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Fruit seeds and their nutritional importance: review

Alya Jameel Ali Alsaad¹,¹ Zainab Abd Ali, Sara H.M. Shareef¹, Alaa gazi Al-Hashimi¹, and Kafa Ali Hussien²

¹*Food Science department, University of Basrah, Basrah, Iraq*

²*Directorate of seed testing and certification, Basrah*

Corresponding author: Zainab.abdali@uobasrah.edu.iq

Abstract:

Fruit seeds are usually discarded as waste during processing or after human consumption. Over the years, researchers have dedicated their efforts to assess the food and nutritional values of many different fruit seeds. This review unravels and discusses the value of eight different fruit seeds including avocado, citrus, watermelon, pumpkin, Pomegranate, Grape, Apricot and Mango,. The macronutrient components such as oil, protein, and carbohydrates are varied due to either varietal differences or geographical variations. Among the seed content discussed, the range of oil was from 1.8 to 49 % while the protein was from 6 to 40%. High-oil fruit seeds are potential new sources of oil, those with high protein content can be used for recovery of protein. As some of fruit seeds are edible and found to possess a host of phytonutrients, they can be harnessed for medicinal purposes. We concluded that utilization of fruit seeds could not only bring health and wealth but also help to minimize the waste disposal problem of agricultural-based industries.

Keywords: Fruit, seeds, Antioxidant, Antimicrobial, health food.

Introduction

Fruit is a type of plant generally consumed by humans and animals as a source of food. Apart from energy, humans also need nutrition and various bioactive compounds from fruits, which show many health benefits. In addition, fruits can be useful in reducing the risk of certain diseases and functional declines associated with aging [1].

We usually eat fruits and discard their seeds under the mistaken belief that seeds cause many health problems. The fruit seeds have many nutrients that are important for the body health. The seeds are rich in proteins, healthy fats, fiber, and minerals such as magnesium, potassium, calcium, iron, and zinc. They contain vitamins such as B1, B2, B3, and E as antioxidants. Fruit seeds show their broad potential as a natural source for creating added value in modern foods. Potential includes nutritional and bioactive ingredients for uses in the food, cosmetics and pharmaceutical industries. Currently, many techniques have been developed to use fruit seeds in the form of powder and extracted compounds at low costs for their use in the food industries, as they are rich in fat, protein and carbohydrate content.

Some fruit seed extracts can be used in many food applications such as preservatives, flavour enhancers, colourings and in the manufacture of Confectionery and bakeries [2].

Many researchers isolated bioactive compounds from fruit by-products, especially their seeds, and have been used in nutritional supplements, functional foods, and pharmaceutical products. Others have reported that about 35-60% of fruits are discarded as by-products after processing, especially in the case of their seeds[3]

Most fruits contain seeds amounting to about 5-45% of their total weight with the exception of bananas, oranges and pineapples. The total polyphenolic content of mango, papaya, orange and guava fruit seeds varies from 212 to 839 mg gallic acid equivalent (GAE) per 100 g of seeds [4,5]. Polyphenols contribute to many medicinal properties such as antioxidant, anti-inflammatory, antiviral, anticoagulant and anti-cancer cell proliferation activities. The main phenolic acids found in fruit seeds are caffeic acid, pomegranate acid, ferulic acid (such as mango, sweet orange, and papaya seeds) and gallic acid in avocado seeds [6].

In addition, fruit seeds also contain flavonoids, a group of phenolic compounds capable of enhancing immunity, anti-allergic, anti-cancer, antioxidant, anti-inflammatory, anti-platelet, tumour growth inhibition, antiviral, antimicrobial, antispasmodic and Protecting vessels, sweet orange seeds contain the highest flavonoid content compared to other fruit seeds. In addition, sweet orange and papaya seeds show a high content of fat and beta-carotene. They enrich food with carbohydrates and protein and are also used in the manufacture of various food products [7]. Since most fruit kernels have wide potential in many applications such as the production of functional foods and food products, qualitative and quantitative analyses of their nutritional and bioactive components are crucial, the main objective of this study is to clarify and summarize the potential and advantages of fruit seeds in terms of their nutritional importance to humans, their bioactive compounds, their functional and medicinal properties, and their role in getting rid of various diseases.

