



**REVIEW ON APPLE : MOST POPULAR & DELICIOUS FRUITS AND APPLE SEEDS
RELEASE CYANIDE WHEN CRUSHED**

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ABSTRACTS

Apples are one of the world's most popular fruits. They contain small, black seeds that are usually avoided because of their bitter taste, but people may occasionally eat them by accident or not bother to spit them out. Many people believe apple seeds are poisonous, while others may consider them a healthy snack. Apple seeds contain amygdaline, which is converted into cyanide when the seeds are chewed or crushed. Cyanide is highly poisonous and can be deadly in high doses. Small amounts of cyanide, ranging from 0.2-1.6 mg for every pound of body weight, cause acute poisoning and may even be deadly. Eating a few apple seeds is safe. Large quantities of ground or crushed seeds (over 100 grams) are potentially fatal. The benefits of apple seed oil come from the impressive mineral and protein content and include reducing the appearance of acne, reducing wrinkles, and moisturizing the skin. This oil also helps in preventing skin cancer, boosting skin elasticity, preventing sun damage, and stimulating the production of collagen to produce new, healthy skin cells. It should not be consumed orally but can be used for topical applications. This review based study also concluded that apple seed oil could be used as edible oil, with the oil cake being used to supplement animal feed. Apple Seeds are known to contain low concentrations of amygdalin, (lower than apricot or almond seeds) a compound that degrades into HCN or Hydrogen Cyanide when metabolized. Based on results from all of these studies, it appears that apples may play a significant role in reducing the risk of a wide variety of diseases."

KEYWORD: Apple Seeds, Amygdaline, HCN, Disease

INTRODUCTION

Apples are some of the most popular and delicious fruits on the planet. There is nothing like biting into a bright, red, juicy apple to quench thirst and satisfy sweet tooth while boosting health in a major way. Apples

are pomaceous fruits whose tree belongs to the *Rosaceae* family and has the scientific name *Malus domestica*. Their ancestor is the *Malus sieversii*, which still grows wild in numerous parts of Central Asia.



Figure Showing the Seedling of Apple Plant and Initial Fruiting Stage of Apple.

They have been cultivated for thousands of years throughout Asia and Europe, and they make appearances in the cultural history of many ancient civilizations, including the Greeks, Romans, and Nordic tribes. Apples

gradually made their way to the Americans with the help of European colonizers and are now grown extensively in America.

There are more than 7,500 varieties of these delicious fruits and they come in a variety of colors namely red, yellow, and green. The skin of apples is thin but sturdy and the inner flesh is thick and juicy, and it softens as it ripens. The inner core holds the seeds, which are dangerous for your health. The nutrients are in the flesh and the skin, which are a rich source of anthocyanins and tannins. It's indeed true when they say, "An apple a day keeps the doctor away!"

NUTRITIONAL VALUE OF APPLES

The long list of health benefits attributed to apples is due to the vitamins, minerals, nutrients, and organic compounds found in them. These important nutritional elements include vitamin C, vitamin K, vitamin B6, and riboflavin. The list also includes minerals like potassium, copper, manganese, and magnesium. Apples are very good sources of dietary fiber and a single serving provides 12% of the daily fiber requirement. They are packed with phytonutrients and flavonoids like quercetin, epicatechin, phloridzin, and other polyphenolic compounds.^[1,5]



Figure showing the Different Varieties of Green and Red Apple.

Apples are one of the world's most popular fruits. They contain small, black seeds that are usually avoided because of their bitter taste, but people may occasionally eat them by accident or not bother to spit them out. Many

people believe apple seeds are poisonous, while others may consider them a healthy snack.

CRUSHED OR CHEWED APPLE SEEDS RELEASE CYANIDE

Apple seeds contain a plant compound known as amygdalin. It is found in relatively high amounts in the seeds of fruits in the rose family, which includes apples, almonds, apricots, peaches and cherries.^[1-3] Amygdalin is a part of the seeds' chemical defenses. It is harmless when intact, but when the seeds are damaged, chewed or digested, amygdalin degrades into hydrogen cyanide. This is very poisonous and even lethal in high doses.^[4-5] Cyanide has been used as a poison throughout history. It works by interfering with cells' oxygen supplies, and may lead to death within minutes at a sufficiently high dose.^[6-7]

CYANIDE TOLERANCE OF THE BODY

Consuming 0.2-1.6 mg of cyanide for each pound of body weight (0.5-3.5 mg/kg) may lead to severe poisoning, causing a coma, paralysis, heart and lung failure or even death.^[8] For a 180-pound (81 kg) adult, this equals 41-286 mg of cyanide. Lower amounts of cyanide may cause various milder symptoms, such as headache, nausea, vomiting, stomach cramps, dizziness, weakness and confusion. The exact amount needed to make sick depends on body weight. Young children are at a greater risk.

