Review Article **www.ijcps.com**

International Journal of Chemical and Pharmaceutical Sciences
2025, Mar, Vol. 16 (1)

ISSN: 0976-9390
IJCPS

Review on avocado seeds: extraction, chemical and phytochemical compositions, fat profiles and biological activities

***Nourou Dine Balogoun[1], Amoussatou Sakirigui [1,2*], Louis Fagbohoun[1], Franck Yovo[1], Eléonore Yayi Ladékan[2], Joachim Djimon Gbénou [1,2]**

[1]Kaba Research Laboratory in Chemistry and Applications (LaKReCA), University of Technical Sciences, Engineering and Mathematics (UNSTIM), PO Box 266 Natitingou, Republic of Benin.

[2]Laboratory of Pharmacognosy and Essential Oils (LaPHE), Faculty of Sciences and Techniques (FAST)/University of Abomey-Calavi (UAC), Cotonou, Republic of Benin.

* **Corresponding Author:** E-Mail**:** dinnballo@gmail.com

Received: 15th Feb 2025, Revised and Accepted: 7th Mar2025

ABSTRACT

Avocado is the fruit of Persea americana well known by the general public for its flavor, taste, seedritional value and pharmacological benefits. The virtues of its seed are still very little known by the population because it is not directly edible. However, it is full of health benefits in view of its chemical and phytochemical compositions which are no longer to be demonstrated. Secondary metabolites such as alkaloids, polyphenols, tannins and flavonoids etc. are contained in the seed. From several solvents such as Chloroform, acetone, methanol, ethanol, distilled water, ethanol-distilled water mixture, extracts of the seed are prepared by maceration, infusion, decoction etc. The avocado seed is also rich in vegetable oil mainly consisting of fatty acid very beneficial in several sectors including cosmetics. Several scientific studies report the very interesting biological properties of seeds. We can retain the antioxidant, hypocholesterolemic, antimicrobial, antiviral, insecticide, herbicide, antibacterial, anti-inflammatory, analgesic, anti-ulcerative properties, etc. This review provides an advance in the knowledge of the virtues of avocado seeds and aims to contribute to the valorization of this substance considered in some countries as waste.

Keywords: Persea americana, phytochemical composition, seeds, biological properties.

1. INTRODUCTION

The importance of medicinal plants is no longer in doubt, especially in rural areas in developing countries. The main reasons are poverty, inaccessibility to modern medicine, and the effectiveness of plants in the treatment of pathologies, Jiofack et al., 2010; Dibong et al., 2011 (1,2). According to the World Health Organization (WHO), more than 80% of the population of developed or developing countries traditionally use plant extracts, especially higher plants or their active ingredients, for primary health care Traoré, 2008; Ahouansikpo et al., 2016 (3,4). Better still, in some developing countries, traditional healers are still the only or main healthcare providers for millions of rural people Batcho et al.,2022 (5) Among these millions of plants and/or parts of plants used, we can cite Persea americana M. (avocado) and its different parts since in recent years this fruit has been the subject of several scientific studies due to its high seedritional value and health benefits; Wang et al.,2020 (6); Fernandes et al.,2018 (6,7) The avocado is native to Central and South America Orhevba et al.,2011 (8). Like its leaves and bark, which have already been studied and are used in medicine for different properties, Tatsinkou et al., 2020 (9). The avocado fruit is also known for its richness in chemical compounds because the main bioactive compounds present in avocado include phenolic compounds (such as hydroxycinnamic acids, flavonoids and proanthocyanins), acetogenins, phytosterols, carotenoids and alkaloids D'Ambrosio et al., 2011 (10); Salazar-López et al.,

2020 (10,11). The avocado fruit represents a by-product, that is generally unused and discarded during pulp processing. The seed waste can represent a serious ecological problem (Rodrigo et al., 2018 (12). Currently, the avocado kernel represents an underutilized resource and a waste problem for avocado processors. The avocado kernel is discarded in most countries, although in some countries such as the Republic of Niger, it is consumed Owolabi et al., 2007 (13). This waste, although compostable; nevertheless represents a hazard to the environment (14). According to Arukwe et al.,2012 (15), avocado kernels are rich in tannins (flavonoid; alkaloids; phenols; steroid and saponin), which could justify the valorization of its extracts Tatsinkou et al., 2020 (9) Several biological activities of the avocado seed have been reported, such as antioxidant, antihypertensive, larvicidal, fungicidal, hypolipidemic Tatsinkou et al., 2020 (9) and recently amoebicidal and giardicidal activities. In addition, several studies have also focused on the assessment of the acute toxicity of the fruit and leaves. Anaka et al., 2009 (16). The seed of P. americana has a diverse applications in ethnomedicine, ranging from the treatment of diarrhea, dysentery, toothache, intestinal parasites to the field of skin treatment and beautification without forgetting its action against cancer cells and prostate. Tatsinkou et al., 2020 (9)

The objective of this work is to provide an overview of the various works already conducted on the avocado seeds, its phytochemical composition ; its biological activities as well as the extraction and the biological properties of its oil.

Traditional uses of the avocado tree

Leaves and bark

Persea americana has therapeutic virtues as an antidiabetic and laxative. Avocado leaf tea (young leaves) is used to combat fatigue, headaches, irregular menstruation, respiratory problems, stomach weakness, atonic dyspepsia, coughs, colds, chills, throat problems, mouth inflammations, bronchitis and neuralgia. Infusion of avocado leaves : for menstrual pain, headaches, etc. They are also an effective remedy against mouth ulcers (17).

Pulp and roots

The skin of the fruit is vermifuge. The pulp of the avocado and the oil extracted from its stone are mainly used in cosmetics. They soften and nourish the skin, heal wounds and stimulate hair growth (18).

Extraction methods

Several extraction methods are used both for the preparation of extracts that will be used to evaluate biological activities, the extraction of large families of chemical compounds and for the isolation of molecules specifically ; these are maceration and decoction Rojas-García et al., 2020 (19), Pacheco et al., 2020 (20), Widiyastuti et al. 2018 (21), Abubakar et al. 2017 (22).

2. **METHODOLOGY**

Regarding the analysis methods used specifically for the isolation of molecules, we can give gas chromatography Takenaga et al., 2008 (23) and Soledad et al., 2021 (24), gas chromatography coupled with mass spectrometry Leite et al., 2009 (25), ultra-performance liquid chromatography mass spectrometry Rosero et al., 2019 (26), HPLC Rojas-García et al., 2022 (27)

Extraction solvents

The following solvents were used for the preparation of the seeds extracts : Chloroform Gupta et al., 2018 (28), Takenaga et al., 2008 (23); hexane Leite et al., 2009 (25); acetone and methanol Soledad et al., 2021 (24), ethanol Sakirigui et al., 2020 (29) and Rojas-García et al., 2022 (27); methanol Pacheco-Coele et al., 2020 (20); distilled water Pacheco-Coele et al., 2020 (20) for the different operations. It should be noted that for various reasons, the extraction can be done by mixing solvents: ethanol-distilled water or Hept: MetOH (1:1, v/v) Salinas-Salazar et al., 2016 (30).

Depending on the extraction method chosen and the solvent that accompanies it, the composition of the extract would be different and also the yield. Thus, Sakirigui et al., 2020 (29) reported an extraction yield of 11.12% while Harrizul et al., 2023 (31) reported a yield of around 15.7±09%. The causes of this gap would be deep because the two authors used ethanol as a solvent since they are still different from those reported by Hamani and Boudaoud, 2018 (32) which are 10.5 and 23.2 respectively for the aqueous and ethanolic extract having a pasty appearance.