The role of seeds in human food

Seeds are a good alternative to meat, fish and eggs because they are rich sources of fibre, protein, iron, zinc and vitamins. Usually take the seeds with foods rich in vitamin C such as tomatoes, pepper and citrus juices to help them increase iron absorption. Edible seeds help reduce the risk of heart disease and diabetes and regulate body weight. The seeds are rich in omega-3 fatty acids, fiber, energy and boost the body's immunity.

Edible seeds help reduce the risk of heart disease, diabetes, and regulate body weight. Seeds are rich in omega-3 fatty acids, fiber, energy and enhance the body's immunity. Pumpkin seeds are rich in zinc, which helps in the development and functioning of the body in fighting white blood cell infections. Pumpkin seeds are rich in proteins. They also contain high levels of fat, similar to other oilseeds, so these seeds are a good source of proteins and fats [8].

The benefits of fruit seeds

Below is the most important information about the benefits of fruit seeds:

1- Avocado seeds

Avocado is one of the most beneficial fruits for health, as it contains healthy fats, and its seeds have many benefits, including reducing inflammation and relieving joint pain, as they contain antioxidants that help reduce pain and swelling caused by inflammation. The oil extracted from these seeds can also be used as a natural anaesthetic to massage the tingling site associated with arthritis. On the other hand, they can be considered natural anti-inflammatory agents, so they are very useful for reducing inflammatory diseases to which our body may be exposed, such as rheumatoid arthritis, which causes pain and stiffness in the joints [10].

Avocado seeds can be used as antioxidant tea drinks. Snack fruit seeds are also highly valuable in the health or pharmaceutical industries due to their excellent activity in preventing the growth of cancer cells. Since most of the fruit seeds have broad potential in many applications such as the production of functional foods and nutritional products, therefore analysing the quality and quantity of their nutritional and biologically active components is crucial. Two-thirds of the amount of fat in an avocado is unsaturated fat, as it is mainly concentrated in the seed. These unsaturated fats work to reduce levels of bad cholesterol and raise good cholesterol in return. In addition, avocado seeds contain high levels of soluble fiber, which is important. To promote heart health. In a scientific study published in 2013 in the journal *Current Pharmaceutical Design*, it was found that avocado seeds are a good source of phytochemicals that reduce cholesterol levels, blood pressure, and enhance immunity [11].

One of the most prominent benefits of avocado seeds is that they soothe stomach ulcers, as they are rich in antioxidants and contain more than 70% of the antioxidants found in the entire fruit, which are known as phenol, and their antibacterial and antioxidant properties make them effective in preventing ulcers within the lining of the organ. Digestive. Avocado seeds also have a magical treatment in getting rid of diarrhea, constipation, annoying gases, indigestion, bloating, toxins, and body waste. They work well to reduce swelling in the digestive tract and treat kidney stones. They also play a vital role in fighting harmful bacteria and viruses and providing the first line of defense against them [12].

Avocado seeds also contain sodium, calcium, and magnesium which regulate enzymes that help the body form glucose and use it better, thus helping to treat diabetes. Avocado seeds also contain antioxidants that reduce glucose levels, such as flavonoids. In the blood and its properties in fighting cancer or reducing tumor growth. The presence of healthy fats and the compound (avocatin B) in avocado seeds helps in getting rid of leukemia cells without causing any harm to healthy cells in the body [13].

The soluble fiber found in these seeds reduces appetite and gives a feeling of fullness that lasts longer than usual. Mineral elements such as calcium, magnesium and potassium found in the seeds also help in losing weight and regaining physical fitness significantly. Avocado seed extract contains a group of amino acids, which reduce high blood pressure by reducing total cholesterol levels and triglyceride levels and thus increasing good cholesterol. It maintains the health and safety of the heart and arteries, helps reduce the risk of vascular disease, and reduces the chances of heart attacks or stroke [14].

