

Composition, Nutraceutical Potentials and Utilization of Avocado (*Persea americana*) Seeds in the Development of a Functional Beverage (Tea): A Review

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Abstract

The pulp of the well-known tropical fruit avocado (*Persea americana*) is used extensively for culinary, cosmetic, and medicinal purposes; however, the seed, which accounts for 13–18% of the fruit, is typically discarded as agro-food waste. Avocado seeds have lately garnered scientific interest due to their wealth of bioactive compounds and potential as a nutraceutical. This article thoroughly examines the origins, botany, variations, and agronomic characteristics of avocados, with particular focus on the chemical composition, practical applications, and health benefits of avocado seeds. The quantity of dietary fiber, starch, phenolic compounds, flavonoids, carotenoids, and antioxidants in avocado seeds is linked to a variety of biological activities, including antioxidant, antibacterial, anti-inflammatory, hypocholesterolemic, antihypertensive, and antidiabetic effects. The presence of antinutritional components such as tannins, phytates, oxalates, and cyanogenic glycosides—which may limit nutrient bioavailability—as well as processing techniques that can reduce these compounds are discussed. The review also highlights the use of avocado seeds in non-food and food applications, with a focus on their increasing use in the production of tea, a functional beverage. The sensory appeal, phytochemical retention, and consumer acceptability of avocado seed tea have been shown to be impacted by processing methods such as drying, roasting, fermenting, and blending. Despite problems with bitterness, aroma, and uniformity, avocado seed tea offers a practical, sustainable route for waste reduction and the production of beneficial beverages. This study highlights the need for more research on varietal differences, processing optimization, safety evaluation, and bioavailability in order to increase the commercial viability of avocado seed-based functional products.

Keywords: Avocado seed; *Persea americana*; Nutraceuticals; Functional beverage; Avocado seed tea; Antioxidants; Agro-food waste valorization; Bioactive compounds; Antinutritional factors; Food sustainability.

Introduction

A beverage is any drinkable substance that isn't water. The word "beverage" comes from the old French word "boivre," which means "a drink." Therefore, liquid drinks meant for human consumption are called beverages. They offer refreshing qualities, alleviate weariness, and stimulate the neurological system in addition to quenching thirst [36]. Juice from fruits was most likely the first beverage that humans drank. Over time, we learned about a wide variety of stimulating and pleasant drinks to satisfy our thirst. Drinks may contribute to the water needs of people. [54] stated that drinks accounted for 20–24% of total energy consumption.

Beverages come in two varieties: non-alcoholic and alcoholic. Alcoholic beverages are made from various fruits and cereals and contain alcohol, as their name suggests. Tea and coffee are examples of non-alcoholic beverages that have energizing and refreshing qualities because they contain modest levels of caffeine.

Tea is a popular beverage that originated in China and is consumed by many people worldwide. It is currently gaining attention due to its positive health effects, which are being studied for having antioxidant activity, which is primarily attributed to the high concentration of polyphenols (phenolic acids, flavonoids, and catechins) [55] [52]. One of the most popular drinks in the world is tea (*Camellia sinensis* (L.) syn. *Thea sinensis* (L)) [36]. Green, oolong, and black tea are the three main varieties. In order to prevent oxidation, green tea is cooked shortly after harvest. The majority of Chinese restaurants use oolong tea, which oxidizes a little more slowly. Black tea is the darkest of the teas because it oxidizes for the longest. The avocado (*Persea americana*) is a tropical and Mediterranean tree and shrub that is a member of the Perseal genus and the Lauraceae family. It came from Central and South America as well as Mexico [5]. The fruit is an ovate to spherical, big, fleshy berry that is 5–15 cm long and contains a solitary, hard, nut-shaped seed [63]. In Nigeria, *Persea americana*, popularly known as the avocado, goes by several different names, which reflects

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the country's linguistic and cultural diversity.

Ripe avocado fruits have purplish-black skin. The edible meat (65%), seed (20%), and skin (15%) make up the entire avocado fruit. Between 71 to 88% of the total calories are made up of fat [28].

Avocado pear fruits have significant therapeutic benefits in addition to some nutritional components. Protein, fiber, monounsaturated fatty acids, antioxidants, vitamins, and minerals like folic acid, pantothenic acid, copper, potassium, sodium, vitamin K, and vitamin B6 can all be found in avocado pulp [51]. Avocado pears are high in glutathione, vitamin E, and antioxidants [65]. In addition to being a significant source of potassium, the fruit has 75% insoluble and 25% soluble dietary fiber [28]. Scientists have recently focused on the potential of incorporating avocado seeds in food design. Previous research has examined the use of avocado seed in cakes, candies, coffee substitutes [57], and extruded snacks [21]. Because of their alleged anti-hypertensive properties, avocado seeds are traditionally used in soups and puddings and eaten as tea in several African nations. However, its dark hue and harsh flavor have lessened its widespread consumer popularity [8]. [36] [4] created moi-moi, or steaming cowpea pudding, using mixtures of cowpea and avocado pear seed flour and found that cowpea may be substituted up to 10% of the time for avocado pear seed flour to produce a satisfactory and nourishing moi-moi. Thirteen to eighteen percent of the fruit is made up of avocado pear seeds. However, it is frequently thrown away as agro-food waste during the pulp's processing and consumption; as a result, a sizable amount of the fruit is lost, posing a serious ecological issue [45]. Insects and rats, which are an environmental annoyance, are drawn to the abandoned seeds in the trash heaps.

Therefore, processing can effectively improve the nutritional quality of avocado seeds for potential usage in food compositions. In order to guarantee the population's nutrient security in industrialized nations, a variety of processing techniques and treatments, including soaking, cooking, roasting, fermenting, and drying, have been effectively employed to convert food ingredients into better products with maximum nutritional content [46]. Recent research has demonstrated that avocado pear seeds include a variety of components, including secondary metabolites, which also impede the usage of avocado pear seeds. However, little work has been done to eliminate these metabolites. Avocado seeds have been shown to contain oxalates, some tannins, hydrocyanic acid, and cyanogenic glycosides, including the well-known amygdalin and persin. Animal research on avocado seed ethanol extract revealed no genotoxic effects; therefore, it could be used as a food, cosmetic, or pharmaceutical additive, despite the paucity of human studies examining the impact of the antinutrients present in avocado seed and their health effects [59].