There are several reasons for the difference in extraction yield during a process. Among others we have :

1. Nature of the solvents

Polarity of the solvent:

Polar solvents (water, ethanol) preferentially dissolve polar compounds, such as sugars or polyphenols. Non-polar solvents (hexane, chloroform) mainly extract non-polar compounds, such as lipids or essential oils.

Selectivity:

Some solvents are more selective for specific compounds. For example, ethanol is often used for polyphenols, while hexane is preferred for lipids.

2. Properties of the matrix

• Composition of the matrix: Water content, cellular structure, and the presence of other compounds interfere with the extraction.

• Pretreatments: Grinding, drying, or freeze-drying often increase the yield by increasing the contact surface between the solvent and the matrix.

Previous work on oil extraction from avocado seed

Press extraction

Press extraction is a process that produces vegetable oil by applying pressure to the plant material Permal et al., 2020 (33). This method is reported for avocado oil by authors such as Ortiz-Moreno et al.,2003 (34) extracted avocado oil by heating the fruit pulp up to 95°C using microwaves, followed by either Soxhlet extraction with hexane or pressing Woolf et al.,2009 (35) studied the extraction of oil from dried avocado pulp using the cold-pressed oil extraction method according to the methods outlined in the work of Chimuti et al., 2021(36)

Solvent extraction

Several groups of researchers have reported cases of solvent extraction of avocado oil including water. In 2015, Saha (37) in a study optimized the aqueous extraction of avocado oil. It should be noted that extraction by volatile organic solvents remains the most practiced method. Avocado oil has been subjected to extraction by organic solvents. Extraction with hexane (60 ° C for 2 h) and ethanol (78 ° C for 2 h) gives extraction yields of 23.9% and 42% respectively Adama and Edoga, 2011 (38). Ariza-Ortega et al., 2013 (39) showed that a hexane extraction conducted at 69 ° C for 4 h gave an extraction yield of 90%. Mostert et al., 2007 (40) also studied the method of drying fruits on the extractability of avocado oil with hexane and supercritical CO2. The results of the study showed that hexane produced high oil yields.

Extraction by supercritical fluids

Avocado oil was produced by means of supercritical carbon dioxide extraction Botha, 2008 (41). The extraction temperature was 37°C with a pressure of 135 atm for a time of one hour. The extraction yield of avocado oil obtained on avocado pulps dried at 80°C was 60.4%. Muleta et al.,2022 (42).

Oil extraction by solvents

Several solvents are used to extract avocado oil. This is the case of water according to the work of Saha in 2015 (81); ethanol according to the work of Ariza-Ortega et al.,2013 (39); Adama and Edoga, 2011 (38); hexane Bora et al., 2001 (43); Nelson Lemeh, 2024 (44), cyclohexane, dichloromethane and acetone and sometimes a mixture of solvents as reported by Muleta et al., 2022 (42). Accordingly, during 3 hours of extraction time, ethanol-hexane combinations of 60:40 and 40:60 percent (volume ratios) had higher oil yields of 44% and 41.2%, respectively, than 40.35% hexane Muleta et al., 2022 (42).

Pressing is ideal for producing high-quality and organic oils, with low environmental impact, but with limited yield. Solvent extraction is preferred for large-scale industrial production and to maximize yield, at the expense of quality and ecology.

Phytochemical compositions

Avocado seed is spectacularly rich in secondary metabolites Dohoué et al., 2024 (45) and Bahru et al., 2019 (45,46). Several studies in this direction have reported different results with some differences.

Qualitative analysis of avocado seed extracts revealed the presence of reducing compounds, alkaloids, flavonoids, phenolic compounds consisting of catechic and gallic tannins, saponins and terpenoids, free anthracenic and leucoanthocyanins and the absence of mucilages and O-heterosides, anthocyanins, quinonic compounds, carotenoids according to Brena et al., 2018 (47). Lillo et al.,2023 (48) reported the presence of flavonoids, phenylpropanoids and tannins. The presence of kaempferol, quercetin, luteolin and their derivatives such as glycosides and sulfates has been specified without forgetting the hexuronic acid of quercetin/isomer has been reported. Dabas et al., 2013 (49); Figueroa et al., 2018 (50); López-Cobo et al.,2016 (51); Melgar et al., 2018 (52) have also shown the presence of caffeoyl quinic acids, such as chlorogenic acid and its isomers, important phenylpropanoids in avocado seeds. The presence of flavonoids in avocado seeds has already been reported by previous works by authors such as Figueroa et al., 2018(50); Kosińska et al., 2012(53); Lopez-Cobo et al., 2016 (50-51). These flavonoids have been shown to be contained in plants with anti-gastric ulcer properties Awaad et al., 2013; Somensi; al., 2017; Owoyele et al. 2015; El-Ashmawy et al., 2016; Pereira et al., 2017 (54-58). Sakirigui et al., 2020 (29) demonstrated the presence of reducing compounds, alkaloids, flavonoids, phenolic compounds consisting of catechic and gallic tannins, saponins and terpenoids, free anthracenic

and leucoanthocyanins and the absence of mucilages and O-heterosides anthocyanins, quinonic compounds and carotenoids in the ethanolic extract of avocado seeds. These results are found to be identical to those reported by Brena et al., 2018 (47) but quite different from those reported by Vinha et al., 2013 (59) because the latter have dismantled the presence of carotenoids. Harrizul et al., 2023 (31) reported that avocado seed has a rich phytochemical composition with the presence as confirmed by the above-mentioned works of alkaloids, flavonoids, phenolic compounds and the absence of saponins, steroids and terpenoids. These results are different from those reported by Widiyastuti et al., 2018 (60) on the chloroform extract, they reported the presence of alkaloid, saponin and terpenoid, while the methanolic extract contained alkaloids, saponins, tannins, terpenoids and flavonoids. Quantitative analysis of avocado seed extracts by mass spectrometry reveals the presence of peaks representing several classes of secondary metabolites such as flavonoids, phenylpropanoids and tannins Brena et al.,2018 (47). Similar results were reported by Lillo et al.,2023 (48) with peaks in the [M-H] spectrum indicating the presence of caffeoyl quinic acids, such as chlorogenic acid and its isomers, phenylpropanoids. The presence of these flavan-3-ols (catechin and epicatechin) was confirmed by HPLC-DAD.

About quantitative analysis, the presence of reducing compounds, alkaloids, flavonoids and tannins is observed with respective contents of 1.72 ± 0.019, 2.14 ± 0.012, 5.33 ± 0.064, 7.68 ± 0.027 from the work of Sakirigui et al., 2020 (29), while based on the results of Vinha et al., 2013 (59) they find phenolic compounds, flavonoids, carotenoids, vitamin C and vitamin E respectively at contents of 704.0 ± 130.0, 47.9 ± 2.7, 0.966 ± 0.164, 2.6 ± 1.1 and 4.82 ± 1.42. It has been shown that the flavonoid content is higher in the pulp and leaves than in the pit and skin. Procyanidins are among the polyphenolic compounds identified by HPLC, in the pulp, skin, leaves and seed of avocado, have been identified, with a content of (2,370–5,560 mg/100 g) in the seeds a content that, probably due to the release of tannins bound to the cell wall structures, will increase with the maturity of the fruit. Jimenez et al., 2020 (61)