APPLE SEEDS RELEASE ENOUGH CYANIDE TO MAKE SICK

The amygdalin content in one gram of apple seeds ranges from 1-4 mg, depending on the variety.^[9-10] However, the amount of cyanide derived from apple seeds is much less. One gram of finely crushed or chewed apple seeds may deliver up to 0.06-0.24 mg of cyanide.^[11-12] As a result, eating two cups of ground apple seeds might be fatal. At the very least, it could make you sick. The exact lethal dose of apple seeds varies widely. It depends on body weight, individual tolerance and the type of apple. Keep in mind that much lower amounts might make sick.

Table showing that the how many apple seeds need to eat to risk death, relative to body weight

BODY WEIGHT (POUNDS)	BODY WEIGHT (KG)	APPLE SEEDS (GRAMS)	APPLE SEEDS (NUMBER)
20 (toddler)	9	19-529	27-756
120	54	113-3,175	162-4,536
130	59	123-3,440	176-4,914
140	64	132-3,704	189-5,292
150	68	142-3,969	203-5,670
160	73	151-4,234	216-6,048
170	77	161-4,498	229-6,426
180	82	170-4,763	243-6,804
190	86	180-5,027	256-7,182
200	91	189-5,292	270-7,560

For example, 243-6,804 apple seeds would be needed to kill a 180-pound individual. To put this in perspective, a whole apple may contain anywhere from 0-20 seeds.

Additionally, swallowing whole apple seeds is unlikely to cause any symptoms. The seed coat protects them from digestive enzymes, and they pass harmlessly

through digestive system. Nevertheless, it's probably a good idea to remove the seeds before giving apples to young children or pets.

THE BOTTOM LINE

Apple peels and flesh are very healthy and pose no risks to health. However, chewed or crushed apple seeds release small amounts of cyanide, which is highly toxic. Nevertheless, probably need to thoroughly chew and swallow over 150 seeds before you experienced any adverse symptoms. So if accidentally eat a few apple seeds, there is no need to worry.

APPLE SEEDS POISONOUS

Apple seeds have developed a mysterious reputation of being potentially fatal when ingested. However, before you decide on whether to consume the seeds of this healthy apple, it is better to understand a bit more about apple seeds. Apples, along with cherries, peaches, and almonds, are members of the rose family. The seeds of apples and these other fruits contain natural chemicals that are toxic to some animals.

TOXICITY OF APPLE SEEDS

APPLE SEEDS

Apple seeds are the small black seeds found in the center of apples, which grow on an apple tree, scientifically known as *Malus pumila*. The tree is one of the most widely cultivated fruit trees in the world, and while it is native to Central Asia, apples are now consumed and produced in countless nations and regions. While the flesh of the apple is sweet and juicy, the seeds are bitter, present in the range from 8 to 15, and are encased in a hard outer shell.



Figure Showing the Apple Seeds.

Apple seeds do contain a small amount of cyanide, which is a lethal poison, but you are protected from the toxin by the hard seed coating. If someone eat whole apple seeds, they pass through the digestive system relatively untouched. If chew the seeds thoroughly, it will be exposed to the chemicals inside the seeds, but the dose of toxins in an apple is small enough that body can easily detoxify it.

APPLE SEEDS AS A KILLER

Cyanide is deadly at a dose of about 1 milligram per kilogram of body weight. On average, an apple seed contains 0.49 mg of cyanogenic compounds. The number of seeds per apple varies, but an apple with 8 seeds, therefore, contains about 3.92 milligrams of cyanide. A person weighing 70 kilograms would need to eat 143 seeds to reach the lethal dose or about 18 whole apples.

APPLE SEEDS CAN KILL

As anyone watch someone carelessly munching on an apple core, some vague alarm bells go off in head. Didn't hear somewhere that apple seeds are poisonous? Well, apple seeds can indeed be poisonous, but it takes quite a few of them to kill and only if they have been crushed. Apple seeds (and the seeds of related plants, such as pears and cherries) contain amygdalin, a cyanogenic glycoside composed of cyanide and sugar. When metabolized in the digestive system, this chemical degrades into highly poisonous hydrogen cyanide (HCN). A lethal dose of HCN can kill within minutes.