Due to their size and hardness, avocado seeds can cause choking, especially in young children or those who have trouble swallowing. The gritty texture and harsh taste of avocado seeds make them less appealing for cooking. Additionally, there hasn't been enough effort to enhance the flavor and perfume of avocado pear seeds. Optimizing the use of avocado seeds in both conventional and contemporary food applications is hampered by this knowledge gap.

Green tea has only been made from one type of avocado pear seed thus far. To produce different kinds of tea, it is necessary to experiment with different types of avocado seeds.

Thus, the composition, characterisation, nutraceutical potential, and usage of avocado seeds in tea manufacturing are the main topics of this paper. The effort will reflect the origins and agronomy of avocado pears, as well as their chemical composition, which includes several antinutrients, and health advantages.

LITERATURE REVIEW

Origin of Avocado Pear

Originally from Mexico and Central America, the avocado tree is a member of the Lauraceae family, genus *Persea*, which has two subgenera: *Eriodaphne* and *Persea*. *Persea americana* Miller var. *Drymifolia* (a Mexican species), *Persea americana* Miller var. *American* (a West Indian species), and *Persea nubigena* Miller var. *Guatemalensis* (a Guatemalan species) are the three botanical varieties of avocados grown for agricultural purposes. The avocado tree can only be produced in subtropical or tropical regions since it cannot withstand freezing temperatures. The Gainesville, Florida area is home to a number of cold-hardy cultivars that can withstand temperatures as low as -6.50 °C (200F) with relatively slight leafloss.

Similar to bananas, avocados are climatic fruits that develop on trees but ripen off of them. They are harvested hard and green and stored in coolers at 3.3 to 5.60C (37.9 to 42 10F) until they arrive at their destination. When an avocado reaches maturity, it is often harvested and allowed to ripen at room temperature (it ripens more quickly when stored with other fruits like apples or bananas due to the influence of ethylene gas). Avocados that fall from trees ripen on the ground. When a ripe avocado is held in the palm of the hand and gently pressed, the flesh is susceptible to enzymatic browning and soon turns brown when exposed to air [40].

Botany of Avocado

The tree *Persea americana* can reach a height of 20 meters (66 feet) and has alternating leaves that range in length from 12 to 25 centimeters (5 to 10 inches). The axils of leaves or new growth produce panicles of flowers with deciduous bracts. The flowers are small, greenish-yellow, and range in width from 5 to 10 mm (3 to 8 inches).

Due to human selection pressure to create larger, fleshier fruits with a thinner exocarp, the species is varied. Because of the invisible endocarp that covers the seed, the avocado fruit is not a drupe but rather a climacteric, single-seeded berry. The fruit, which resembles a pear, is typically 7–20 cm (3–8 in) long, weighs between 100 and 1,000 g (3+1/2 and 35+1/2 oz), and has a huge central seed that is 5–6.4 cm (2–2+1/2 in) long [37].

Description of Avocado Pear

Temperature and rainfall are the primary climatic requirements for avocado trees, and their behavior varies depending on their race. The enormous piri-shaped fruits of the Antillean race (common), which originated in the lowlands of South and Central America, have a low oil content (less than 8%) and can withstand temperatures as low as -2°C. Compared to the Antillean race, which can withstand temperatures as low as -4°C, varieties of the

Guatemalan race, which originated in the Central American highlands, have round-shaped fruit that matures later and has a higher oil content (8–20%). On the other hand, the Mexican races, which originated in the Andes and Mexico's highlands, are distinguished by their small fruits, high oil content (over 20%), and ability to withstand temperatures as low as -6°C [7]; [37]. After seven years of planting, the avocado tree may produce 138 kg of fruit. It doesn't compete with annuals that are suited to flatlands because it is a perennial that can be grown in uneven areas [13]. Quintal fruits are huge (500–800 grams), piriform, with green-smooth skin, yellow flesh, medium to large seeds, and somewhat loose within the fruit. They are hybrids of Antillean and Guatemalan races. About 63% of its lipid component is made up of omega-9 fatty acids, making it the most popular kind in Brazil [43].

The Hass avocado, which weighs between 180 and 300 grams on average, is the most exported cultivar in the world [14].

Unlike other fruit species, avocados have rapid growth and development. Following harvest, the fruit reaches full maturity with significant metabolic changes and an increased respiratory rate. This results in a high generation of ethylene, which is highly perishable in the environment and produces a lot of waste. In this way, preparing avocado pulp can help it be used to its fullest potential, either for oil extraction or as a food product.

Cultivation of Avocado

Avocados require an environment free of frost and low wind because they are a subtropical species. Strong winds dehydrate the blooms, lessen humidity, and interfere with pollination. Although the 'Hass' cultivar can withstand temperatures as low as -1 °C, premature fruit drop may occur when even mild frost occurs. The Gainesville, Florida, area is home to a number of cold-hardy cultivars that can withstand temperatures as low as -6.5 °C (20 °F) with relatively slight leaf loss.

Table 1. The Different varieties of Avocado pear

Variety	Characteristics	Regions of Cultivation
Hass	The most popular variety, known for its rich flavor, creamy texture, and long shelf life	California, Mexico, Chile, New Zealand, South Africa
Fuerte	A large, pear-shaped avocado with a smooth, green skin and a buttery, nutty flavor	California, Florida, Mexico
Bacon	A medium-sized avocado with a slightly bumpy, green skin and a rich, nutty flavor	California, Florida
Zutano	A large, pear-shaped avocado with a smooth, green skin and a slightly sweet, nutty flavor	California, Florida
Gwen	A medium-sized avocado with a smooth, green skin and a slightly tart, nutty flavor	California, Florida
Reed	A large, pear-shaped avocado with a smooth, green skin and a slightly sweet, nutty flavor	California, Florida
Pinkerton	A medium-sized avocado with a smooth, green skin and a slightly tart, nutty flavor	California, Florida
Nabal	A medium-sized avocado with a dark green skin and a rich, nutty flavor	California, Florida
Topa Topa	A medium-sized avocado with a reddish-purple skin and a mild, nutty flavor	California, Florida
Ettinger	A large, pear-shaped avocado with a smooth, green skin and a slightly sweet, nutty flavor	California, Florida
Booth7	A medium-sized avocado with a smooth, green skin and a slightly tart, nutty flavor	California, Florida

Source: [60].