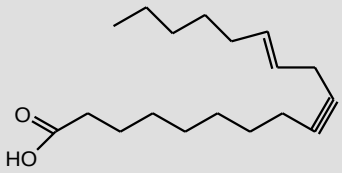
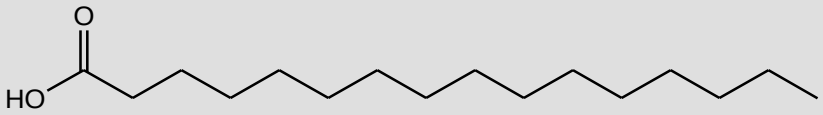
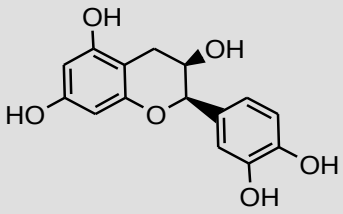
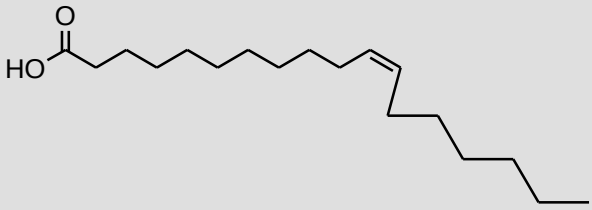
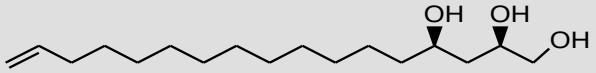
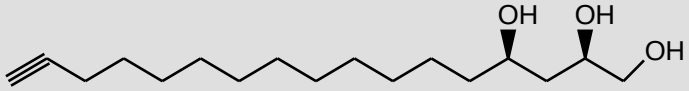
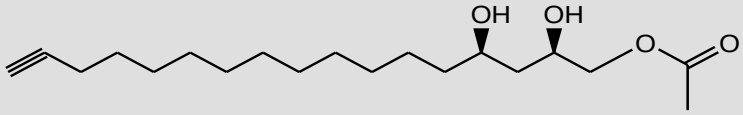
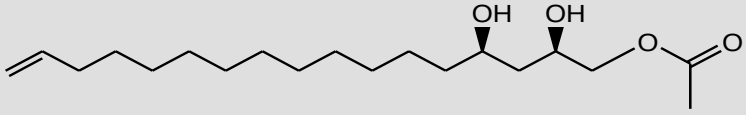
All these differences observed in the results obtained by the ones and the others would be due to the extraction methods used, the solvents used and especially the variety of avocados studied. The table 1 below resulting from the work of Harrizul et al., 2023 (31) clearly demonstrates this since it proves that the phytochemical composition is a function of the extract analyzed. Ce tableau nous renseigne sur la composition phytochimique des extraits hexanique, acétonique, éthanolique et aqueux. Ces différents extraits bien qu'ils présentent des similitudes font quand même apparaître aussi des différences chimiquement importantes telles que la présence des carbohydrates dans l'extrait aquex mais absents dans les trois autres extraits ; l'absence des composés phénoliques dans l'extrait hexanique ; l'absence des flavonoides dans l'extrait aqueux et hexanique mais présents dans les extraits éthanolique et acétonique ; la présence des alcaloides uniquement dans l'extrait éthanolique.

Table 1 : Phytochemical screening of avocado seed
Source : Harrizul et al., 2023 (31)

Tests	**Extracts**			
	Hexane	**Acetone**	**Ethanol**	**Distilled water**
Carbohydrate				
-Molish	-	-	-	-
-Benedict	-	-	-	+
-Felhing	-	-	-	-
Fatty acid				
-Sulfuric acid	+	+	-	-
Phenolics				
-$FeCl_3$	-	-	+	+
--Lead acetate	-	+	-	-
Tannins				
-$FeCl_3$	-	+	+	+
Flavonoides				
-Lead acetate	-	-	-	-

-Shinoda	-	+	+	-
Alkaloids				
-Mayer	-	-	+	-
-Wagner	-	-	+	-
Terpenoids				
-Acétate anhydre + acide sulfurique	-	-	-	-
Huile volatile				
-$KMnO_4$	-	-	-	-
Saponine				
Test de Foam	-	-	-	-
Steroides				
Anhydrous acetate + sulfuric acid	-	-	-	-

Table 2: Some molecules isolated from the avocado seed

Noms	Structures	References
9,12 octadecadienoic acid (Z, Z)		
N – hexadecanoic acid		
Epicatechin		Arueya et al., 2021 (62)
Cis –Vaccenic acid		
Avocadene		Dohoué et al., 2024 (45)
Avocadyne		
Avocadyne acetate		
Avocadene acetate		

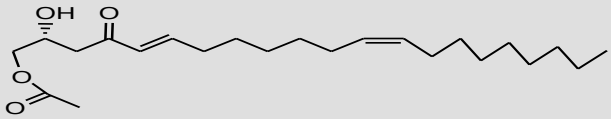
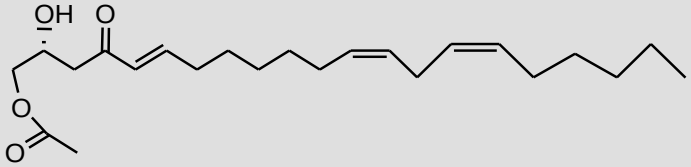
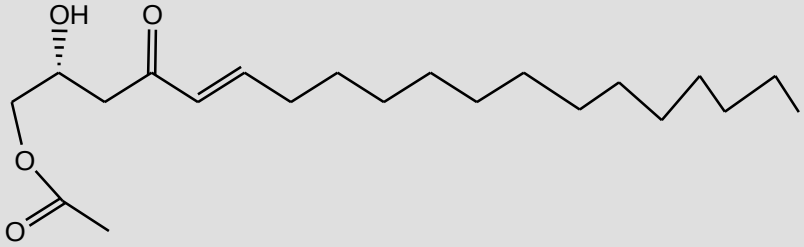
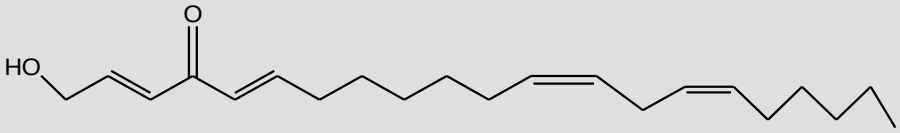
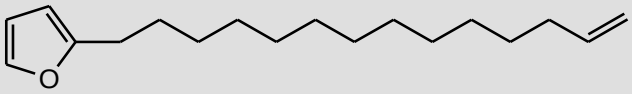
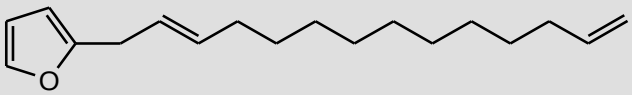
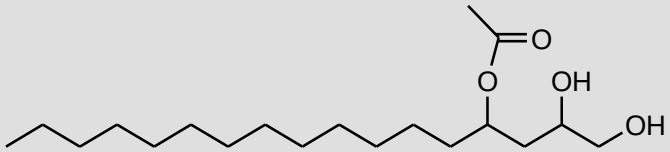
(5*E*,12*Z*)-2-Hydroxy-4-oxo-heneicosa-5,12-diene-1-yl acetate		
(5E,12Z,15Z)-2-Hydroxy-4-oxo-heneicosa-5,12,15-trien-1-yl acetate (Persenone A)		
Persenone (B)		
(2E,5E,12Z,15Z)-1-Hydroxy-heneicosa-2,5,12,15-tetraen-4-one		Fakultat et al., 2007 (63)
2-(tridec-12-ene)-furan		
Avocadienofuran		
1,2-Dihydroxy-4-acetoxy-heptadecane		

Table 3: Composition of avocado seed (Source : Saray et al.,2022 (70))