Avocado seed powder works as a natural moisturizer and exfoliator for the skin. It helps you remove dead skin cells and other impurities, protects against aging, gives the skin softness and freshness, and reduces dark spots and wrinkles. It repairs damage and helps produce more collagen, and this of course improves the texture of the skin and gives it a healthy glow [15].

Table 1. Chemical composition of avocado seeds

Components	Protein	Sugar	Starch	Ash	Fiber	Oil	Moisture
Percentage%	4.69	0.14	59.3	2.34	7.45	1.94	52.5

2- Citrus seeds:

The nutritional value found in the seeds of citrus fruits is similar to that found in the whole citrus fruits themselves [16]. All seeds of citrus fruits are safe for consumption and will not lead to risks when swallowed by mistake. One of their most prominent benefits is that they contain quantities of salicylic acid, which is the component The main one is in aspirin, so taking some of it will not harm the body but will help relieve pain [17].

The citrus fruits seeds contribute to cleaning the stomach and intestine from parasites, including threadworm infections. They also help clean the toxins and any harmful substances from the body. The various antibiotics in the citrus fruit's seeds contribute to treating urinary tract infections and reducing their symptoms. Citrus fruit seed oil with a pleasant nice smell is used in massage preparations and oils. It calms the nerves, helps relax and improves the mood [18].

Citrus seeds also have cosmetic therapeutic properties similar to those of the lemon itself, including containing vitamin C and antioxidants that enhance skin health, nourish it, and maintain its moisture [19].

Citrus fruit seed extract is used to fight fungus in the feet and nails. It is effective in treating itching and burning sensation on the skin around the toes and fingers. Chewing the seeds of citrus fruits can help cleanse the mouth, relieve bad breath, help secrete saliva, and clean the tongue of bacteria and fungi [20].

3-Watermelon seeds

Watermelon belongs to the Cucurbita family, which is the family to which include cantaloupe, cucumber and pumpkin squash. The pulp is red, dark red, or yellow. Watermelon is divided into three types based on how the seeds grow, open-pollinated, hybrid, and seedless. [21.22]. Watermelon contains small, hard, black seeds, while hybrid watermelon does not contain seeds [23]. The seeds are edible whether raw or roasted, and they can also be cooked, dried and served as a snack, in addition to being cooked, ground and fermented for use as a flavour enhancer in stocks and soups in West Africa [24].

Watermelon seeds rich in nutrients, the most important of which is magnesium, as 4 g of watermelon seeds contain 21 mg of magnesium, which is equivalent to 5% of the daily amount needed by humans. The National Institutes of Health recommends that adults get 420 mg of magnesium daily that necessary for many metabolic processes Functions in the body, maintaining nerve and muscle functions, in addition to immunity, heart and

bone health. Some grams of watermelon seeds also contain about 0.29 mg of iron, which is equivalent to about 1.6% of the daily amount, and the National Institutes of Health recommends that adults get 18 mg per day, as iron is one of the important elements that make up haemoglobin, which is responsible for transporting oxygen. It also helps the body convert calories into energy. watermelon fruit seeds contain about 26% of the daily value of zinc, which is an important and necessary nutrient for the immune system, digestive system, and nervous system, in addition to its importance in cell regrowth and division [25].

It is considered a rich source of nutrient fiber, as 100 grams of watermelon seeds contain approximately 33.99% of it, which consists of non-starch polysaccharides, indigestible part of plant foods, include of water-soluble fiber and insoluble fiber. Fiber soluble in water consuming in large quantities and associated with slow absorption of glucose in the intestine, reducing insulin secretion and type 2 diabetes protection[21].

4- Pumpkin seeds

Pumpkin or gourd, scientifically known as *Cucurbita pepo*, is an annual plant grows in the shape of a long stem that may reach five meters in length. It produces large fruits and has several varieties grown all over the world. They differ in terms of flavour, texture and color, and inside the fruits are small-sized seeds. And edible. Pumpkin is famous for its seeds, fruits and leaves as well, as its seeds are considered the most important parts in terms of nutritional value, followed by the fruits that are often used in the manufacture of sweets and drinks in addition to cooking [26].

