

Pharmacognosy And Phytochemistry of *Persea Americana* (Avocado)

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ABSTRACT

Nature is a source of many beneficial foods to mankind. Some are staple foods for everyday consumption while others are superfoods that are great sources of vitamins, minerals, oil, and good fat. One such superfood is avocado. Recently avocado has gained worldwide popularity as a source of good vegetable fat consumption. Meanwhile, it has great medicinal properties and many other unexplored properties that are still unknown to many. The present article is compiled to bring such many unknown properties to light. The present review mainly focuses on avocados pharmacognosy, phytochemistry and pharmacological aspects.

KEY WORDS: *Avocado, Persea americana, Butter fruit, Healthy fat,*

INTRODUCTION

The avocado (*Persea americana*) is a tropical and subtropical tree and shrub species that belongs to the Lauraceae family. Cultivated for thousands of years, it is native to Mexico and parts of Central and South America. Both historically and currently, avocados are valued for their nutritional value as well as their potential medical and dermatological uses. Its medicinal promise, especially in the treatment of numerous skin problems, is attributed to its high nutritional content and bioactive components.¹ Avocado fruit's pulp is composed of roughly 60% oil, 7% peel, and 2% seed.²

Avocados (*Persea americana*) are known to be nutrient-dense fruits that provide a wide range of vital vitamins as well as a well-balanced composition of macronutrients such dietary fiber, protein, and carbs. These include of essential minerals like phosphorus (P), sodium (Na), magnesium (Mg), potassium (K), iron (Fe), and zinc (Zn), as well as polyphenols, healthy fats, and oils. Avocados are also a great source of B-complex vitamins, such as B1 (thiamine), B2 (riboflavin), B6 (pyridoxine), and B9 (folate), as well as vitamins C, E, and K.³

The avocado tree (*Persea americana*) is an evergreen, perennial plant that is grown mainly for its nutritious fruit. Under ideal environmental conditions, it is a crop that can produce fruit constantly throughout the year. A broad, spreading canopy made up of many long, lateral branches is a characteristic of mature trees, which normally reach heights of 12 to 24 meters (about 40 to 80 ft). Dense foliage with leaves that are typically elliptic to oblong in shape and range in length from 7.5 to 25 cm (3 to 10 inches). The adaxial side of the leaves has a dark green, leathery, glossy surface, whilst the abaxial side is lighter in color and less glossy. Avocado leaves contain a variety of aromatic chemicals in addition to their photosynthetic function, which may help explain the plant's innate resistance to pests.⁴



Figure 1: Image of avocado³⁰

HISTORY

Avocados have been an integral component of the traditional diets of indigenous populations in southern Mexico and Central America for approximately 5,000 years. The earliest known written reference to the fruit dates back to 1554 in Mexico, highlighting its early documentation and cultural relevance. Prior to European colonization, avocados held considerable economic and dietary value, as evidenced by their presence in the vibrant markets of Tenochtitlan, the capital of the Aztec Empire. This underscores the fruit's longstanding significance within the culinary practices and socio-economic systems of pre-Columbian Mesoamerican civilizations.

Paleo botanical research has revealed that avocado remnants discovered in Mexico date back as far as 10,000 years, highlighting the fruit's deep-rooted presence in Mesoamerican history. Long before European colonization, avocados were cultivated extensively from the Rio Grande in the north to central Peru in the south. With the onset of European exploration and colonization, avocado cultivation expanded beyond the Americas, eventually reaching a wide array of tropical and subtropical regions across the globe.

It was originally introduced to Singapore between 1830 and 1840, followed by Florida in 1833 and California in 1871. In 1892, it arrived in India, and in 1955, it entered Pakistan. Due to its commercial significance, avocados are valued highly and are referred to as "Green Gold," symbolizing its economic potential in tropical and subtropical agriculture systems.