Solvants	Méthode d'analyse	Composés	Références
Chloroforme /Methanyl 2 :1 (v/v)	Chromatographie en phase gazeuse	•Monogalactosyl-diacylglycerol • Sterylglucoside • Cerobroside • Diagalactosyl-Diacylglycerol • Phosphatidic acid •Phosphatidylethanolamine • Phosphatidylcholine • Phosphatidylinositol	Takenaga et al., 2008 (23)
Hexane	Gas chromatography coupled to mass spectrometry	• 1,2,4-trihydroxy-nonadecane • β-sitosterol	Leite et al.,2009 (25)
Acetone Methanol	Ultra-performance liquid hromatography Tandem mass spectrometry	• Quinic acid, Citric acid, Procyanidin dimer A, Procyanidin trimer, B-isomer 1, Procyanidin dimer B1 • Procyanidin trimer B-isomer 2, Syringic acid • Procyanidin dimer B-isomer 2, Catechin • Procyanidin trimer A, Procyanidin dimer B2	Rosero et al., 2019 (26)

Acetonic Ethanolic	Gas chromatography coupled to mass spectrometry	• Procyanidin dimer B2, 5-O-caffeoyl-quinic acid, Caffeic acid, Epicatechin, Vanillin, p-Coumaric acid • Ferulic acid, Sinapic acid, Procyanidin dimer B-isomer 4 • Quercetin diglucoside, Quercetin 3-O-arabinosyl-glucoside, Quercetin-3-O-glucoside, Quercetin-3-O-rutinoside (rutin) • Isoestragole, Estragole, α-Cubebene, Cubebene, α-Caryophyllene, α-Farnesene, Germacrened D • Palmitaldehyde, 11-Dodecen-2 one, 9,12-Octadienal • Tridecanoic acid, methyl ester, Linoleic acid, methyl ester, Linolenic acid, methyl ester, Linolelaidic acid, methyl ester, 9,12-Octadecadien-1-ol, 9,12,15-Octadecatrien-1-ol	Soledad et al., 2021 (24)

On the other hand, let us specify that several molecules (51) have been isolated from avocado seed by several researchers. Quelques une de ces molécules y compris leur structure sont repertoriées dans le tableau 2. Ces molécules appartiennent à la famille des alcaloides, des acides, des tanins, des trpènes, des polyphénols (épicatéchine)

Chemical composition (version française)

The chemical composition of avocado nut has been the subject of several scientific research studies, as shown in Table 3, it is found that the seed of P. americana contains carbohydrates Ejiofor et al.,2018 (64); Arukwe et al., 2012 (15). This nut also has a high lipid content Martins et al.,2022 (65); Okolo et al.,2012(20); Arukwe et al., 2012 (15); Oluwole et al.,2013(21) as well as fat Okolo et al.,2012 (65); Nwodo et al.,2012 (66) as shown in Table 3. Protein and ash although several groups of researchers have reported different values Arukwe et al., 2012(15); Oliveira et al.,2013 (67); Oluwole et al.,2011 (68) and Okolo et al.,2012 (65) are also present in the nut. It is also noted from Table 3 that the methanolic extract of the avocado nut followed by fractionation revealed compounds of chlorogenic acid and its isomers, quinic acid, salidrosides as well as proantocyanidin B1 and B2 Ramos-Jerz, 2013 (69). According to the results of Saray et al.,2022 (70) the composition of the avocado nut varies according to the extraction solvent.

Biological properties

Antioxidant activities

Wang et al.,2010 (71) reported that seeds contain the strongest antioxidant properties and the highest phenol and procyanidin content compared to pulp. Polyphenolic compounds have been shown to be bioactive, due to their antioxidant, antimicrobial, antiviral and antitumor activities. Okuda et al., 2009 ; Serrano et al., 2009 ; Soong and Barlow,2004 (72-74) reported significantly higher total antioxidant capacity and phenolic content of fruit seeds than edible parts. Tannins being polyphenols, have been shown to have antioxidant properties Zhao et al., 2011 (75). This antioxidant property of tannins is responsible for their anticancer and antimutagenic potentials by protecting against cellular oxidative damage, including lipid peroxidation Suvanto et al., 2017 (76). The content of phenolic compounds is consistent with antioxidant activity Lin et al., 2016 ; Jan et al., 2019 (77,78). Avocado seed extract showed significantly higher antioxidant properties than seed extract when tested by DPPH, trolox-equivalent antioxidant capacity, and oxygen radical absorbance capacity tests Kosinska et al., 2012 ; Morais et al., 2015 ; Calderon-Oliver et al., 2016 (53,79-80)

Cholesterol-lowering activity

In most fruits, the contribution of the fruit seed fraction to the total antioxidant activity and phenolic content was greater than 95%, and these authors therefore suggested that fruit seeds should be further utilized rather than simply discarded as waste Soong and Barlow, 2004 (74). The findings of Wang et al., 2010 and Soong and Barlow,2004 (71,74) showing that the antioxidant activity of fruit seed components may be responsible for the observed cholesterol-lowering activity. Maria et al., 2012 (81)

Antimicrobial activity

Okoye et al.,2021 (82) in a study on avocado seed found that hexane extract and aqueous extract of Persea americana seeds do not inhibit the growth and therefore have no antimicrobial activity on candida, E. coli, proteus Streptococuspyo gene, Staphylococus aureus. The activities are shown in Dabas et al., 2013 (49). Contrary to the results of Okoye et al., 2021 (82), Okuda et al., 2009 (72) as well as Serrano et al., 2009 (73) found the close correlation between polyphenolic compounds and the antimicrobial, antiviral and antitumor activities of avocado seed. Colombo and Papetti, 2019 (83) showed that different avocado seed extracts (water, ethanol and chloroform) exhibit antimicrobial activity against Listeria monocytogenes, Staphylococcus epidermidis and Mycobacterium avium. In addition, acetogenin-enriched avocado seed extracts significantly inhibit the organisms Salinas-Salazar et al., 2017 ; Guil-Guerrero et al., 2016 (30,84). Aqueous extracts of avocado seeds showed good inhibitory activity against Listeria innocua (ATCC 33090), Escherichia coli (JMP101), Lactobacillus sakei, Weissella viridescens and Leuconostoc mesenteroides isolated from meat products Calderon-Oliver et al., 2016 (80), while a chloroform extract had an anti-Mycobacterium avium effect Jiménez-Arellanes et al., 2013 (85).

Antiviral activities

Okuda et al., 2009 and Okoye et al., 2021 (73,82), reported that the different phenolic compounds contained in avocado seed would give it, in addition to microbial activities, antiviral and antitumor activities. Tannins may interfere with virus absorption. It has been demonstrated by radiolabelled virus particles of Herpes simplex virus that the antiviral effects of hydrolysable and galloylated condensed tannins were due to inhibition of virus absorption. It has also been observed that several hydrolysable tannins significantly inhibit the cytopathic effects of human immunodeficiency virus, HIV, and the expression of HIV-antigen in human lymphotropic virus type I-positive MT-4 cells. Serrano et al., 2009 (73)

Insecticidal effect

Several biological activities of the avocado kernel have been reported including larvicidal activity Rodríguez et al., 2011 (86). The insecticidal activity of avocado seed extracts has been evaluated on different occasions in various studies, both for ecologically important insect species and for arthropod vectors of microorganisms. Similar work was done on biotype B of Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae), an important pest species in tropical conditions. The results indicated that ethanolic and aqueous extracts prepared from P. americana seeds, exhibited promising insecticidal activity against whitefly nymphs Carvahlo et al.,2021 (87). Larvicidal activity against Aedes aegypti of hexane and methanol extracts of avocado seeds. The results showed an LC50 of 16.7 mg. mL-1 for the hexane extract and 8.87 mg. mL-1 for the methanol extract. This activity is attributed to β-sitosterol, present mainly in the hexane extract of avocado kernels Leite et al., 2009 (25); Abe et al., 2005 (88). The results of Abe et al., 2005 (88) indicated that ethanolic extracts of avocado kernels, at doses higher than 500 µg/mL, showed moderate activity against epimastigotes. The results show that avocado seeds are a promising source of insecticidal compounds for the control of B. tabaci biotype B, an excellent opportunity to transform environmental problems into ecological solutions for agriculture Carvalho et al., 2021 (87).