Nutritional Benefits and Culinary Uses of Avocado

In northern South America, Central America, and Mexico, avocados are consumed in a variety of ways, including pureed salads, seasoned with salt, pepper, vinegar, and other condiments, and used to make other cuisines [43]. Along with sugar, honey, and liqueurs, ripe fruit is highly valued in Brazil, where its sensory and nutritional qualities are the primary factors influencing consumption.

In relation to fruit mass, the pulp content ranges from 52.9 to 81.3% in a number of cultivars.

Additionally, the trees require well-aerated soil—ideally deeper than one meter.

The Water Footprint Network reports that one avocado (283 L/kg) requires an average of about 70 liters (18 US gallons) of applied fresh ground or surface water, excluding rainfall and natural moisture in the soil. However, the amount of water required varies depending on the location; in Chile's primary avocado-growing region, one avocado requires approximately 320 L (85 US gal) of applied water (1,280 L/kg). Avocado trees can be multiplied by grafting or seeding. The most popular avocado propagation technique is grafting; grafted plants provide fruit after two years, whilst seeded trees do so after roughly eight years. There is a greater chance of fruit yield and quality losses when trees planted from seed have a longer juvenile stage [15]. The avocado is a climacteric fruit. When the fruit is affixed to the tree, it achieves maturity, however the ripening stage begins when the fruit

It is crucial to lower the temperature, remove mechanical damage, and decrease ethylene production in order to postpone the ripening process. The fruit's post-harvest life is decreased as soon as ripening begins, although the ripening phase is crucial for the fruit's edible quality. The rise in post-harvest illnesses is partially to blame for this. Climacteric fruits can be artificially ripened using a variety of external methods [15].

Avocado Varieties For both domestic and international markets, a number of cultivars have been introduced, including Puebla, Pinkerton, Hass, and Fuerte. Booth 7 and Booth 8 are two other cultivars that have been brought to Kenya; their anthracnose susceptibility is unclear [11]. However, in addition to the regional types in Muranga County, only Fuerte, Hass, and Pinkerton are produced. Below are various characteristics of different avocado varieties as described by [16].

After the water is removed, avocado pulp retains high quantities of lipids and low levels of carbohydrates, giving the product a high dry matter content. As a result, it is regarded as one of the few cultivated fruits that has a significant lipid percentage [65], which can make up as much as 25% of the fruit. The avocado pulp has an energy density of between 140 and 228 kcal, 67 to 78% moisture, 13.5 to 24% lipids, 0.8 to 4.8% carbohydrate, 1.0 to 3.0% protein, 0.8 to 1.5% ash, and 1.4 to 3.0% fiber [64]. With the exception of bananas, avocados are four (4) times more nutritious than other fruits.

They contain proteins (1 to 3%), significant amounts of insoluble vitamins [31], folic acid, and significant amounts of calcium, potassium, magnesium, sodium, phosphorus, sulfur, and silicon as well as vitamins E, B1, B2, and D (Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids).

Compared to other fruits, the fruit has higher potassium levels (339 mg/100g-1), which controls muscular activity and shields the body from cardiovascular disorders. Additionally, it is a source of glutathione, a potent antioxidant that targets substances that may cause cancer.

Because it is strong in protein and contains fat-soluble vitamins that other fruits lack, such as vitamins A and B, as well as median levels of vitamins D and E, avocados are a major tropical fruit. Because of the pulp's varying oil content, it is frequently utilized in the pharmaceutical and cosmetic sectors as well as to produce commercial oils that resemble olive oil due to its similar fatty acid composition [13]. Additionally, this fruit has been acknowledged for its health benefits, particularly because of the components found in the lipid fraction, which include squalene, phytosterols, tocopherols, and omega fatty acids [68].

Avocados have become a global culinary staple due to their distinctive creamy texture and rich flavor. Because of their adaptability, they can be used to add taste and nutritional value to a variety of recipes. Some of the most popular culinary applications for avocados are as follows, per [12]:

1. Guacamole: Perhaps the most famous usage of avocados in cooking is the delicious Mexican dip known as guacamole. Guacamole, which is often made with mashed avocados, lime juice, cilantro, and onions, is a flexible condiment that goes well with burritos, tacos, chips, and sandwiches.

2. Avocado Toast: As a straightforward but filling breakfast or snack choice, avocado toast has become incredibly popular. Usually spread on toast, mashed avocados are topped with extra items like sliced tomatoes, smoked salmon, or poached eggs.

3. Salads and Dressings: Avocados are a nutritious and pleasant addition to salads because of their nutty flavor and creamy texture. Avocados can be blended with olive oil, lemon juice, and spices to create a quick and healthful salad dressing.

4. Smoothies: Adding avocados to smoothies can improve their creaminess, fiber, and healthy fats. Their subtle taste complements a variety of fruits, veggies, and yogurt to make wholesome and filling smoothies.

5. Sushi: Avocados are a common component of sushi rolls, giving the savory flavors of the vegetables a creamy counterpoint. California rolls and other makirolls frequently employ them.

6. Desserts: With their rich and delicious texture, avocados can be surprisingly adaptable in desserts. They work well in brownies, ice cream, and chocolate mousse.

7. Because of their distinct flavor, creamy texture, and remarkable range of health-promoting ingredients, avocados, botanically known as *Persea americana*, have become incredibly popular all over the world [10]. Native to Mesoamerica, these pear-shaped fruits are now a mainstay in many cuisines and are becoming more widely acknowledged for their potential to improve general health.

Avocados are a great provider of several different nutrients, such as:

Heart-healthy fats: Avocados are a great source of monounsaturated fats, especially oleic acid, which has several health advantages. It has been demonstrated that oleic acid increases HDL (good) cholesterol and decreases LDL (bad) cholesterol, which may lower the risk of heart disease. A tiny quantity of polyunsaturated fats, which are similarly important for heart health, can be found in avocados [10].

Fiber: An important nutrient for digestive health, dietary fiber is abundant in avocados. Fiber helps maintain a healthy gut microbiota, facilitates regular bowel movements, and aids in the absorption of nutrients. Consuming enough fiber can also help against diverticulosis, constipation, and potentially some forms of colon cancer [71].