Avocados are cultivated commercially across a wide geographic range, including the United States, tropical regions of the Americas, and several major Caribbean islands. The avocado tree (*Persea americana*) is an evergreen species that typically attains a height of 40 to 80 feet and is characterized by its extensive branching structure. The foliage consists of ovate to oval leaves, measuring approximately 3 to 10 inches in length. As a tropical plant with an estimated domestication history of over 10,000 years, the avocado is renowned for its smooth, buttery texture, distinctive flavour, and exceptional nutritional value.⁵

CLASSIFICATION:

Avocado is a widely studied plant recently in various fields. The scientific classification for the avocado is given below.^{6,7}

Taxonomic Rank	Scientific Name	Common Name
Kingdom	Plantae	plant
Sub kingdom	Tracheobionta	Vascular plants
Super division	Spermatophyta	Seed plants
Division	Magnoliophyta	Angiosperms
Class	Magnoliopsida	Dicotyledons
Subclass	Magnoliidae	-
Order	Lurales	-
Family	Lauraceae	Laurel family
Genus	Persea	-
Species	Persea American Mill	-

Table1: The classification of Avocado.

PHARMACOGNOSY:

Avocado is widely studied for its pharmacognostic properties including macroscopical, microscopical characters, details are briefly described below tables 2 & 3.^{8,9,10,11}

Macroscopical characters

Plant	Description
Fruit Type	Berry (single- seeded) type fruit
Shape	It is often pear-shaped, but depending on the cultivation, it can also be oval or spherical.
Size	Varies in length from 7 to 20 cm and weight from 100 grams to more than 1 kilogram.
Color	Typically, green when ripe; can also be yellow, purple.
Surface	Rough or smooth, depending on the type
Skin	Thick and leathery, it might be change to green or purplish-black up on ripening
Flesh	Creamy and Soft; buttery; green near the skin, yellow near the seed
Seeds	Large, round or oval, smooth, and light brown or tan in color
Taste	Bland to slightly nutty

Table 2: Macroscopical character

Microscopical characters

Part	Under the Microscope
Outer layer(epidermis)	Single-layered epidermis with a thin layer of cuticle covering the upper and bottom layers.
Pulp cells	Large polygonal cells having starch grains, oil globules, and thin walls.
Trichomes	Uniseriate or multicellular, small, and more noticeable in young fruits.
Seed coat	Made up of pigmented, compacted cells that forms a hard, protective coating.
Crystals	Calcium oxalate crystals are seen
Vasular Tissue	Xylem with spiral and pitted vessels Phloem with companion Cotyledon
Cotyledons	Thin walled parenchymotus cells ^{10,11}

Table 3: Microscopical characters

PHYTOCHEMISTRY

The Phytochemical makeup of *Persea Americana* (avocado) is shown in detail in the table below, also describes the wide range of bioactive components found in different anatomical regions.^{12,13,14,15,16}

S.No	Phytochemical group	Main Compounds	Part of plant found	Key function
1.	Fatty acid	Oleic acid, linoleic acid	Pulp, seed	Improve nutrient absorption, lower blood cholesterol, and promote heart health.
2.	Flavonoids	Quercetin, rutin	Leaves, peel, seed	Decrease inflammation, combat free radicals, and promote immunological and vascular well-being.
3.	Carotenoids	Lutein, neoxanthin	Pulp	Provide oxidative stress protection, act as antioxidants and support the health of the skin and eyes.
4.	Phenolic acids	Caffeic acid, gallic acid	Leaves, seed, peel	Supply antibacterial, neuroprotective, antidiabetic, and antioxidant benefits.