Herbicidal effect

The use of avocado seeds is considered to initiate studies on the herbicidal properties of avocado seed extracts, since its size and characteristics would allow obtaining results in a short time Thomson and Dennis, 2013 (89) as well as its richness in phenolic compounds Kaab et al., 2022 (90)

Antibacterial activity

Avocado seeds had broad spectrum antibacterial activity, selective antifungal activity and predominant activity against Aspergilus niger Egbuonu et al., 2018 (91). The result of the study by Neboh et al., 2016 (92), indicates that daily oral administration of the aqueous and phenolic extract of Persea americana seeds for a period of 3 weeks at a dose of 500 mg/Kg showed a hepatotoxic effect. Egbuonu et al.,2018 (91) reported that avocado seed extract induced not only antibacterial activity against Proteus mirabilis, Staphylococcus aureus and Pseudomonas aeruginosa although lower than the corresponding activity of the standard, ciprofloxacin and in vitro antibacterial activity against Porphyromonas gingivalis with 50% - 60%.) but also activity against the fungi Aspergilus niger, Candida. Hamani and Boudaoud, 2018 (32) demonstrated that at 100 mg/ml the aqueous extract of avocado seed showed fungal effects on A. Flavus, A. Parasiticus, A. Carbonarius and A. Fumigatus while the ethanolic extract proved effective on these different fungal strains at 50 mg/ml.

Anti-inflammatory activity

Bioactive phytochemical molecules have been found and have the effect of improving hypercholesterolemia, inflammation, diabetes and hypertension Maes and Chloé, 2017 (93). A group of American researchers has shown that the avocado kernel would be a source of new compounds capables of effectively reducing inflammation according to in vitro experiments on immune cells called macrophages (94)

Analgesic activity

According to Arukwe et al.,2012 (15), avocado pits are rich in tannins (flavonoid; alkaloids; phenols; steroid and saponin); which may justify their analgesic activity.

Antiulcer activity

Farzaei et al.,2015 (95) and Awaad et al.,2013 (54) described the importance of polyphenols as bioactive molecules that can be applied in the management of peptic ulcer with protective actions that prevent the ulcer development process by promoting cytoprotection, re-epithelialization and suppression of oxidative damage due to their antioxidant properties. In addition, polyphenols are responsible for anticancer, anti-inflammatory, antidiabetic and antihypertensive activities Dabas et al., 2013 ; Araujo et al., 2018 (49,96).

Other activities reported in the literature

According to Arukwe et al.,2012 (15), avocado kernels are rich in tannins (flavonoid; alkaloids; phenols; steroid and saponin), which could justify the valorization of its extracts as an additive in animal feed Tatsinkou et al., 2020 (9); Polyphenolic compounds have been shown to be bioactive, due to their antioxidant, antimicrobial, antiviral and antitumor activities Okuda et al., 2009 ; Serrano et al., 2009 (72,73). This antioxidant property of tannins is responsible for their anticancer and antimutagenic potentials by protecting against cellular oxidative damage, including lipid peroxidation Suvanto et al., 2017 (76). The content of phenolic compounds is associated with antioxidant activity Lin et al., 2016 ; Jan et al., 2019 (77,78). Methanolic extract of avocado seeds may be useful in the anticoagulant treatment of coagulation disorders Bahru et al., 2019 (46) ; reduction of blood pressure, decrease in serum lipid levels and modulation of immune responses Ejiofor et al., 2018 (64). In vitro tests have shown that chlorogenic acid molecules and its isomers, quinic acid, salidrosides, proantocuanidins B1 and B2 have inhibitory and stimulating effects on human keratinocyte and fibroblast Ramos-Jerz M., 2013 (69).

Activities of avocado seed oil

Several biological activities are conferred to avocado seed oil including antioxidant activity according to Astuti and Fitri, 2021 (97). It has been shown by Hennessey-Ramos et al., 2019 (98) that the oil obtained from avocados unfit for consumption has a significant value of unsaturated fatty acids (mainly oleic) which favors its seedraceutical and cosmetic characteristics. Avocado oil incorporated into liquid soap showed good behavior because parameters such as ΔE* and pH were kept constant; In addition, no separation of the oil from the matrix was observed during the evaluated period. Therefore, this oil may have a synergistic effect on the evaluated matrix. Salinas-Salazar et al., 2016 demonstrated that avocado seed oil showed antimicrobial activity against L. monocytogenes similar to that of commercial antimicrobials, Avosafe R and Mirenat R. It was demonstrated in the work of Dagde, 2019 (99) that oil with low acidity is suitable for consumption, which is the case of avocado seed oil. The results also show that the oil had low peroxide values therefore a high degree of unsaturation (Ikhuoria and Maliki, 2007 (100). But it should be noted that the oil extraction yield at the avocado seed level being very low about 9%, this seed cannot therefore be qualified as an oilseed FAO, 1982 (101).

3. CONCLUSION

The avocado seed is spectacularly rich in secondary metabolites such as alkaloids, flavonoids, reducing compounds without forgetting saponins. Polyphenols are the most represented as well as alkaloids. This seed far from being traditionally used, proves to be pharmacologically very effective because it has several biological activities such as antimicrobial, anti-inflammatory, antioxidant, anti-cancer activities which are conferred on it by these families of chemical compounds mentioned above. It is moderately rich in fat with an oil that can be extracted from various methods ranging from pressure extraction to solvent extraction and which also has several biological activities such as the fight against osteoarthritis.

4. REFERENCES

1. Jiofack, T., Fokunang, C., Guedje, N., Kemeuze, V., Fongnzossie, E., Nkongmeneck, B.A., Mapongmetsem, P.M., & Tsabang, N. (2010). Ethnobotanical uses of medicinals plants of two ethnoecological regions of Cameroon. International Journal of Medicine and Medical Sciences, 2(3), 60-79.
2. Dibong, S.D., Mpondo, M.E., Ngoye, A., Kwin, M.F., & Betti, J.L. (2011). Ethnobotanique et phytomédecine des plantes médicinales de

Douala, Cameroun. Journal of Applied Biosciences, (37), 2496-2507.