There are several factors that make death-by-apple-seed very unlikely. First, the amygdalin is accessible only if the seeds have been crushed or chewed; a whole unbroken seed will pass right through. Second, the human body can process HCN in small doses, so a couple of chewed seeds are usually completely harmless. Finally, the average adult would need to eat anywhere from 150 to several thousand crushed seeds (depending on the apple variety) to be at risk of cyanide poisoning. The average apple contains only about five to eight seeds. So unless someone is eating their 18th consecutive apple core and has been meticulously chewing all the seeds, they should be fine with their occasional absentminded core chomping.

PURCHASING AND STORAGE OF APPLES

When anyone buys apples, make sure they are firm. Don't buy the ones that have wrinkles, since they have lost most of their health benefits and nutritional values. Apples that are overripe or are beginning to rot, metabolize their nutritional resources by releasing a compound called ethylene gas.^[2-6] This ethylene gas can stimulate the rapid ripening and rotting of other apples. So be sure to not keep them for too long and if do, remove any unusually soft or bruised apples from the bag.

USES OF APPLES

Apples can be eaten raw right off the tree or in a variety of dishes such as fruit salads and custards. Apple juice is also a common drink throughout the world and it is also included in many desserts. These fruits can be baked, minced, mashed, frozen, or even dried into chips as a healthy, sweet snack. Apart from the fruit, the oil extracted from its seeds is also useful and has many applications especially in the cosmetic industry. The benefits of apple seed oil come from the impressive mineral and protein content and include reducing the

appearance of acne, reducing wrinkles, and moisturizing the skin. This oil also helps in preventing skin cancer, boosting skin elasticity, preventing sun damage, and stimulating the production of collagen to produce new, healthy skin cells. It should not be consumed orally but can be used for topical applications.^[1,5,7]

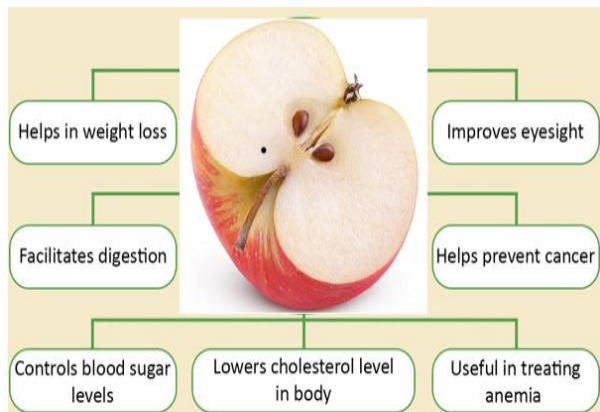


Figure Showing the Raw Diagram about the Benefits of Apple.

APPLE SEEDS CAN BE POISONOUS

Apple is considered as one the healthiest fruits but this same nutritious fruit can turn fatal. Yes, it is right. Apple seeds are capable of poisoning and causing death. Apple seeds contain amygdalin, a substance which releases cyanide when it comes in contact with human digestive enzymes. Amygdalin contains cyanide and sugar which when ingested by the body gets converted into hydrogen cyanide (HCN). This cyanide can make someone sick and can even kill someone. But acute toxicity is rare with accidental ingestion of seeds.

WORKING MECHANISM OF CYANIDE

Cyanide is infamous as one of the deadliest poisons with a long history in mass suicide and chemical warfare. Cyanide works by interfering with oxygen supply. And yes, apart from its chemical form it is also found in seeds of some fruits including, apricots, cherries, plum, peaches and apples. These seeds have tough protective coating which seals the amygdalin inside them. This strong protective layer of seeds is resistant to the digestive juices.

AFFECTIVITY OF CYANIDE

About 200 grinded apple seeds, which means around a cup of it, can be fatal for the human body. Cyanide can damage your heart and brain. It can even lead to coma and death in rare cases. In fact, if consumed in large quantities, the symptoms can occur instantly including, seizures, shortness of breath, trembling, spasm, increased heart rate, respiratory failure, low blood pressure, all of which can lead to loss of consciousness. Survivors of poisoning can show evidence of heart and brain damage.

Also, lower amount of cyanide can lead to problems like nausea, headache, vomiting, stomach cramps, dizziness, confusion and weakness. The exact amount that can

poison someone depends on their body weight. To be more precise 0.5 to 3.5mg of cyanide per kg of a human body can be poisonous. Though it also depends on individual tolerance and the type of apples. 1 gram of finely crushed or chewed apple seeds contains 0.06-0.24 mg of cyanide.