5.	Phytosterols	Stigmasterol	Pulp, seed	Modify immunological responses, control lipid metabolism, and prevent the absorption of cholesterol.
6.	Alkaloids	Indole-type and Isoquinoline-type alkaloids	Leaves	Show possible analgesic, antioxidant, and neuroprotective properties.
7.	Saponins	Triterpenoid saponins	Leaves, peel	Reduce the cholesterol, boost immunity, and have antibacterial properties.
8.	Vitamins	Vitamin-E, Vitamin-C	Pulp	Support enzymatic process, boost immunity, aid in tissue healing, and act as antioxidants.
9.	Minerals	Potassium, calcium, iron	Seed, pulp	Preserve electrolyte equilibrium, promote heart and bone health.
10.	Amino acids	Glutamic acid, aspartic acid	Pulp	Promote neurotransmission, protein synthesis, and immune system assistance.
11.	Volatile Compounds	Anthelo, terpens	Essential oil, seed, leaves	Possess antibacterial properties, enhance fragrance, and have possible cosmetic applications.
12.	Sugars & polysaccharides	Glucose, Fructose	Seed, pulp	Enhance intestinal health, control blood sugar, and serve as prebiotics.

Table 4: Phytochemistry of avocado

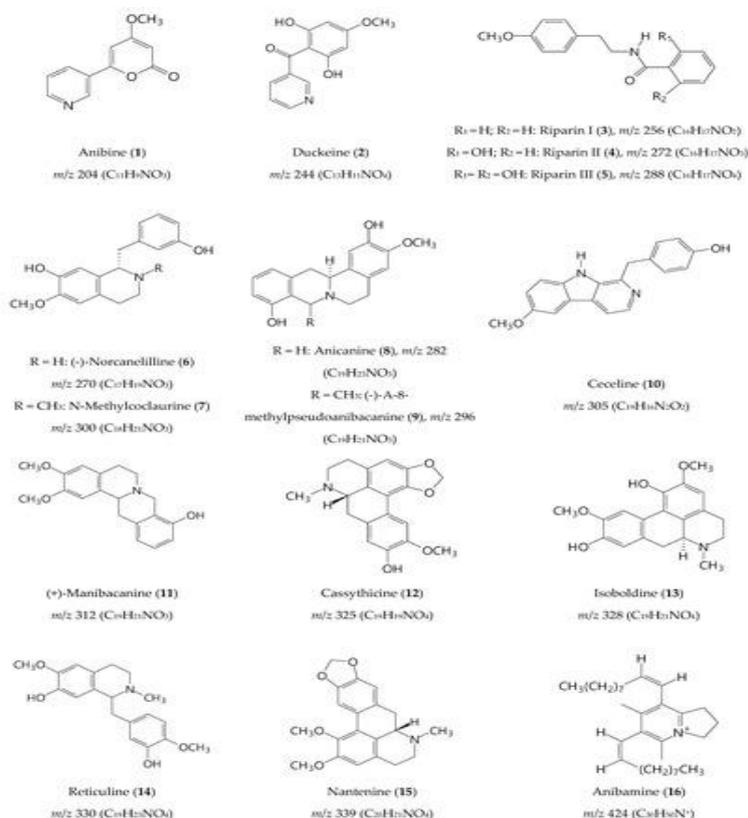


Figure 2: Phytochemical constituents of avocado²⁹

PHARMACOLOGY:**ANTIOXIDANT ACTIVITY:**

Persone A and B, which are found in *Persea americana* fruit, are notable for their strong and unique antioxidant qualities. Investigating the antioxidant components found in this plant's leaf extract is crucial, even though these substances also add to the fruit's bioactivity. According to research, *P. americana* leaf methanolic extract has a strong hepatoprotective impact and a substantial antioxidant capacity against acute liver damage caused by paracetamol. These results highlight *P. americana* leaf extract's medicinal potential in treating conditions linked to oxidative stress, such as liver ailments.¹⁷

ANTI-VIRAL ACTIVITY:

