst T. Krebs Sr.'s theory, Amygdalin Could Be an Effective Anticancer Agent, but It Works Toxic to Humans, published in 1920. Despite this statement, his son Ernst Theodore Krebs Krebs Jr. synthesised a less toxic single-subunit amygdalin derivative in 1952 and named it Laetrile. Amygdalin and a mixture of its modifications are not amygdalin or amygdalin, but are described by cancer researchers as "vitamin B17." Laetrile is also not a vitamin; the FDA (USA) made a statement in 1977 pointing this out [19].

Europe and the US have outlawed laetrile and amygdalin. Treatments and preparations including amygdalin are offered by this Mexican clinic and laboratory. Despite the passage of time (such as Cyto Pharma De Mexico's 40 years on the market), no conclusive clinical evidence has been found to support the efficacy of these medicines in treating patients. However, research using in vitro cell cultures has demonstrated the existence of some amygdalin actions that are advantageous for the treatment of cancer. Amygdalin, for instance, can: Apoptotic proteins and signalling molecules, which may explain why tumour growth has decreased in these areas. Treatment with amygdalin-induced apoptosis of his HeLa cervical cancer cells via endogenous substances decreased adhesion and migration of mitochondrial pathways, UMUC-3 and RT112, increased and decreased Bax expression, Bcl-2 expression, and caspase-3 activation in human prostate cancer cells. Bladder cancer cells through integrin-mediated activation and control of focal adhesion kinase (FAK) β-1. Additionally, amygdalin can prevent the expression of genes that fight apoptosis, such as XIAP and Survivin. Additional biological properties of amygdalin include antibacterial, antioxidant, asthmatic, anti-atherosclerotic, and hepatoprotective properties. In addition, amygdalin lessens pancreatic fibrosis and enhances microcirculatory abnormalities. It has analgesic and anti-inflammatory effects and promotes the proliferation of muscle cells [14-16].

Examine how amygdalin works as an anticancer agent.

Ernest T. Krebs, Jr.'s research indicates that rhodanese is a human enzyme that is found in every part of the body, except for tumour cells. This enzyme can produce thiocyanate from

hydrocyanic acid, which is present in vitamin B17. Thiocyanate is a precursor of the enzyme beta-glucosidase and vitamin B12, and it benefits the body by decreasing blood pressure. While it is missing in other bodily normal cells, beta-glucosidase is prevalent in cancer cells. The enzyme β-glucosidase is not present in individuals who are healthy and cancer-free. One molecule of hydrocyanic acid (hydrocyanic acid), two molecules of glucose, and one molecule of benzaldehyde (an analgesic) make up the chemical makeup of vitamin B17.

The enzyme rhodanese breaks down vitamin B17 when it is introduced to the body. This enzyme converts benzaldehyde and hydrocyanic acid into the byproducts benzoate and thiocyanate. These have a beneficial impact on the feeding of healthy cells and the production of a vitamin B17 metabolic pool. The only enzyme that can break down and neutralise B17 when it comes into touch with cancer cells is β-glucosidase, which is found in large amounts in cancer cells. Thus, when B17 and beta-glucosidase interact, a chemical process is set off that results in the production of a toxin that kills and destroys cancer cells by synergistically combining benzaldehyde and hydrogen cyanide. We refer to this entire process as selective toxicity. The only cells that are targeted and eliminated are those that show signs of tumour or malignant growth [15-18].

Amygdalin as immunomodulator

Stated differently, amygdalin stimulates the production of polyhydroxyalkanoates by promoting the growth of T cells in circulation. The secretion of interleukin (IL) 2 and interferon (IFN) γ is the outcome of this mechanism. Nonetheless, the inhibition of β1 release of transforming growth factor-beta 1 (TGF) ultimately results in enhanced immune function. Nonetheless, it's important to remember that amygdalin regulates T lymphocyte cell expression. Amygdalin at 10 mg/kg was shown in clinical trials to suppress the growth of immune cells [19]. This dosage was also shown to lessen immunosuppressive activity in animals with kidney transplants in other investigations. Patients experience these two elements of immune system activity following amygdalin injection or consumption. Certain research indicates that amygdalin boosts immune cell effectiveness. Patients do, however, occasionally have a higher success rate with organ transplants. Consequently, amygdalin may benefit the immunocompromised patient by supporting them during chemotherapy [20-21].