Avocados' Fat Content Avocados contain about 70% monounsaturated fats, 12% polyunsaturated fats, and 18% saturated fats. Avocados are an important part of a balanced diet since they are a nutrient-rich fruit with a distinct fat profile. Their potential health benefits, such as enhanced heart health, digestive wellness, and general well-being, are attributed to their richness of heart-healthy fats, fiber, vitamins, and minerals [10]. **Applications and Health Benefits of Avocados** Native to Mesoamerica, these pear-shaped fruits are now a mainstay in many cuisines and are becoming more widely acknowledged for their potential to improve general health.

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Health Benefits/Applications of Avocado

These pear-shaped fruits, native to Mesoamerica, have become a staple in many cuisines and are increasingly recognized for their potential to contribute to overall well-being.

Heart-Healthy Fats for Cardiovascular Health

Avocados' high fiber content also helps you feel fuller for extended periods of time, which may help you manage your weight [10].

Numerous vitamins and minerals, such as potassium, which is necessary for controlling blood pressure and muscular function, may be found in avocados.

Folate: Essential for cell division and DNA synthesis, especially for expectant mothers.

Vitamin E: A potent antioxidant that shields cells from harm brought on by free radicals.

Vitamin K: Essential for healthy bones and blood coagulation.

These minerals and vitamins are vital for many body processes, supporting general health and wellbeing.

Possible Advantages for Particular Medical Conditions
Avocados have been connected to potential advantages for certain medical disorders in addition to their overall nutritional value:

Weight management: The high fiber content of avocados helps control hunger and increase fullness, which may help with weight management. Regular avocado eating may help people lose weight or maintain a healthy weight, according to studies [20].

Blood Sugar Control: The fiber in avocados may aid those with diabetes or prediabetes by slowing down the absorption of carbs. Consuming avocados may enhance blood sugar regulation and lower the likelihood of insulin resistance, according to studies [70].

Eye Health: The antioxidants lutein and zeaxanthin found in avocados shield the eyes from age-related macular degeneration, which is a major cause of vision loss [19].

Anti-inflammatory Properties: Compounds found in avocados have anti-inflammatory qualities that may help lessen inflammation linked to long-term conditions such as inflammatory bowel disease and arthritis [70].

2.3 Allergies Linked to Eating Avocado Pear
Although they are relatively rare, those who are predisposed to allergies may develop avocado allergies. These reactions might be moderate or severe, so it's important to recognize them and take appropriate action.

Avocado-Related Allergies:

1. **The Latex-Fruit Syndrome** Latex-fruit syndrome, in which those allergic to latex may also have allergic reactions to specific fruits, including avocados, is frequently linked to avocado allergy (Leung and Sampson, 2020). This is because some fruits and the proteins in latex are cross-reactive [70].

2. **Oral Allergy Syndrome (OAS):** When eating avocados, some people may get moderate oral allergy symptoms as itching or swelling of the lips, mouth, or throat. Cross-reactivity with pollen allergens may be linked to this [60].

3. **Histamine Intolerance:** Avocados naturally contain histamine, much like a lot of other foods [62]. After eating foods high in histamine, such as avocados, people with histamine intolerance may have symptoms like headaches, rashes, or stomach problems [44]. Although allergic responses to avocados are possible, they are rather uncommon. People who have a history of latex-allergy syndrome may be particularly vulnerable. In order to properly diagnose and treat an avocado allergy, a person should consult a healthcare provider.

Symptoms of Avocado Allergies

According to Leung and Sampson (2020), symptoms of avocado allergy usually appear minutes after eating avocados or coming into touch with its flesh or skin. These signs could consist of:

Skin reactions: eczema, edema, redness, hives, and itching [63].

Symptoms related to the digestive system: diarrhea, cramping in the abdomen, nausea, and vomiting. Symptoms of the respiratory system include tightness in the chest, wheezing, and breathing difficulties.

Anaphylaxis: A severe allergic reaction that can affect several systems, including a sharp drop in blood pressure and potentially fatal breathing problems. If you feel you have an allergy or have negative responses to avocados or any other food, always get medical advice.

This material should not be used in place of expert medical advice [31].

Avocado Pear Seed

13–18% of the entire avocado fruit is made up of the hard-shelled avocado seed. Although little is known about its composition, it does contain a good variety of fatty acids, dietary fiber, carbohydrates, and a little quantity of protein. Additionally, the seed is said to be a rich source of phytochemicals, which are compounds that plants make to defend themselves. Avocado seeds contain some phytochemicals that may have antioxidant properties. Others might not be beneficial to health [38]. An avocado seed's dry weight is almost 75% starch, which makes up the majority of its carbohydrates.

Long chains of sugars make up starch, and scientists have started looking at its possible application in food items. Over 18% of the delectably creamy avocado fruit is made up of avocado seeds, which are frequently thrown away. However, it has been discovered that each avocado's seeds contain over 70% of their antioxidant content, making them a great source of nutrients with numerous health advantages. Together with natural oils, vitamins, and minerals, the amazing fiber content improves digestion, lowers inflammation, and may even stop the growth of cancer cells. Keeping the seed may seem unusual, but it's as simple as cutting it into quarters and adding it to sauces, smoothies, and juices for a fantastic health boost. Additionally, it can be mixed into a powder and added to meals and inventive dishes to help you achieve new levels of health with little effort [41].

Avocado Seed Compositions

In fact, avocado seeds have a diverse and advantageous compositional profile.

Triterpenes, fatty acids, and phytosterols make up the majority of the seeds, according to [65]. Additionally, it has been discovered that they have an antidiabetic effect, antihypertensive qualities, and a tendency to decrease cholesterol [38]. The seed has fibrous residues that can hold water and oil several times their weight, as well as starch with good physicochemical and rheological qualities.

It can therefore be used as a raw material in a variety of food systems. It's interesting to note that some of the seed's beneficial qualities have been successfully applied as a food additive/flour substitute in biscuits [46], a natural yellow food colorant, and an antioxidant and microbicide in pig burgers and meat chops. There is no doubt that the usage of underutilized resources, like avocado seeds, has significant effects on the general health and wellbeing of people who frequently eat them. Regular metabolic processes and external influences that produce reactive oxygen species (ROS) (free radicals) in cellular fluids are important contributors in this regard.