The antiviral properties of dried *Persea americana* leaf infusion and ethanol extract were assessed against certain viruses in vitro. Herpes simplex virus type 1 (HSV-1), adenovirus (ADV), and adenovirus type 3 (AD3) were all screened for. The infusion demonstrated broad-spectrum antiviral potential by showing inhibitory effects against all three viruses. Conversely, the ethanol extract exhibited no discernible antiviral activity in the experimental circumstances employed, as it was evaluated solely against HSV-1 and ADV. According to these findings, the active antiviral ingredients are probably soluble in water and might be better extracted by infusion.¹⁸

ANTI HEPATOTOXICITY:

Potential for antihepatotoxicity of *Persea americana* leaf extract in a methanolic form in a rat model of acute liver damage caused by paracetamol. The results showed that the extract significantly reduced oxidative stress and liver damage. The activation of antioxidant defense mechanisms, specifically through the increase of enzymes like glutathione peroxidase, catalase (CAT), and superoxide dismutase (SOD), is thought to be linked to this hepatoprotective impact. These enzymes' levels were markedly increased in rats that had hepatic damage from paracetamol, even though their activity was essentially unaffected in healthy control rats who received the extract. These enzymes are important intracellular defense mechanisms that lessen oxidative damage when stress is present.¹⁹

ANTI-CONVULSANT EFFECT:

The plant's leaf extract was comparatively more effective at causing convulsions caused by picrotoxin (PCT) and pentylenetetrazole (PTZ) than it was at causing seizures caused by bicuculline (BCL). In general, the average convulsion onset and duration were significantly delayed and shortened, respectively. These results generally point to the possibility that *P. americana* leaf aqueous extract may have prevented and/or lessened the mice's seizures caused by PTZ, PCT, and BCL by promoting or otherwise interfering with GABAergic activity and/or neurotransmission.²⁰

ANTIMICROBIAL AND ANTIFUNGAL ACTIVITY:

Avocado leaves, seeds, and oils have all been demonstrated to exhibit antibacterial activity against a range of harmful microbes. Essential oils, alkaloids, saponins, and tannins are primarily responsible for the antibacterial properties. Antifungal effectiveness against *Candida albicans* and inhibitory effects against bacteria like *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa* have been documented in studies. The precise mechanism could be the prevention of nucleic acid replication, breakdown of microbial cell walls, or interference with protein synthesis. Avocado extracts are therefore excellent candidates for the creation of natural antibacterial agents because of these characteristics.²¹



ANTICANCER ACTIVITY:

Persenenones A and B, avocatin B, and D-mannoheptulose are among the chemicals produced from avocados that have shown anticancer potential in vitro. It has been demonstrated that these substances cause apoptosis, stop the growth of cancer cells, and alter oxidative stress in cancer cells. The processes could include increased expression of pro-apoptotic genes, modification of signaling networks such as PI3K/Akt, and disruption of mitochondrial function.²²

HYPOLIPIDEMIC AND CARDIOPROTECTIVE ACTIVITY:

Avocado oil and pulp are well-known for their cardioprotective and lipid-lowering properties because they are high in phytosterols and monounsaturated fatty acids, particularly oleic acid. When regularly consumed, HDL cholesterol can rise while total cholesterol, LDL, and triglycerides can decrease. The risk of coronary heart disease is decreased and atherosclerosis is prevented because to these modifications. Increased triglyceride breakdown, competitive suppression of cholesterol absorption by phytosterols, and inhibition of LDL synthesis in the liver are the reasons behind avocado's lipid-modifying actions. Further promoting cardiovascular health include its high oleic acid content and antioxidants like vitamin E, which lessen inflammation and oxidative stress.²³

ANTI-INFLAMMATORY EFFECT:

Avocado's anti-inflammatory properties are associated with its polyphenols, persin and lupeol, which aid in controlling the synthesis of inflammatory mediators. It has been demonstrated that pro-inflammatory cytokines such as TNF- α , IL-1 β , and IL-6 can be decreased by avocado extracts. For long-term inflammatory disorders such as arthritis, gastrointestinal inflammation, and cardiovascular illnesses, these qualities might be therapeutically advantageous.²⁴