3. Traoré A. contribution à l'étude des plantes à activité phytoéstrogènique utilisées dans la pris en charge des troubles de la ménopause dans le district de Bamako. [Bamako] : Thèse pharmacie, 2008 ; n°8 ; 98p
4. Ahouansinkpo, E., Atanasso, J., Dansi, A., Adjatin, A., Azize, O., & Sanni, A. (2016). Ethnobotany, phytochemical screening and toxicity risk of Cleome gynandra and Cleome viscosa, two traditional leafy vegetables consumed in Benin. International Journal of Current Microbiology and Applied Sciences, 5(2), 813-829.Akoègninou, A.,
5. Batcho I. Akossibe ;Eben-Ezer Baba Kayodé Ewédjè ;Richard Menson Somanin ;Paul Ezin Ogan (2022). Disponibilité des Plantes Aphrodisiaques dans les Jardins de Case et Forêt Classée de l'Ouémé-Boukou au Centre-Bénin. ESI Preprints. https://doi.org/10.19044/esipreprint.12.2022.p133.
6. Wang L, Tao L, Hao L, et al. A Moderate-Fat Diet with One Avocado per Day Increases Plasma Antioxidants and Decreases the Oxidation of Small, Dense LDL in Adults with Overweight and Obesity: A Randomized Controlled Trial. J Seedr. 2020;150(2):276-284. doi:10.1093/jn/nxz231.
7. Fernandes G, Gómez-Coca R, Camino M, Moreda W, Arellano D. Chemical characterization of commercial and single-variety avocado oils. Grasas Aceites. 2018;69:256. doi:10.3989/gya.0110181.
8. Orhevba B. A., A.O. Jinadu. (2011). determination of physico-chemical properties and seedritional contents of avocado pear (persea americana m.). Academic Research International. ISSN: 2223-9553 Volume 1, Issue 3, November 2011.
9. Tatsinkou A. S., Miegoue E, Marie Noëlle Bertine NOUMBISSI, Camara SAWA, Hervé KUITCHE MUBE, Géneviève NGUEDIA, Mama MOUCHILI, Josué FOSSI et Fernand TENDONKENG. (2020). Effet des extraits de noyaux d'avocat sur la croissance et la variation du microbiote caecal chez le cochon d'inde (Cavia porcellus). Int. J. Biol. Chem. Sci. 14(9): 3241-3253, December 2020 ISSN 1997-342X (Online), ISSN 1991-8631 (Print).
10. D'Ambrosio SM., Han C., Pan L., Kinghorn AD., Ding H. Aliphatic acetogenin constituents of avocado fruits inhibit humanoral cancer cell proliferation by targeting the EGFR/RAS/RAF/MEK/ERK1/2 pathway. Biochem Biophys Res Commun 409:465–469 (2011).
11. Salazar-López N., Domínguez-Avila A., Yahia E., Belmonte-Herrera B., Wall-Medrano A., Montalvo-González E., González-Aguilar G. Avocado fruit and by-products as potential sources of bioactive compounds. Food Res Int. 138(Pt A): 109774 (2020).
12. Ferrareze Rodrigo Roberto, Sergio Silva Braga Junior, Renato Dias Baptistar,(2018) Modelo de gest˜ao de resíduos: desafios e perspectivas do setor de frigoríficos. DRd – Desenvolvimento Regional em debate, Santa Catarina, vol. 8, 29 jun. 2018, pp. 68–88, 2.
13. Owolabi MA, Jaja SI, Coker HAB. Vasorelaxant action of aqueous extract of the leaves of Persea americana on isolated thoracic rat aorta. Fito. 2005; 76(6): 567-573. doi: 10.1016/j.fitote. 2005.04.020
14. www.aquitaineonline.com
15. Arukwe U, Amadi BA, Duru MKC, et al. Chemical composition of Persea americana leaf, fruit and seed. IJRRAS. 2012; 11(2): 346-349.
16. Anaka ON, Ozolua RI, Okpo SO. Effect of the aqueous seed extract of Persea americana Mill (Lauraceae) on the blood pressure of Sprague-Dawley rats. Afr J Pharm Pharmacol. 2009; 3(10): 485-490.
17. https://lesjardinsdenini.com/
18. https://www.omp.uliege.be/upload/docs/application/pdf/2024-01/avocatier.pdf
19. Rojas-García, A.; Fuentes, E.; Cádiz-Gurrea, M.d.l.L.; Rodriguez, L.; Villegas-Aguilar, M.d.C.; Palomo, I.; Arráez-Román, D.; Segura-Carretero, A. Biological Evaluation of Avocado Residues as a Potential Source of Bioactive Compounds. Antioxidants 2022, 11, 1049. https://doi.org/ 10.3390/antiox11061049
20. Pacheco-Coello, Franklin; Seijas-Perdomo, Desirée (2020). evaluation of the antioxidant activity of the aqueous and methanolic extracts of seeds of persea americana mill, variety hass, from the state aragua in Venezuela. Revista Boliviana de Química, vol. 37, no. 3, 2020, July-, pp. 142-147
21. Yuli Widiyastuti1,_ , Rarastoeti Pratiwi2, Sugeng Riyanto3, and Subagus Wahyuono3 (2018). Cytotoxic activity and apoptosis induction of avocado Persea americana Mill. seed extract on MCF-7 cancer cell line. Indonesian Journal of Biotechnology. volume 23(2), 2018, 61-67

22. Abubakar ANF, Achmadi SS, Suparto IH. 2017. Triterpenoid of avocado (Persea americana) seed and its cytotoxic activity toward breast MCF-7 and liver HepG2 cancer cells. Asian Pac J Trop Biomed 7(5):397–400. doi:10.1016/j.apjtb.2017.01.010.
23. Takenaga, F., Matsuyama, K., Abe, S., Torii, Y., & Itoh, S. (2008). Lipid and Fatty Acid Composition of Mesocarp and Seed of Avocado Fruits Harvested at Northern Range in Japan. 597(11), 591–597.
24. Soledad, C. P. T., Paola, H. C., Carlos Enrique, O. V., Israel, R. L. I., GuadalupeVirginia, N. M., & Raúl, Á. S. (2021). Avocado seeds (Persea americana cv. Criollo sp.): Lipophilic compounds profile and biological activities. Saudi Journal of Biological Sciences, 28(6), 3384–3390. https://doi.org/10.1016/j.sjbs.2021.02.087
25. Leite, J. J. G., Brito, É. H. S., Cordeiro, R. A., Brilhante, R. S. N., Sidrim, J. J. C., Bertini, L. M., De Morais, S. M., & Rocha, M. F. G. (2009). Chemical composition, toxicity and larvicidal and antifungal activities of Persea americana (avocado) seed extracts. Revista Da Sociedade Brasileira de Medicina Tropical, 42(2), 110–113. https://doi.org/10.1590/S0037-86822009000200003
26. Rosero, J. C., Cruz, S., & Osorio, C. (2019). Analysis of Phenolic Composition of Byproducts (Seeds and Peels) of Avocado (Persea americana Mill .) Cultivated in Colombia. Molecules, 24(3209).
27. Rojas-García, A.; Fuentes, E.; Cádiz-Gurrea, M.d.l.L.; Rodriguez, L.; Villegas-Aguilar, M.d.C.; Palomo, I.; Arráez-Román, D.; Segura-Carretero, A. Biological Evaluation of Avocado Residues as a Potential Source of Bioactive Compounds. Antioxidants 2022, 11, 1049. https://doi.org/ 10.3390/antiox11061049
28. Shiv Kumar Gupta*, Prateek Singhal, Anuradha Singh, Ritu Chauhan, Babita Kumar (2018). Seedritional and pharmceutical benifits of avocado plant. J Adv Sci Res, 2018, 9 (2) : 04-11
29. Sakirigui Amoussatou 1,2*, EléonoreYayi Ladekan1, Louis Fagbohoun1,2, KamirouChabi Sika3, Fidèle Assogba1 and Joachim Djimon Gbenou1,2(2020). Phytochemical composition and potential antimicrobial activity of extracts of two neglected seeds (MangiferaindicaL. and Persea Americana L.) in Benin. IOSR Journal of Applied Chemistry (IOSR-JAC) e-ISSN: 2278-5736.Volume 13, Issue 5 Ser. III (May. 2020), PP 21-26
30. Salinas-Salazar Carmen, Carmen Hern´andez-Brenes, Dariana Graciela Rodr´ıguez-S´anchez, Elena Cristina Castillo, Jes´us Manuel Navarro-Silva, and Adriana Pacheco (2016). Inhibitory Activity of Avocado Seed Fatty Acid Derivatives (Acetogenins) Against Listeria Monocytogenes. Journal of Food Science. Vol. 00, Nr. 0, 2016
31. Rivai1Harrizul *, Yolanda Triana Putri2, Rusdi Rusdi2. Qualitative and Quantitative Analysis of the Chemical Content of Hexane, Acetone, Ethanol and Water Extract from Avocado Seeds (Persea americana Mill.). Sch Int J Tradit Complement Med ISSN 2616-8634(Print)|ISSN 2617-3891. DOI:10.21276/sijtcm.2019.2.3.1
32. HAMANI Manar&BOUDAOUD Djamilasur (2018). Effet antifongique des extraits aqueux et éthanoliques des feuilles et des noyaux de Persea americana. Mémoire, universite akli mohand oulhadj – bouira; 52p
33. Permal R, Chang L, Seale W, Hamid B, Kam N (2020) R. Converting industrial organic waste from the cold-pressed avocado oil production line into a potential food preservative.Food Chem;306
34. Ortiz MA, Dorantes AL, Gallndez MJ, Cárdenas SE. Effect of a novel oil extraction method on avocado (Persea americana Mill) pulp microstructure. Plant Foods Hum Seedr. 2004; 59(1): 11-14. doi: 10.1007/s11130-004-0032-3
35. Woolf, A., Wong, M., Eyres, L., McGhie, T., Lund, C., Olsson, S., Wang, Y., Bulley, C., Wang, M., Friel, E. and Requejo-Jackman, C. (2009). Avocado oil. In Moreau, R. and Kamal-Eldin, A. (Eds), Gourmet and Health-Promoting Specialty Oils, p. 73-125. Urbana, Illinois: AOCS Press. https://doi.org/10.1016/B978-1-893997-97-4.50008-5
36. Chimuti, N., 2Takalani, T.K. and 3,4,*Anyasi, T.A. (2021),Organoleptic and physicochemical properties of 'Hass' avocado (Persea americana Mill) oil extract obtained using cold press technology, Food Research 5 (4) : 360 - 365 (August 2021)
37. Saha Foudjo Brice Ulrich. Optimisation de l'extraction aqueuse et détermination de quelques proprietes physicochimiques et fonctionnelles de l'huile d'avocat. 2015. Doctorat/Ph.D. en Biochimie 256p
38. Adama K. K., Edoga M. O. Avocado apple (Persea americana) pericarp waste: A source of oil for industrial application obtained and characterized using extraction with different