VERDICT

Swallowing whole apple seeds is unlikely to cause any complications, as they pass without causing any harms to the body. Still it's a good idea to remove the seeds before eating the apple. Nevertheless, if accidentally eat a few seeds, don't worry. But immediately spit them out to avoid any potential issues.



Figure showing the Apple and the TS section of Apple which contains seeds.

APPLE SEED OIL

Apple seed oil is a fixed oil found in apple seeds. It is used in the cosmetic and medical industries. A study on apple seed oil was conducted in 2007 which found that apple seeds contain a high amount of both oil and protein (27.5 to 28% and 33.8 to 34.5%, respectively). Analysis of amino acids in apple seeds concluded that they also contain a significant amount of sulfur. Other elements significantly found in apple seeds include phosphorus, potassium, magnesium, calcium and iron. This review based study also concluded that apple seed oil could be used as an edible oil, with the oil cake being used to supplement animal feed.^[1,6,8-10] Apple Seeds are known to contain low concentrations of amygdaline, (lower than apricot or almond seeds) a compound that degrades into HCN or Hydrogen Cyanide when metabolized.

APPLE SEEDS RELEASE CYANIDE WHEN CRUSHED

Apple seeds contain amygdalin, a plant compound known as a cyanogenic glycoside. It's part of the seeds' chemical defenses, but when apple seeds are chewed or crushed and metabolized, the amygdalin turns into hydrogen cyanide. Hydrogen cyanide, in turn, is a poisonous substance that prevents your cells from using oxygen properly, leading to death within minutes at high-enough exposure levels. It's perhaps most known for its use as a chemical warfare agent by the Germans during World War II, but it was also reportedly used during the Iran-Iraq War in the 1980s, also as a chemical weapon.¹ Apple seeds aren't the only food to contain cyanide

precursors. Amygdalin is also found in apricot, peach and cherry pits, for instance, and much more (over 2,500 plant species in all^[2]). But consuming a few apple seeds is not the same thing as being exposed to straight hydrogen cyanide, and here's why: apple seeds have a protective coating that's resistant to digestion. If you've ever eaten whole apple seeds, you may have noticed that they pass through your body basically unharmed. The cyanide is only produced if the seeds are damaged (i.e., crushed or chewed), so swallowing a few seeds whole is likely to be of little consequence. It's one of Mother Nature's ingenious protections, as the seeds' ability to produce cyanide when crushed discourages animals from chewing them, thus allowing for the whole undamaged seeds to return to the Earth and grow new apples.^[11-14]

EAT A LOT OF CRUSHED APPLE SEEDS TO BE DANGEROUS

While consuming the number of apple seeds in one apple (the average apple contains 5 seeds, according to the Washington State Apple Commission^[3,15-18]) is not cause for alarm, it is possible to be harmed by apple seeds — if you crush them and consume a large enough quantity. Children and pets, due to their smaller size, may be at increased, though still infinitesimal, risk. To look at it in more mathematical terms, 1 gram of apple seeds contains anywhere from 1 to 4 milligrams (mg) of amygdalin. If chewed, the same amount of apple seeds may turn into 0.06 to 0.24 mg of cyanide, with a lethal dose of cyanide from apricot kernels reported as being 0.5 to 3.5 mg/kg body weight.^[5-7]

LAETRILE, PURPORTED CANCER TREATMENT, IS MADE FROM AMYGDALIN

As an aside, the same compound that makes apple seeds questionable — amygdalin — has been used to make the patented anti-cancer drug Laetrile. Cyanide is believed to be the active cancer-toxic ingredient in Laetrile, also known as Amigdalina B-17 or vitamin B17 (although there is very little evidence it warrants classification as a vitamin). By 1978, it was estimated that more than 70,000 Americans had tried it — despite its being banned in the U.S. since 1963. Most people obtain Laetrile from Tijuana clinics, as the agent is still legal in Mexico.^[8,19-24] Some have also tried to make their own anti-cancer treatment by consuming crushed apricot seeds, which can be dangerous. New York's Memorial Sloan Kettering Cancer Center's highly respected cancer scientist Kanematsu Sugiura found that Laetrile significantly reduced the spread of lung cancer in mice,^[9,25-29] but the cancer research center reportedly brushed positive Laetrile studies under the rug, bowing to politics and conflicts of interest.