MEDICINAL VALUE:

- 1. Heart Health:** Avocado, which is high in potassium and monounsaturated fats, lowers bad cholesterol (LDL) and maintains normal blood pressure.
- 2. Digestive Health:** The avocado's high fiber content promotes intestinal health and helps ward against constipation.
- 3. Skin and Wound Healing:** Because of its hydrating qualities, avocado oil is used to treat skin disorders like psoriasis and to help heal wounds.
- 4. Eye Health:** Avocados are high in lutein and zeaxanthin, which are good for the eyes and help prevent age-related damage.
- 5. Bone Health:** The vitamin K found in avocados is crucial for absorbing calcium and preserving bone mass.
- 6. Weight Management:** Although avocados are high in calories, their fiber and good fats help you feel full and reduce your hunger.
- 7. Boosting Immunity:** Rich in vitamins C, E, and B6, which are necessary for a strong immune system, this food helps to boost immunity.
- 8. Mental Health:** May help lessen depressive symptoms since it contains B vitamins and omega-3 fatty acids, which are important for brain function.^{25, 26}

MISCELLANEOUS: Details about possible drug interactions, toxicity issues, and allergic reactions associated with *Persea americana* (avocado) are included in the following table.^{27, 28}

Category	Information
Toxicity	In general, avocados (<i>Persea americana</i>) are safe for human eating, particularly the fruit pulp and oil, which are used extensively in cosmetics and food. The plant's leaves, bark, skin, and seed, on the other hand, contain a toxin known as persin, which is harmful to many animals but innocuous to most people in tiny doses. Because the seed contains tannins and persin, consuming large amounts of it can irritate the human gastrointestinal tract. Additionally, because avocados contain cross-reactive proteins, they can cause allergic reactions, especially in those who have latex allergies.
Allergy	Although avocado allergies are uncommon, cross-reactive proteins can cause them in those who have latex or pollen allergies. While oral allergy syndrome (OAS) results in milder reactions like tingling or itching in the mouth, generally after eating raw avocado, latex-fruit syndrome can produce symptoms including itching, swelling, upset stomach, or anaphylaxis. Skin contact can occasionally result in dermatitis. Testing for allergies is part of the diagnosis, and treatment entails avoiding avocado and, in the case of severe responses, using medicine or epinephrine.
Drug interactions	Although avocado is usually safe, several drugs may interact with it. By altering the metabolism of vitamin K, it may decrease the effectiveness of the blood thinner warfarin and perhaps lower INR levels. Small quantities of tyramine, which might result in hypertensive responses when taken with MAOIs, are present in very ripe avocados. Avocado- <i>soybean unsaponifiables</i> (ASU) are also sometimes used in conjunction with NSAIDs to treat osteoarthritis and may even improve their benefits. Although there are rarely any drug interactions, care should be used when taking these prescriptions.

Table 5: Miscellaneous**MARKET VALUE:**

The avocado market value is around 19.2 billion US dollars in 2023 and projected to reach 47.54 billion by 2032.

PHARMACOLOGICAL ACTIVITY SUMMARY

Avocado possess many medicinal properties the pharmacological profile is summarized in the Table 6 below.