Pumpkin seeds are rich in zinc which helps in the development and function of the body in fighting infection of white blood cells. Pumpkin seeds are rich in proteins and contain high levels of fats, similar to other oilseeds. These seeds are considered a good source of proteins and fats [5,15].

Pumpkin seeds contain a high percentage of manganese, magnesium, phosphorus, copper, iron, zinc, and potassium, in addition to many essential vitamins for human health, such as vitamins E, C, B2, A, K, folic acid, and amino acids, especially citric acid. Tryptophan. It also contains a very high percentage of high-quality protein, essential fatty acids, and antioxidants such as: carotenoids and vitamin E, which work to protect against diseases, reduce inflammation, protect the body's cells from harmful free radicals, and contribute to improving public health from By maintaining testosterone levels .The benefit of pumpkin seeds is that they contain proteins, unsaturated fatty acids, vitamins, and minerals that help reduce the risk of stomach, colon, lung, and breast cancer, and slow the growth of prostate cancer cells [27].

One of the benefits of pumpkin seeds is that they contain antioxidants, in addition to helping maintain heart health by dilating blood vessels due to their ability to produce nitric oxide, thus reducing blood pressure, in addition to improving heart health and reducing the risk of plaque growth in the arteries ([27].

These seeds are available in multiple forms, such as raw, roasted, salted, and unsalted, or they can be ground and added to juices, yogurt, and fruits. They can also be added to salads, soups, cereals, and baked goods. The ground seeds can be used to coat chicken, to

give it a crunchy layer. Fresh and dry seeds can be stored for two months and preserved without being damaged in an airtight container in the refrigerator. They can also be roasted at low heat in the oven (no more than 170°F or 75°C) for 15-20 minutes [26].

Pumpkin seeds contain sterols linked to protection against hormonal cancers. Pumpkin seeds may help prevent diabetes complications by reducing oxidative stress through insulin regulation. Pumpkin seeds are rich in the amino acid tryptophan, which is important in the production of serotonin which is one of the main components of our mood. A handful of roasted pumpkin seeds may help maintain high spirits and avoid depression. Eating pumpkin seeds a few hours before bed, along with a small piece of fruit, is particularly beneficial for melatonin and serotonin production to help promote a restful night's sleep. In addition, pumpkin seeds contain some omega-3 fatty acids and vitamin E and folic acid, which helps maintain heart health [28].

Table 2. peel-free pumpkin and watermelon seeds ingredient per100 gm

Nutritional ingredients	Pumpkin seeds	Watermelon seeds
energy	109 calories	557 calories
Water	9.6 gm	5.05 gm
Carbohydrates	6.5 gm	15.31 gm
Proteins	1 gm	28.33 gm
Fats	0.1 g	47.37 gm
magnesium	12 mg	515 mg
Iron	0.8 mg	7.28 mg
Zinc	0.32 mg	10.24 mg
Phosphorus	44 mg	755 mg
Manganese	0.125 mg	1.614 mg
Copper	0.127 mg	0.688 mg
Potassium	340 mg	648 mg
Calcium	21 mg	54 mg

(El-Ghany *et al.*, 2017)

5- Pomegranate seeds:

Pomegranates contain substances known as polyphenol compounds, and these substances interact with bacteria in the colon, producing a substance known as Urolithin A, which works to protect the digestive system from diseases, and also helps in treating them, by preventing toxic substances and harmful bacteria from entering. For the colon, thus preventing it from causing inflammation [29].

One of the benefits of pomegranate seeds for ulcerative colon is that it helps relieve inflammation, its accompanying symptoms, and irritation of the digestive system. The importance of the benefits of pomegranate seeds for the stomach lies in that they contain a group of antioxidants, which work to protect the stomach and digestive system from harmful bacteria and gastritis, such as *H. Pylori*, and other types of bacteria transmitted by contaminated food and drink. Saponin, tannins, vitamin E, vitamin C, and flavonoids are antioxidants found in pomegranate seeds [30].