MORE LIKELY TO GET CYANIDE POISONING FROM CASSAVA THAN APPLE SEEDS

Cassava is a tropical root plant used in Asia, Africa and South America because it's plentiful and inexpensive. It has some notable nutritional benefits, as does tapioca, a digestive-resistant starch that's extracted from this root.

What cassava has to do with apple seeds is that they both contain cyanogenic glycosides, cassavas' being a different type than that found in apples. Cassava roots contain the toxic compound linamarin, which converts to hydrogen cyanide. Improper cooking of cassava root is associated with cyanide poisoning, which can cause symptoms of vomiting, nausea, dizziness, stomach pains, headache, and irreversible paralysis from a disease called konzo^[10,31-32] and even death. Cassava should not be eaten raw, however, if the cassava are peeled and cooked, toxic substances are removed. It should be noted that the tapioca you buy at the store or prepare from a package does not contain harmful cyanide levels, so it's perfectly safe to eat.

HEALTHIEST PART OF AN APPLE

While the debate rages on over whether apples should be consumed whole—core, seeds and all — what's not controversial is the importance of eating the peel, where much of apples' antioxidant power is contained.^[11] Apple peels also contain ursolic acid, which may help prevent age-related and illness-related muscle wasting.^[12] Since while eating the peel, look for organic apples, which will be free from pesticides and other chemicals. Apples are one of the most pesticide-contaminated fruits there is, so if you're planning to eat more apples, make them organic.

In addition, a wealth of research suggests that eating apples may impact health in a number of beneficial ways.

- **Brain Health:** Apples have been found to protect neuron cells against oxidative stress-induced neurotoxicity and may play an important role in reducing the risk of neurodegenerative disorders, such as Alzheimer's disease.^[13,30,35]
- **Stroke:** Eating apples is linked to a decreased risk of stroke.^[14,30,33-38]
- **Diabetes:** Three servings of apples (and other fruits, such as blueberries and grapes) is linked to a 7 percent lower risk of type 2 diabetes.^[15,39-52] This may be due to their beneficial role in blood sugar regulation, as apples contain compounds that may:^[16,50-56] Lessen absorption of glucose from digestive tract, Stimulate beta cells in your pancreas to secrete insulin, Increase uptake of glucose from your blood by stimulating insulin receptors
- **Cancer:** Apples have a number of properties that may help reduce the risk of cancer, including antimutagenic activity, antioxidant activity, anti-inflammatory mechanisms, antiproliferative and apoptosis-inducing activity, as well as "novel mechanisms on epigenetic events and innate immunity."

According to the journal *Planta Medica*,^[17] "Apple products have been shown to prevent skin, mammary and colon carcinogenesis in animal models. Epidemiological observations indicate that regular

consumption of one or more apples a day may reduce the risk for lung and colon cancer."

• **Heart Disease:** Eating apples is associated with a lower risk of death from heart disease, an association that's thought to be related to their content of antioxidant flavonoids.^[18,57-66]

ELSE SHOULD EAT APPLES

Apples contain a wealth of nutrients and antioxidants, including quercetin, which is known to fight cancer and prevent histamine release, the latter of which may be helpful against allergy symptoms. Interestingly, children born to women who eat apples during pregnancy are also less likely to have asthma at age 5.^[19,64-66]

Further, according to the New York Fruit Quarterly:^[20,67] "Since apples are so high in antioxidants, it is no surprise that apples, specifically, are associated with a decreased risk of chronic disease. Three studies have specifically linked apple consumption with a decreased risk for cancer..."

[and] a study has shown that apple and pear consumption has been associated with a decreased risk of asthma.

Apple consumption has also been associated with a decreased risk of coronary heart disease...

[and] a reduced risk of Type II diabetes was associated with apple and berry consumption in another major Finnish study.

CONCLUSION

In the laboratory, apples and the compounds in them have properties that may explain their effects in protecting against disease. Our lab has found that apples, and especially apple peels, have powerful antioxidant activity and can greatly inhibit the growth of liver cancer and colon cancer cells. Based on results from all of these studies, it appears that apples may play a significant role in reducing the risk of a wide variety of diseases."

Despite their healthy attributes, apples are a relatively high-fructose fruit, with 9.5 grams in a medium-sized apple. They should, therefore, be consumed in moderation. In addition, apple juice will contain considerably more, which is why far better off eating apples in their whole — not juiced — form. As for consuming the seeds, as mentioned, the amount contained in average apple is virtually harmless.

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