In fact, oxidation in biological systems has been associated with these species, leading to diseases like cancer, neurological degeneration, and food rancidity. Antioxidants that provide biomolecules with some degree of protection have been linked to remedies for these occurrences. They have been demonstrated to slow down the aging process and cardiovascular deterioration when frequently taken (as in fruits). Natural antioxidants found in fruits, vegetables, and their byproducts such as avocado seeds, such as phenolic acid, flavonoids, and carotenoids, are the cause of this decrease [51].

In various nations, different studies look into the phytochemicals, minerals, and nutritional makeup of avocado seeds. The majority of them came to the conclusion that, rather than being waste or an environmental annoyance, avocado seeds have nutritional properties that could be further studied for use in the food business. Using normal procedures, avocado seed was also evaluated for certain vitamin contents and antioxidant qualities (both *in vitro* and *in vivo*). Their findings demonstrate the abundance of phytochemicals, with avocado seeds having far higher levels of oxalates and flavonoids than other species. According to [17], avocado seeds' approximately 30% starch concentration makes them a possible source of starch. According to him, microscopic analysis of the components revealed traits resembling those of corn. According to [47], the best circumstances for producing dextrin from avocado seeds were a treatment concentration of 0.15 N HCl, a heating time of 30 minutes, and a temperature of 90°C. [1] produced bioethanol using diluted acid hydrolysis of avocado seed wastes (6.365%), which was quite excellent. As a result, it is a promising feedstock for the manufacture of bioethanol. Additionally, their work's elemental analysis revealed a lower lead value (0.79 mg/L) and no chromium. *Persea americana* is a strong source of nutritional protein, and its high fat content may add calories to animal and human rations, according to [66]. The high levels of antinutritional components (tannin, phytic acid, and alkaloids) in avocado seeds prevent them from being fully utilized for animal and human nutrition. However, the amount of these antinutrients in the raw seeds was decreased by processing techniques like boiling and soaking. [20] stated that while everyone is aware of avocados, some of us were unaware of the many health advantages of avocado seeds. Avocado seeds contain more soluble fiber than almost any other food and more antioxidants than the majority of fruits and vegetables on the market, as well as polyphenols like green tea.

Nutraceutical Benefits/Applications of Avocado Pear Seed

• Rich source of antioxidants

Avocado seeds cannot be fully exploited for animal and human nutrition due to their high quantities of antinutritional components (tannin, phytic acid, and alkaloids). However, processing methods like boiling and soaking reduced the quantity of these antinutrients in the raw seeds. [20] noted that although everyone knows about avocados, some of us were not aware of the numerous health benefits of avocado seeds. In addition to having more antioxidants than most fruits and vegetables on the market, avocado seeds also contain polyphenols like green tea and more soluble fiber than practically any other meal. It was discovered that a substance called avocetin B not only eliminates AML cancer cells but also has no detrimental effects on healthy blood cells—something that is not possible with the existing cancer treatment [66].

treats intestinal issues For hundreds of years, South Americans have been aware of the digestive advantages of avocado seeds and have used them to cure diarrhea, constipation, and ulcers. Soluble fiber and potent anti-inflammatory chemicals found in avocado seeds help reduce bloating and gas while also getting rid of waste and toxins that can lead to problems [59].

Helps to lower cholesterol and prevent heart disease

Avocado seeds include some of the highest concentrations of soluble fiber of any natural dietary source, according to Dr. Tom Wu, a physician who has been recognized by the United Nations and the American Cancer Society.

By removing cholesterol and plaque from the circulatory system, soluble fiber helps to avoid heart disease, heart failure, and stroke. Avocado seeds, in example, contain important fatty acids that help boost HDL (good) cholesterol levels and lower LDL (bad) cholesterol levels, thereby restoring a healthy cholesterol balance (Dabois, Breton, Linder, Fanes, and Parmencer, 2007).

Aids in preventing blood sugar imbalance.

Type 2 diabetes can be avoided and blood sugar rises and dips can be avoided with a diet rich in fiber and low in sugar. Because avocado seeds are a rich source of fiber that helps balance out sugar intake and maintain stable blood sugar levels, they are the ideal addition to any smoothie or meal [27].

Decreased inflammation

Catechins and procyanidins, two potent anti-inflammatory substances found in avocado seeds, help lower the chance of developing chronic inflammation. It is crucial to confront and treat chronic inflammation because it can cause a variety of illnesses and discomforts, including arthritis, hypertension, and even Alzheimer's disease [25].

Enhance the skin's Appearance and Health.

The intense burst of antioxidants in each avocado pits helps to reduce oxidative stress caused by the sun's harmful UV rays as well as pollution, chemicals and our modern environment. This helps to reduce the visible signs of aging, as well as rejuvenating the tone and condition of skin tissue, [17]. Avocado seed also contain nourishing oils which helps to smooth wrinkles and improve the elasticity of skin, making you look younger and healthier in just one simple step [5].

Excellent source of potassium

- Avocado seeds are a rich source of potassium which makes it an excellent source of fluid balancing nutrition.
- Potassium helps to eliminate excess toxins and fluid from the body as well as reducing muscle cramps [54].

Utilization of Avocado Pear Seed

The avocado pear seed is a by-product representing 13-18% of the fruit. It is often discarded as agro-food waste during the processing of the pulp, thereby representing a severe ecological problem. In Nigeria, the seed is utilized for the treatment of hypertension, diabetes and high blood pressure by incorporating the seed flour into existing food products such as soups, pap and puddings [45]. [50] developed acceptable candies from avocado pear seed and reported that the sample with 85% avocado pear seed was most preferred. Additionally, [30] created moimoi, or steamed cowpea pudding, using mixes of cowpea and avocado pear seed flour. They found that cowpea can be substituted with avocado pear seed flour at a 10% level to produce a satisfactory and nourishing moi-moi. According to reports, the fruit pulp has fewer antioxidant components than the seed.

The proximate composition of avocado pear seed was examined by [29], who found that it included 49.03 g of carbohydrates, 17.90 g of lipids, 15.5 g of protein, 15.10 g of moisture, and 2.26 g of ash.