Amygdalin in the cell cycle

According to reports, prostate cancer (PCa) cell lines LNCaP, DU-145, and PC3 were exposed to various amygdalin concentrations. It was discovered that cell multiplication was repressed, specifically as indicated by a significant decrease in G2/M stage and S stage cells and a critical increase in the number of stages and G0/G1 stage cells by stream cytometry [22-23]. After amygdalin organisation, the expressions of cell cycle proteins such as CKD1, CKD2, cyclin A, and cyclin B were reduced in expansion, indicating that amygdalin inhibited cell multiplication by regulating the PCa cell cycle. Similarly, amygdalin inhibited the human colon cancer cell cycle to exert its anticancer effects. After amygdalin administration at a dosage of 5 mg/mL for 24 hours, critical contrasts in the quality expression of SNU-C4 cells were observed based on the results of the cDNA microarray assessment [25]. They discovered that in SNU-C4 human colon cancer cells, amygdalin down-regulated the following cell cycle-related factors: ATP-binding cassette, exonuclease 1 (EXO1), sub-family F, and topoisomerase (DNA) I (TOP1). This affected the tumour cell cycle, inhibited cell proliferation, and exerted its antitumor effect. These results demonstrated that amygdalin may prevent potentially dangerous tumour cell growth by regulating tumour cell cycle-related proteins or characteristics, impacting the cell cycle, and limiting cell growth, especially in human PCa and colon cancer.

Amygdalin in trials

Laetrile is a chemically modified version of amygdalin. One of its early proponents claimed that it is effective, citing this as one of the reasons for its longevity in the market. Apart from that, Sir Ernst Krebs Jr. proposed that amygdalin might be the vitamin that is lacking, based on his theory that cancer results from a vitamin shortage. He made a public declaration that laetrile is vitamin B17, a claim that was later disproved but gained traction among many Americans and political heavyweights in the mid-1970s. A new analysis by Blaheta et al. titled "Amygdalin: quackery or cure" offers a thorough summary of what is currently known about amygdalin trials. Based on an examination of many journals from reliable databases and other pertinent online sources, the evaluation comes to the inconclusive conclusion that there is not enough evidence to substantiate the idea that amygdalin can successfully treat cancer. According to the research, clinical trials with cancer patients—especially those with advanced stages of the disease—did not demonstrate any induction of apoptosis or tumour regression. The authors also point out that normal cells don't seem to be harmed by purified amygdalin. It has not been shown whether amygdalin has therapeutic potential when administered more than once. Laetrile's potential as a cancer treatment was refuted by a different team of Cancer Networks researchers, who linked it to myths regarding vaccine-induced autism and the idea that AIDS is a disease specifically targeted at Black people [26].

Amygdalin's prospects and challenges in cancer treatment

There is insufficient scientific data from carefully planned clinical trials to support the effectiveness of amygdalin as a cancer treatment. The majority of claims are supported only by anecdotal evidence and testimonies, which fall short of the strict requirements needed to prove their efficacy. The chemical cyanide, which is present in amygdalin, is hazardous to the body even in minute concentrations. The possibility of cyanide poisoning and damage to healthy cells persists as a serious safety worry, despite supporters' claims that the cyanide is delivered specifically to target cancer cells. Several health regulatory bodies, such as the U.S. Food and Drug Administration, have prohibited or limited the use of goods containing amygdalin because of safety concerns and a dearth of empirical data demonstrating its effectiveness. This restricts its use and accessibility as a cancer treatment. If amygdalin is the only medication used to treat cancer, evidence-based and clinically validated medicines that may be more successful in treating cancer may not be received as quickly. The course of treatment for a patient might be seriously affected by poor or delayed care. Patients may be misled by promotional campaigns and false information on amygdalin to think that it is a valid cancer treatment, which could cause them to forego tried-and-true treatments. Since amygdalin-containing items are not subject to the same strict regulations as pharmaceutical pharmaceuticals, there can be a significant range in their quality and purity. Patients who might not be aware of what they are truly consuming run the danger of suffering from this. The expense of seeking amygdalin treatment can be high, and