solvents. Archives of Applied Science Research, 3 (4), 398-410. (2011).

39. Ariza, J., López, F., Coyot, J., Ramos, M., Díaz, J. and Martínez, A. (2011). Effect of different extraction methods on the profile of fatty acids in avocado oil (Persea americana Mill. Var. Hass). Revista Venezolana de Ciencia y Tecnologia de Alimentos, 2(2), 263–276.
40. Mostert, M.E., Botha, B.M., Du Plessis, L.M. and Duodu, K.G. (2007). Effect of fruit ripeness and method of fruit drying on the extractability of avocado oil with hexane and supercritical carbon dioxide. Journal of the Science of Food and Agriculture, 87(15), 2880–2885. https://doi.org/10.1002/jsfa.3051
41. Botha B.M. Supercritical fluid extraction of avocado oil. South African Avocado Growers' Association Yearbook, 27, 24-27. (2008).
42. Melkiyas Diriba Muleta, Bulcha Jifara ,Daba Abnet Mengesha, Dube R. Ramesh (2022). xtraction of Avocado Peel Oil Using a Soxhlet Extractor and Investigation of Its hysicochemical Properties. DOI: https://doi.org/10.21203/rs.3.rs-1918209/v1
43. Pushkar S. Bora, Narendra Narain*, Rosalynd V.M. Rocha and Marçal Queiroz Paulo (2001) Characterization of the oils from the pulp and seeds of avocado (cultivar: Fuerte) fruits. Grasas y Aceites 171 Vol. 52. Fasc. 3-4 (2001), 171-174
44. Nelson Lemeh[1,2] (2024). Extraction and Characterization of oil from Avocado Pear Seed (Persea Americana) and African Pear Seed (Dacryodes Edulis). DOI: 10.14293/PR2199.000845.v1
45. Bossou Annick Flore Arlette Dohoué, Adoko S. Dieudonné, Avlessi Félicien and Sohounhloue K.C. Dominique (2024). ASPECTS botaniques, profils seedritionnels et chimiques, propriétés biologiques et utilisations cosmétiques de persea americana mill. Int. J. Adv. Res. 12(02), 134-143
46. Bahru TB, Tadele ZH, Ajebe EG A Review on Avocado Seed: Functionality, Composition, Antioxidant and Antimicrobial Properties.Chem Sci Int J2019:1–10. https://doi.org/10.9734/csji/2019/v27i230112.
47. Brena Ramos Athaydes, Gisele Maziero Alves, Arícia Leone Evangelista Monteiro de Assis, João Victor Dutra Gomes, Ricardo Pereira Rodrigues, Bianca Prandi Campagnaro, Breno Valentim Nogueira, Dâmaris Silveira, Ricardo Machado Kuster, Thiago de Melo Costa Pereira, Rodrigo Rezende Kitagawa, Rita de Cássia Ribeiro Gonçalves , Avocado seeds (Persea americana Mill.) prevents in domethacin-induced gastric ulcer in mice. Frin (2018), doi:10.1016/ j.foodres.2018.10.057
48. Lillo A. a* , F. Carvajal-Caiconteb , W. Vitalc , P. I. Silva Juniord , E. J. Paredes-Gameroe , M. Alvearb , and A. Miranda. Bioactive properties of Persea lingue Ness (Lauraceae) fruit and leaf extracts. Brazilian Journal of Biology, 2023, vol. 83, e248063 | https://doi.org/10.1590/1519-6984.248063
49. Dabas, D., Shegog, R. M., Ziegler, G. R., & Lambert, J. D. (2013). Avocado (Persea americana) seed as a source of bioactive phytochemicals. Current Pharmaceutical Design, 19(34). https://doi.org/10.2174/1381612811319340007
50. Figueroa, J. G., Borrás-Linares, I., Lozano-Sánchez, J., & Segura-Carretero, A. (2018). Comprehensive characterization of phenolic and other polar compounds in the seed and seed coat of avocado by HPLC-DAD-ESI-QTOF-MS. Food Research International, 105, 752–763. https://doi.org/10.1016/j.foodres.2017.11.082
51. López-Cobo A., Gómez-Caravaca, A. M., Pasini, F., Caboni, M. F., Segura-Carretero, A., & Fernández-Gutiérrez, A. (2016). HPLC-DAD-ESI-QTOF-MS and HPLC-FLD-MS as valuable tools for the determination of phenolic and other polar compounds in the edible part and by-products of avocado. LWT - Food Science and Technology, 73, 505-513.https://doi.org/10.1016/j.lwt.2016.06.049
52. Melgar, B., Dias, M. I., Ciric, A., Sokovic, M., Garcia-Castello, E. M., Rodriguez- Lopez, A. D., … Ferreira, I. C. R. F. (2018). Bioactive characterization of Persea americana Mill. by-products: A rich source of inherent antioxidants. Industrial Crops and Products, 111(June 2017), 212-218. https://doi.org/10.1016/j.indcrop.2017.10.024
53. Kosinska, A., Karama_c, M., Estrella, I., Hern_andez, T., Bartolom_e, B. & Dykes, G.A. (2012). Phenolic compound profiles and antioxidant capacity of Persea americana Mill. peels and seeds of two varieties. Journal of Agricultural and Food Chemistry, 60, 4613–4619.