In Nigeria and other nations where avocado pear seed is grown, industrial processing and use have not reached its full potential due to anti-nutritional factors. The underutilization of this lesser-known plant seed in various food compositions can possibly be attributed to ignorance of its nutritional properties. According to [33], avocado pear seeds include high levels of anti-nutritional components like phytate, oxalate, tannin, alkaloids, and cyanogenic glycosides, making them potentially hazardous and worthless for feeding humans and animals. The bioavailability of minerals in avocado pear seeds may be impacted by these anti-nutritional factors. The maximal quantity of mineral that is liberated from the matrix during gastrointestinal digestion and made available for intestinal absorption is known as mineral bioavailability. In addition to inhibiting digestive enzymes and precipitating protein, anti-nutritional factors chelate metals like iron and zinc and decrease the absorption of these nutrients.

For instance, it has been observed that phytates bind calcium, magnesium, iron, copper, and zinc and prevent the small intestine from absorbing them, whereas oxalate forms complexes with dietary calcium, making it inaccessible for absorption and assimilation. There are several studies on the nutrient and anti-nutrient properties of avocado pear seed, but little is known about the mineral bioavailability of these nutrients.

Other Applications: Culinary Applications of Avocado Seeds

The following are some possible culinary uses for avocado seeds: Avocado Seed Flour: Avocado seeds can be dried, ground, and used as a gluten-free flour substitute, adding a nutty flavor and slightly grainy texture to baked goods, pancakes, and other culinary creations; Avocado Seed Tea: Avocado seeds can be roasted, steeped in hot water, and enjoyed as a caffeine-free herbal tea, known for its earthy flavor and potential health benefits, like better digestion and lower inflammation.

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Characterization of Flour from Avocado Seed Kernel

Even though avocado seeds are usually thrown away as waste, they are a rich source of nutrients. The avocado seed, also known as the pit, is the plant's storage organ and is rich in vital nutrients. Avocado seeds are high in potassium and phosphorus, according to a report released by the California Avocado Society. Potassium keeps the body's fluid balance and heart rate stable. Strong bones, DNA production, and phospholipids—which transport fats through the bloodstream—all depend on phosphorus.

Magnesium and calcium, which are necessary for blood coagulation, muscle contraction, and healthy teeth and bones, are likewise less concentrated in avocado seeds. Furthermore, avocado seeds have a protein content of 2.5% to 5% [54]; [11]. Although avocado seeds are usually thrown away as waste, they are actually a rich source of nutrients. The avocado seed, also known as the pit, is the plant's storage organ and is rich in essential nutrients. A report released by the California Avocado Society claims that avocado seeds have a high potassium and phosphorus content. Potassium keeps the body's fluid balance and heart rate constant. Strong bones, DNA production, and phospholipids—which transport fats through your bloodstream—all depend on phosphorus. Additionally, avocado seeds have a lesser concentration of calcium and magnesium, which are necessary for strong teeth and bones, blood coagulation, and muscular contraction. Avocado seeds also have a protein content of 2.5% to 5% [54]; [11].

Baked goods, which are mostly made with flour, are at the top of the global food demand. Bread, cookies, cakes, and other baked goods are excellent sources of nutrients that provide energy. These goods are made from a range of cereals, such as corn, wheat, barley, and rye, and are processed to produce premium baking flour. These flour-based products are in high demand, which could result in higher raw material costs or, worse, unavailability. The most popular food item in the Philippines is flour-based items, second only to rice. However, because the ingredients for flour-based items are imported from other nations, these goods become expensive and out of reach for the most disadvantaged.

2.12 Antioxidant and Antimicrobial Properties of Avocado Pear Seed Researchers looked into the effect of Avocado Seed Flour (ASF) on the lipid levels in mice on a hyperlipidemic diet. The total phenolic content in the methanolic extract was 292.00 ± 9.81 mg gallic acid equivalents/g seed dry weight, and the antioxidant activity resulted in $173.3 \mu\text{mol}$ Trolox equivalents. Because avocado and its oil contain a wide variety of bioactive chemicals, they can be used therapeutically. The butter fruit and its oil demonstrate a variety of pharmacological actions that are attributed to bioactive substances [62]. Avocados' excellent nutritional value and biological activity, such as their antioxidant, antibacterial, and analgesic qualities, have been extensively studied, according to [18]. The findings show that avocado seeds are a possible source of antimicrobial chemicals and spark a lot of interest in further studies using more refined extracts to identify the molecules causing the antimicrobial activity. As an antioxidant, glutathione shields cells from harmful chemicals including reactive oxygen species.

Avocado leaf and seed extracts have been used in a number of medical applications, such as the treatment of diarrhea, dysentery, and as an antibiotic [2]. The oil extracted from avocado seeds was assayed for its physicochemical properties and antioxidant potential using a variety of standard methods. The results of the antioxidant activities of the seed oil showed that the flavonoid content (80 ± 1.41 mgQE/g), peroxide value (2.40 ± 0.57 mg O₂/kg), and ester value (31.26 ± 0.03 mgKOH/g).

Thus, the hypocholesterolemic activity in a hyperlipidemic mouse model may be caused by the antioxidant activity of phenolic chemicals and dietary

fiber in ASF. Compounds with antioxidant properties that aid in shielding cells from damage caused by free radicals include polyphenols, vitamin C, carotenoids, and vitamin E. Additionally, these substances have anti-inflammatory properties that may aid in preventing atherosclerosis, which is the thickening and hardening of the arteries linked to heart disease [24].

According to [28], the antibacterial activity (mm) of avocado seed extract (ASE) against *Proteus mirabilis* (23 ± 0.14), *Staphylococcus aureus* (16 ± 0.04), and *Pseudomonas aeruginosa* (15 ± 0.11) was lower than that of the reference, ciprofloxacin.

Additionally, they found that ASE was more active (18 ± 0.31 mm) against *Aspergillus niger* than the standard antifungal Ketoconazole (8 ± 0.22 mm), while it was as active as the standard against *Candida albicans* but inactive against *Penicillium notatum* (6 ± 0.24 mm). Avocado seeds exhibited overwhelming action against *Aspergillus niger*, specific antifungal activity, and broad spectrum antibacterial activity. According to [24], avocado seed ethanol extract has a 50%-60% antibacterial activity *in vitro* against *Porphyromonas gingivalis*.