Pomegranate works to calm the stomach and treat its disorders. It is worth noting that all parts of the pomegranate tree provide a group of pomegranate benefits for the stomach and digestive system. It has been found that drinking pomegranate leaf tea helps treat digestive system disorders and improves digestion. Also, eating pomegranates in large quantities may cause bouts of heartburn, constipation and diarrhea, so it is recommended to eat moderate amounts of pomegranate to avoid its harmful effects. Pomegranates, and pomegranate seeds in particular, contain a high percentage of fiber, and it has been found that 50% of the fiber content in pomegranates is in the seeds [30].

Table 3. Nutritional value for every 100 grams of pomegranate seeds

Water	77.9 gm
energy	83 Calories
Total protein	1.67 gm
Total fat	1.17 gm
Ash	0.53 gm
Fiber	4 gm
Carbohydrates	18.7 gm
Total sugars	13.7 gm
Calcium	10 gm
Iron	0.3 mg.
Magnesium	12 mg.
Phosphorous	36 mg
potassium	236 mg
sodium	3 mg.
zinc	0.35 mg
copper	0.158 mg
Manganese	0.119
Selenium	0.5 µg
Vitamin C (Ascorbic)	10.2 mg
Vitamin B1 (thiamine)	0.067 mg
Vitamin B2 (riboflavin)	0.053 mg
Vitamin B3 in the form of niacin	0.293 mg
Vitamin B9 in the form of folate	38 µg
Choline	7.9 mg
Vitamin E (alpha tocopherol)	0.6 mg
Vitamin K (phylloquinone)	16.4 µg
Total saturated fatty acids	0.12 gm
Campesterol	1 mg
Beta sitosterol	4 mg

Source: USDA database

6- Grape seeds

Although their taste may be sour and not delicious, the benefits of grape seeds exceed what is expected, and the importance of eating them stems from their containment of many important nutrients and vitamins for the body, which are fatty acids, amino acids, and antioxidants known as flavonoids [31].

The most prominent benefits of grape seeds are the following [32].

- 1- Fight aging and signs of aging: Grape seeds contain powerful antioxidants, which play a major role in fighting aging and signs of aging, including wrinkles.
- 2- Reducing the risk of heart disease: eating grape seeds contributes to reducing the risk of heart attacks, irregular heartbeats, and reducing high cholesterol levels.
- 3- Treating varicose veins and swelling of the legs: the antioxidants found in grape seeds contribute to improving blood circulation, thus reducing the possibility of developing varicose veins. Not only that, but they also help women, especially those who sit for long periods, to reduce swelling of the legs.
- 4- Fighting cancer although this benefit associated with eating grape seeds and fighting cancer early has been emphasized, preliminary results indicate that grape seed extract contains anti-cancer properties that are mainly linked to antioxidants.
- 5- Contributing to weight loss: It has been found that eating and chewing grape seeds may help in losing weight, as grape seed extract helps speed up metabolism and get rid of body fat. However, there is a need to do more scientific research on the subject, as proving this may help researchers develop a mechanism that works to fight obesity. And its treatment.
- 6- Getting rid of depression: Antioxidants called proanthocyanidins found in grapes are able to affect the brain and rid a person of depression, as these antioxidants have contributed to increasing the level of serotonin in the brain in addition to other chemical compounds responsible for depression.
- 7- Healing wounds: A study published in the Scientific Journal of Free Radical Medicine and Biology found that applying an antioxidant extracted from grape seeds, known as bronchodilators, to helped wounds heal them faster [32].

7- Apricot seeds

Apricot are one of the most delicious natural fruits that are available in the summer. Their color tends to be orange or reddish-yellow, and they contain a pit inside them. The seeds have many health benefits for the human body, as it is ground well and added to food or consumed as tea. Apricot seeds enhance It is also beneficial to the health of women’s beauty and it is used in the preparation of many cosmetic products that are applied to the skin and hair due to it containing a high percentage of important substances, chemical compounds, vitamins and minerals.