S. No	Plant part	Activity	Extract	Model	Standard drug	Dose	Parameters	Mechanism	Stats Pvalue	Author year
1.	Fruit pulp	Nutrient absorption	Whole fruit	Human clinical trial	None	With meals	Carotenoid blood levels	Lipid facilitated absorption	P<0.05	NurayZ Unlu et al., 2005 ³¹
2.	Fruit	Anticancer activity	Chloroform	In vitro (Human cancer cell lines)	Not specified	100µg/ml	Cell proliferation, Aptosis, ROS, mitochondrial integrity	Induction of apoptosis via ROS generation, mitochondrial depolarization, cell cycle arrest	P<0.05	Haiming Ding et al.,2007 ³²
3.	Seed	Anti-fungal	Acetone Extract	In vitro (Candida albicans)	Ketoconazole	25µg/ml	Zone of inhibition	Disruption of fungal cell wall	P<0.01	João Jaime Giffoni Leite et al., 2009 ⁴³
4.	Seed	Antihypertensive	Aqueous Extract	Spontaneously Hypertensive Rat (SHR)	Losartan	100mg/kg	Blood pressure levels	ACE inhibition, vasodilation	P<0.05	KE Imafidon et al., 2010 ³³
5.	Pulp	Cardioprotective activity	Aqueous Extract	Ischemia-Reperfusion Injury (Rat)	Atorvastatin	50mg/kg	Cardiac enzyme levels (CK-MB, LDH)	Antioxidant and anti-inflammatory effects	P<0.001	Dreher ML et al., 2013 ³⁴
6.	Leaf	Hepatoprotective Activity	Ethanollic Extract	CCl ₄ -Induced hepatotoxicity (Rat)	Silymarin	100mg/kg	Liver enzymes (ALT, AST, ALP)	Antioxidant and anti-inflammatory effects	P<0.05	Bartholomew I C Brai et al., 2014 ³⁶
7.	Pulp	Antioxidant and anti-aging	Methanol Extract	Human skin Fibroblasts	Vitamin E	200µg/ml	Collagen production, ROS levels	ROS scavenging, collagen promotion	P<0.01	Ya-Han Huang et al., 2018 ³⁷
8.	Seed	Anti-cancer (Pro-apoptotic)	Methanolic Extract	Human Breast Cancer Cells	Paclitaxel	20µg/ml	Apoptotic markers (Caspase-3,PARP)	Induction of apoptosis	P<0.01	Kiran R Kharat et al., 2019 ³⁵
9.	Peel	Anti-bacterial	Hexane Extract	<i>In vitro</i> (Bacterial culture)	Ciprofloxacin	50µg/ml	Zone of inhibition	Disruption of cell membrane	P<0.05	Igor Trujillo-Mayol et al.,2020 ⁴¹

10.	Leaf	Anti-inflammatory	Extract	LPS-Induced Inflammation (Rat)	Ibuprofen	50mg/kg	Inflammatory cytokines (TNF- α , IL-6)	COX-2 Inhibition	P<0.01	Patel et al., 2021 ⁴⁰
11.	Seed	Antioxidant activity	Methanol Extract	Rat model (in vivo)	Vitamin C	100mg/kg	Superoxide Dismutase (SOD) activity	Free radical scavenging	P<0.05	HY Setyawan et al., 2021 ⁴²
12.	Leaf	Antidiabetic (Insulin)	Aqueous Extract	Diabetic Rat Model (Alloxan)	Glibenclamide	50mg/kg	Insulin secretion, blood glucose levels	Pancreatic β -cell stimulation	P<0.05	Oluwafemi Adeleke Ojo et al 2022 ³⁸
13.	Seed	Antidiabetic activity	Aqueous Extract	Streptozotocin-Induced Diabetes (Rat)	Metformin	200mg/kg	Blood glucose levels	-	P<0.05	Oluwafemi Adeleke Ojo et al., 2022 ⁴⁴
14.	Peel	Anti-aging(skin)	Ethanol Extract	In vitro (Human Dermal Fibroblast)	Retinol	1 μ g/ml	Collagen production, proliferation	Cell collagen synthesis stimulation	P<0.01	Susanne M Henning et al., 2022 ⁴⁵
15.	Pulp	Anticancer	Ethanol Extract	Human Cancer cell Line (HeLa)	Doxorubicin	10 μ g/ml	Cell viability (MTT assay)	Apoptosis induction	P<0.001	Taylor E Collignon et al., 2023 ³⁹

Table 6: Summary table of avocado

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