patients may have to pay a large sum of money for an experimental medication, taking funds away from evidence-based therapies. Promoting and implementing experimental or possibly hazardous treatments, such as amygdalin, presents ethical issues since patients may be weak and turn to alternate therapies in a desperate attempt to survive. Because amygdalin has not been scientifically validated and may pose health concerns to patients, there are situations in which anyone who promotes or provides the medication may be subject to legal action. The public's confidence in the scientific and medical communities can be damaged by the promotion of experimental treatments like amygdalin because patients may lose hope if desired results are not realised. Although there have been many obstacles and disputes around amygdalin, sometimes referred to as vitamin B17 or laetrile, as a possible cancer treatment, there are some apparent advantages to its application. It's crucial to remember that these advantages are still pending scientific verification and investigation. Additionally, any prospective amygdalin use should be handled carefully and after consulting with licenced medical professionals.

Cyanide and other substances found in amygdalin may have anti-cancer effects in principle.

Whether these substances can be used or changed to target cancer cells specifically while causing the least amount of damage to healthy cells is still being researched. Amygdalin's supporters speculate that it might be used in conjunction with traditional cancer treatments to increase their effectiveness and possibly lessen adverse effects. We are investigating this integrative strategy to see whether there are any synergistic effects. Certain plant sources, such as bitter almonds and apricot kernels, are the source of amygdalin. These organic sources might serve as a starting point for the creation of novel substances or medications with possible anti-cancer capabilities. According to certain research, amygdalin may be more efficient against specific kinds of cancer cells. The identification of these particular cancer kinds and pathways may eventually result in focused therapeutic interventions. Amygdalin reduces symptoms, controls pain, and enhances general well-being, all of which may contribute to supportive care for cancer patients. This may help to improve the patient's quality of life while receiving cancer therapy. With further investigation, amygdalin or its derivatives might be used in customised treatment regimens that take into account each patient's unique genetic composition, type of cancer, and general health. Research into the interactions between amygdalin and cancer cells as well as the mechanisms underlying these effects may provide important new understandings of cancer biology and therapeutic approaches.

Amygdalin has been examined in certain research as a possible cancer-preventative strategy. Investigations studying how it affects the onset and progression of cancer may help create preventative measures. To establish more individualised and successful treatment regimens, research is looking into the possibilities of mixing amygdalin with other natural chemicals, conventional treatments, or targeted therapies. This strategy might improve overall results by leveraging the advantages of many treatments. According to certain research, amygdalin may have immunomodulatory effects, which means it may affect how the body fights cancer cells with its immune system. Additional investigation into these impacts may pave the way for immunotherapy approaches [27-30].

As studies progress, specific patient characteristics or genetic markers may be able to be used to identify people who potentially benefit from amygdalin-based therapies. This may help with efforts to personalised medication. The precise processes by which amygdalin may impact cancer cells are incompletely comprehended [31-34]. Additional research into these processes may yield important information about possible therapeutic targets for the management of cancer. Amygdalin may be useful in patient-centred care within integrative and holistic medicine, where evidence-based treatments are paired with the patient's preferences and beliefs. This method protects patients' autonomy while making sure they are secure and healthy. Amygdalin may be useful in situations where normal medicines are not appropriate because of a patient's health status, preferences, or unique circumstances, but it should not be used in place of tried and true cancer treatments. Research into amygdalin and its effects on cancer cells advances our knowledge of cancer biology and available treatments, regardless of the drug's eventual effectiveness as a cancer treatment. The results of these investigations may open the door to the creation of whole new kinds of anti-cancer drugs.

CONCLUSION

The anticipated potential of amygdalin as a cancer therapeutic highlights the intricacy of the sector and the ongoing search for novel approaches to treating cancer. Even though there is some hope for these possibilities, it is critical to approach amygdalin and related alternative treatments with scepticism, scientific rigour, and a strong dedication to patient safety. The true promise of amygdalin as a cancer treatment will only be realised through rigorous clinical trials, evidence-based research, and open communication. Patients are highly encouraged to prioritise well-researched and proven cancer therapies up until that point, after speaking with qualified healthcare providers.

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