When treating coagulation disorders, avocado methanolic seed extract may be helpful in anticoagulant therapy. However, in order to prevent amounts that could result in extended coagulation, consumption in the treatment of other disorders should be closely managed. The animals were given 2.5 g/kg of the extract daily for 28 days in order to assess the oral median lethal dose (LD50) and other gross toxicological symptoms on an acute basis, according to experiments done by [3]. Over the course of the 28 days, the animal's weight and fluid intake were noted. Kidneys, hearts, blood, and serum were collected for weight, haematological, and biochemical indicators of toxicity. The findings indicate that with a maximal dose of 10 g/kg, the LD50 could not be ascertained. Subacute therapy with the extract considerably increased fluid consumption ($P < 0.0001$) but had no effect on whole body weight or organ-to-body weight ratios. [58] examined the proportion of mosquito species that died after being exposed to various doses of seed extracts for a whole day. Mortality was dose-dependent; after 24 hours at 40 μ l, ethyl acetate extract showed increased mortalities; other extracts showed a similar pattern. The chloroform extract had the lowest LC50 value, indicating that it was more hazardous than the other extracts tested. The study [61] states that avocado seed possesses antibacterial, antifungal, antiviral, and wound-healing qualities and is used in traditional medicine to treat a variety of illnesses.

They stated that total phenolic content, total flavonoid content, and DPPH radical scavenging activity were used to assess the antioxidant capacity of plant extracts. The methanol extract had the highest phenolic and flavonoid content, whereas the aqueous extract had the lowest. DPPH radical scavenging activity was found to be lowest in the aqueous extract (51%) and highest in the methanol extract (70%) at a concentration of 500 g/mL. The disk diffusion method was used to assess the antibacterial activity of various extracts. Methanol extract showed the strongest antibacterial activity against *S. pyogenes*, whilst aqueous extract showed the least activity against *E. coli*.

Therefore, the effectiveness of *Persea americana*'s stem bark and seed against these microbes offers a scientific basis for the herb's use in the prevention and treatment of bacterial infections brought on by a variety of pathogenic bacteria, including *Escherichia coli* and *Staphylococcus aureus*, which can become resistant to antibiotics [61]. Plant Food Ingredients That Are Anti-Nutritious, Like Avocado Pears Anti-nutritional factors are substances that are produced in natural foods by the normal metabolism of species and by various mechanisms (e.g., inactivation of certain nutrients, diminution of the digestive process, or metabolic utilization of feed) that have an adverse effect on optimal nutrition. These anti-nutrient compounds include phytates, protease, saponin, and tannins.

Plant anti-nutritional factors can be categorized based on their biosynthetic origin, chemical structure, or specific effects they cause [49]

"Saponins

Asteroid (tri-terpene) group is joined to a sugar moiety to form saponins. Legumes and several spices and herbs include those surface-active substances. Because saponins interact with cholesterol in the erythrocyte membrane, they can lyse erythrocytes [39]. Saponins are poisonous at large doses and have a bitter taste and foaming qualities. Increased permeability of small intestinal mucosa cells, which inhibits nutrient transport, growth-depressing action, and decreased protein digestibility—likely due to the formation of sparingly digestible saponin protein complexes—are among the anti-nutritional effects of saponins, according to [42].

Phytates

The functional and nutritional qualities of food can be greatly impacted by phytates, a complex class of naturally occurring phosphorus molecules. Essential elements like calcium, iron, magnesium, and zinc in diet combine with phytic acid to generate insoluble ions that prevent the minerals from being absorbed into the bloodstream. Approximately 50% of the phytic acid phosphorus that humans consume is eliminated unaltered, making it unusable [49]. Rats' calcification is inhibited by phytic acid and the products of its hydrolysis [49]. Mineral availability has been found to be disrupted by dietary phytate levels of 1% or higher [35].

Lectins and Haemagglutinins

Sugar-binding proteins called lectins and hemagglutinins have the ability to bind sugar components and agglutinate red blood cells, or erythrocytes (Liener, 1985). Additionally, they exhibit extraordinary specificity, similar to anti-bodies, in that they may function in high dilution on one type of erythrocyte and either not at all or very weakly on another [49]. Hemagglutinins are primarily found in plants and are connected to leguminous seeds. Lecitins is another name for them. [56] noted that soybean hemagglutinin, for instance, causes rabbit red blood cells to clump together but not sheep or calf red blood cells.

Phenolic Compounds

Plant meals contain phenolic compounds in a range of chemical forms and in relatively considerable quantities. These chemicals act as secondary metabolites to shield tissues from damage, insects, and animals [51].

Many meals and beverages are bitter and astringent due to phenolic chemicals, which also decrease the availability of some minerals like zinc [49].

"Tannins

The complex phenol polymers that make up tannins are divided into two structural groups: condensed tannin and hydrolyzable tannin [49]. Condensed tannins are typically found in plant tissues as leuco-anthocyanins or proanthocyanidins and are much more prevalent in non-grain starch staples. Condensed tannin has been found in yam species, cassava tubers, and the green pulp of numerous banana kinds. Tannins interfere with the absorption of iron from food and block the activity of enzymes such as lipase, amylase, chymotrypsin, and trypsin [54].

Oxalate

It is noteworthy that some families and species exhibit comparatively high concentrations of oxalate, primarily as insoluble calcium salts or soluble sodium or potassium salts, despite the fact that oxalate has been found in almost every type of biological material [49]. Similar to phytates, oxalates bind and disrupt the metabolism of minerals including calcium and magnesium [21]. They also result in paralysis and weakening of the muscles. In addition, oxalate causes hypocalcaemia, necrotic kidney lesions, urinary calculi, gastrointestinal tract irritation, and renal tubule obstruction by calcium oxalate crystals. It has been claimed that 450 mg of oxalic acid per day can disrupt metabolism.

Trypsin (protease) Inhibitors

The majority of leguminous seeds contain globular proteins known as trypsin (protease) inhibitors. They are a typical ally that can reduce trypsin activity but has no effect on chymotrypsin or pepsin. In humans, chronic trypsin inhibitor activity typically causes an expansion of the pancreas along with a shift in the exocrine pancreatic proteolytic activity [46].