Table 4. Nutritional value of apricot seeds

Nutrients	%
Protein	14-45
Fats	28-67

Carbohydrates	18-28
Fiber	5

Benefits of apricot seeds for treating cancer

One of the most common health benefits of apricot seeds is that they treat cancer diseases through their richness in antioxidants, glycosides, and vitamin B17, which helps destroy cancer cells, limit infection, combat and destroy them, and seed powder is used in the manufacture of chemical drugs and all medications and pharmaceutical treatments to eliminate cancer. The seeds also contain hydrocyanic acid, which is effective in breaking up malignant cancerous tumours, especially liver cancer, prostate cancer, skin cancer, and cervical cancer. Therefore, the risk of cancer can be prevented by grinding apricot seeds and adding them to a fruit salad dish. [33-35]

Benefits of apricot seeds for treating colds

Apricot seeds are used to treat all viruses that cause severe colds and chronic influenza, thanks to these seeds containing a very high percentage of important minerals and nutrients to strengthen the immune system, which plays its role in fighting bacteria, microbes, and viruses that penetrate the body and give them the opportunity to infect people with severe cold diseases. Apricot seeds also treat all the symptoms resulting from influenza. It is a natural reliever for headaches and an antibiotic for colds, runny nose, and severe coughs. It also treats sore throat and moisturizes the larynx to help swallowing and reduce its difficulty [36].

Benefits of apricot seeds for the respiratory system

Apricot seeds are very beneficial for the respiratory system and help treat most respiratory diseases, including asthma and chronic chest allergies because they supply blood to the respiratory organs and work to stimulate blood circulation, because they contain a large amount of effective compounds, including carotenoid compounds and lycopene, which work to protect The respiratory system and strengthening the immune system that resists bacteria and germs that penetrate the respiratory system, and it also works as a natural sedative for the nerve disorder that causes asthma.

8- Mango seeds

mango seeds are white, usually located in the middle of the mango fruit, and are one of the largest types of fruit seeds. Mango is a type of fruit, scientifically known as (*Mangifera indica*). Mango seeds may have many benefits for health and beauty, as some people do not realize that by throwing away mango seeds, they may lose part of the nutritional value of the mango fruit, especially the seeds that were taken. Of African mango in particular. Mango seeds contain a variety of nutrients and active compounds such as antioxidants and unsaturated fatty acids. Therefore, these seeds may have many benefits for health as well as beauty [22].

It is possible to benefit from mango seeds for beauty by using mango butter, which is extracted and manufactured from the pulp of mango seeds. It is similar to this butter in its texture and benefits for the skin and for improving skin health [37].

Benefits of mango seed butter: Stimulating production processes. And the production of collagen in the body. Collagen is a protein substance that is included in the composition of various body tissues, such as skin and muscles, but natural aging may cause it to begin to disintegrate and reduce the body's ability to manufacture it in sufficient quantities. Mango butter may work to form an outer protective layer that covers the skin to moisturize it and increase its softness. It also works to combat dry lips and treat some hair problems, such as regrowing hair in cases of alopecia, especially when greasing the gaps with a mixture made of mango butter and mustard oil after drying it in the sun for a few days [38] .

One of the benefits of mango seeds is that they contain substances that may help regulate blood sugar levels, so taking supplements containing the extract of this type of seed may help fight diabetes or reduce the chances of developing diabetes in people who are not affected. 100 grams of the edible part of the fruit contains 82.2% water, 1.6% dietary fiber, 15% carbohydrates (sucrose, fructose, xylose, glucose), 0.4% fat, and 0.8% proteins. The calorie content of ripe mango can vary depending on the variety. 65 to 70 kcal/100 g. Suganthi and Josephine [39], proposed a feasible processing method to convert mango seed kernels into powder which provides wide-ranging technical applications and is more convenient for transportation, storage, and processing. Fortifying food with mango seed powder is a smart way to provide an adequate intake of antioxidants, protein and fats that consumers need at a reasonable price

Conclusion

This article summarizes the useful characteristics of several fruit seeds and the fatty acid composition of their oils. As majority of the fruit seeds discussed above come from edible fruits, they have the potential to be used directly as raw material for food and pharmaceutical formulations. As some of them contain considerable amounts of oils, they can become source materials for functional lipids. The utilization of fruit seeds in future not only can minimize the accumulation of waste but it also can generate extra revenue for fruit processing sector. As many areas of fruit seeds are still needed to be investigated further, this article can be a useful reference for future research activities.

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