Alkaloids

Alkaloids are fundamental natural substances that are mostly found in plants [56]. Alkaloids are typically found in salt with organic acid, and they are likely present in 10–20% of all higher plants. *Mucunapruriens*, *Physostigmavenenosum*, *cocoa beans*, and *Threobromea cocoa*, which contains theobromine steroid glycoalkaloids such as solanine and chaconine found in potatoes and potato-based products, are common sources of alkaloids [56]. Neurological and gastric issues are brought on by alkaloids [65]. Glycoalkaloids found in potatoes and *Solanum* species, such as solanine and chaconine, are haemolytically active and harmful to both people and fungi. Potato glycoalkaloids occur at dosages greater than 20 mg/100 g sample have some toxicological effects [59].

Oligosaccharides

Because humans lack β -galactosidase, oligosaccharides that cause flatulence, such as raffinose, stachyose, and verbascose, are digested anaerobically by bacteria to produce carbon dioxide, hydrogen, and methane.

- Cyanogenic Glucosides Understanding the amount of cyanogenic glycosides in food is crucial because cyanide, an efficient cytochrome oxidase inhibitor, disrupts the aerobic respiratory system and causes convulsions, gasping, and staggering (Onwuka, 2005).

Instead of existing freely, hydrocyanic acid reacts with sugar to create cyanogenic glycoside. The fatal threshold for an adult male is 50–60 mg/kg body, according to [49]. By combining with their respective copper and iron ions, cyanide inhibits the cytochrome oxidase and hydrophenol oxidase enzymes.

Considerations for Processing Avocado Seeds

Around 120 milliliters of tea are consumed daily on average per person worldwide [34]. Tea was first used as a beverage and medication in China from 3000 BC [69]. Since then, tea has been brought to and grown in numerous nations. China, India, Sri Lanka, Japan, Taiwan, and Kenya are the main producers of tea [35]. The two most popular varieties of tea are black and green, with black tea making up more than 70% of the world's yearly production and green tea making up about 20% [36]. In the West, including Europe, the UK, the US, and India, black tea is the most popular and consumed tea variety due to its large annual production volume [34].

Although green tea is primarily drunk in East Asia, particularly in Japan, Korea, and Northern China, its popularity is growing in other parts of the world, including Europe and the US [42]. Oolong tea, which is popular in Taiwan and Southern China, is the most well-known tea variety after black and green tea. Less well-known are puerh and white tea, which are mostly made and consumed in China. However, pu-erh tea has also been gaining popularity, particularly in Southeast Asia [44], while white tea has been growing in favor in Europe due to its gentler tastes, which are considered more acceptable [25]. Commercial tea products are in the form of loose dried tea leaves or tea bags, where customers must make their own tea infusion [40]. Although they are less prevalent, ready-to-drink tea beverages in bottles or cans are also available [23]. As a result, the majority of people drink tea as an infusion, which is made by steeping dried tea leaves in hot water [69].

Health Benefits of Avocado Seed Tea

Since ancient times, tea has been regarded as both a medicinal and nutritious beverage. Tea has been advised by traditional Chinese medicine for headaches, body aches and pains, digestion, depression, detoxification, as an energizer, and generally to extend life. Numerous recent studies and findings using human and animal models [17] also revealed that tea has numerous health benefits, some of which are included here.

Lowers the risk of various types of cancer

It is generally recognized that oxidative damage plays a role in the development of cancer, which is caused by unchecked cell growth. Tea is a great source of potent antioxidants, which may help prevent cancer. According to one study, drinking two or more cups of black tea daily lowered the risk of ovarian cancer by thirty percent. According to some research, people who drank the most green tea had a 57% reduced risk of colon cancer, a 48% lower risk of prostate cancer, and a 22% lower risk of breast cancer.

Reduce the risk of cardiovascular diseases.

Research indicates that some of the primary risk factors for cardiovascular disorders, such as heart disease and stroke, can be mitigated by green tea.

Green tea significantly boosts the blood's antioxidant capacity, shielding LDL cholesterol particles from oxidation—one step in the development of heart disease. Drinking green tea can reduce the risk of cardiovascular disease by up to 31%, according to observational studies.

Burns fat and improves physical performance

Tea's caffeine has been demonstrated to enhance physical performance by releasing fatty acids from adipose tissues so they may be used as fuel. It has been demonstrated that green tea increases human metabolic rate and fat burning.

Improve brain function and make people smarter.

One of the main active components of tea is caffeine, which is recognized as a stimulant. Increased mood, alertness, memory, and reaction time are just a few of the ways that caffeine enhances brain function. Research has indicated that green tea's L-theanine and caffeine may work together to enhance brain function.

Improves dental health

Green tea's catechins have the ability to suppress viruses like the influenza virus and kill bacteria, which may reduce the risk of illness. The most dangerous bacteria in the mouth is *Streptococcus mutans*. It leads to the development of plaque, which is a major cause of cavities and tooth decay. According to studies, green tea's catechins can stop *Streptococcus mutans* from growing. Drinking green tea has been linked to better oral health, a decreased chance of cavities, and less bad breath.

Lower the risk of type II diabetes.

Green tea has been shown in studies to lower blood sugar levels and increase insulin sensitivity. According to a Japanese study, drinking green tea reduced the risk of type II diabetes by 42%. Another study found that drinking green tea reduced the risk of developing diabetes by 18%.

Conclusion

According to studies, processing techniques are essential for maximizing the nutritional and bioactive potential of avocado seeds. We may create plans to maximize the use of avocado seeds in a variety of applications, from gourmet ingredients to functional additions, by comprehending how processing methods affect their composition. Techniques like controlled fermentation or combining with additional ingredients could improve the beverage's palatability.

Results show that although some processing techniques enhance the sensory qualities, consumer acceptance is still difficult because avocado seeds are naturally bitter. Notwithstanding avocado seed tea's nutritional value, potential health benefits, and sustainability, there are still issues to be resolved, such as the need to standardize processing techniques, the lack of information regarding the use of chocoefort and reed avocado seeds for tea production, and the need for additional research on nutrient safety and bioavailability. All things considered, avocado seed tea offers a novel chance for value addition in the food sector, necessitating more research on its long-term health benefits and commercial viability.

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