54. Awaad, A. S., El-Meligy, R. M., & Soliman, G. A. (2013). Natural products in treatment of ulcerative colitis and peptic ulcer. Journal of Saudi Chemical Society, 17(1), 101–124. https://doi.org/10.1016/j.jscs.2012.03.002
55. Somensi, L. B., Boeing, T., Cury, B. J., Steimbach, V. M. B., Niero, R., de Souza, L. M., … de Andrade, S. F. (2017). Hydroalcoholic extract from bark of Persea major (Meisn.) L.E. Kopp (Lauraceae) exerts antiulcer effects in rodents by the strengthening of the gastric protective factors. Journal of Ethnopharmacology, 209, 294-304. https://doi.org/10.1016/j.jep.2017.08.007
56. Owoyele B. V.; Adebayo I. K.; Soladoye A. O. Anti-ulcer effects of aqueous extract of Persea americana Mill (Avocado) leaves in rats. (2015) Comp. Bio. Nat. Pro., 3, 179-184.
57. El-Ashmawy, N. E., Khedr, E. G., El-Bahrawy, H. A., & Selim, H. M. (2016). Gastroprotective effect of garlic in indomethacin induced gastric ulcer in rats. Seedrition, 32(7–8), 849–854. https://doi.org/10.1016/j.seed.2016.01.010
58. Pereira, A. C. H., Lenz, D., Nogueira, B. V., Scherer, R., Andrade, T. U., Da Costa, H. B., … Endringer, D. C. (2017). Gastroprotective activity of the resin from virola oleifera. Pharmaceutical Biology, 55(1), 472-480. https://doi.org/10.1080/13880209.2016.1251467
59. Ana F. Vinha1,2, Joana Moreira1 & Sérgio V. P. Barreira1. Physicochemical Parameters, Phytochemical Composition and,Antioxidant Activity of the Algarvian Avocado (Persea americana Mill.). Journal of Agricultural Science; Vol. 5, No. 12; 2013 ISSN 1916-9752 E-ISSN 1916-9760
60. Widiyastuti Y, Pratiwi R, Riyanto S, Wahyuono S. 2014. Chloroform and methanolic extract of avocado seed (Persea americana Mill.) against MCF-7 cancer cell line. In: W Jokopriyambodo, Y Widyastuti, S Wahyono, R Mujahid, D Subositi, editors. Proceedings of the International Symposium on Medical Plants and Traditional Medicine. volume XLVI. Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan. p. 598–607
61. Paula Jimenez, Paula Garcia, Vilma Quitral, Karla Vasquez, Claudia Parra-Ruiz, Marjorie Reyes-Farias, Diego F Garcia-Diaz, Paz Robert, Cristian Encina & Jessica Soto-Covasich (2020): Pulp, Leaf, Peel and Seed of Avocado Fruit: A Review of Bioactive Compounds and Healthy Benefits, Food Reviews International, DOI: 10.1080/87559129.2020.1717520.
62. Arueya, Gibson L. and Amusat Oluwatobi R. Avocado (persia americana) seed processing into a third-generation functional food snack : Seedritional, antioxidative stress and safety potentials. African Journal of Food Science and Technology (ISSN : 2141-5455) Vol. 12(4) pp. 01-015, March, 2021 DOI : http:/dx.doi.org/10.14303//ajfst.2021.025
63. Von der Fakultat fur Lebenswissenschaften (2007) Phytochemical analysis of avocado seeds (Persea americana Mill., c.v. Hass). der Technischen Universitat Carolo-Wilhelmina. Thèse 347 p
64. Ejiofor NC, Ezeagu IE, Ayoola M, Umera EA. Determination of the chemical composition of avocado (Persea americana) seed. Adv Food Technol Seedr Sci Open J. 2018; SE(2): S51-S55. doi: 10.17140/AFTNSOJSE-2-107.
65. Okolo SC, Olutayo O, Doyinsola I, Adedayo A, Ikokoh PP. Orishadipe AT. Comparative proximate studies on some Nigerian food supplements. Ann Biol Res. 2012; 3(2):773-779.
66. Nwodo UU, Green E, Okoh A. 2012. Bacterial exopolysaccharides: Functionality and prospects. Intl J Mol Sci 13: 14002-14015. DOI: 10.3390/ijms131114002.
67. Oliveira M.C., R. Pio, J.D. Ramos, L.C.O. Lima, M.P. Pasqual, V.A. Santos, Fenologia e características físico-químicas de frutos de abacateiros visando `a extraç˜ao de ´oleo, Ciˆencia Rural. 43 (2013) 411–418.
68. Oluwole, F. S., Onasanwo, S. A., Olaleye, S. B. (2011). Effects of Aqueous and Methanolic Extracts of Persea Americana Leaf (Avocado Pear) On Gastric Acid Secretion in Male Albino Rats, 61(4), 474–481.
69. Ramos-Jerz, M. D. R., Villanueva, S., Jerz, G., Winterhalter, P., Deters, A. M. (2013). Persea americana mill. Seed: Fractionation, characterization, and effects on human keratinocytes and fibroblasts. Evidence-Based Complementary and Alternative Medicine, 2013(November). http://doi.org/10.1155/2013/391247
70. Saray Paternina-Ricardo*, Maria C. Garcia-Espiñeira, Barbara Arroyo-Salgado (2022). Evaluation Of Herbicidal and Insecticidal Properties of Avocado Seed Extract for Application as a Biopesticide. Chemical Engineering Transactions. VOL. 92, 2022. ISBN 978-88-95608-90-7; ISSN 2283-9216. DOI: 10.3303/CET2292123
71. Wang W, Bostic TR, Gu LW (2010) Antioxidant capacities, procyanidins and

pigments in avocados of different strains and cultivars. Food Chem 122(4):1193–1198.

72. Okuda T, Yoshida T, Hatano T, Ito H. Ellagitannins renewed the concept of tannins. In: Quideau S, ed. Chemistry and Biology of Ellagitannins: An Underestimated Class of Bioactive Plant Polyphenols. Singapore: World Scientific Publishing Co. Pte. Ltd.; 2009: 1-54. doi: 10.1142/9789812797414_0001
73. Serrano J, Puupponen-Pimiä R, Dauer A, Aura AM, Saura CF. Tannins: Current knowledge of food sources, intake, bioavailability and biological effects. Mol Seedr Food Res. 2009; 53: S310-S329. doi: 10.1002/mnfr.200900039
74. Soong YY, Barlow PJ (2004) Antioxidant activity and phenolic content of selected fruit seeds. Food Chem 88(3):411–417
75. Zhao S, Liu JY, Chen SY, Shi LL, Liu YJ, Ma C. Antioxidant potential of polyphenols and tannins from burs of Castanea mollissima Blume. Molecules. 2011; 16(10): 8590-600. doi: 10.3390/molecules16108590
76. Suvanto J, Nohynek L, Seppänen-Laakso T, Rischer H, Salminen JP, Puupponen-Pimiä R. Variability in the production of tannins and other polyphenols in cell cultures of 12 Nordic plant species. Planta, 2017; 246(2): 227-241. doi: 10.1007/s00425- 017-2686-8
77. Lin, J.-T., Liu, S.-C., Hu, C.-C., Shyu, Y.-S., Hsu, C.-Y., and Yang, D.-J. (2016). Effects of roasting temperature and duration on fatty acid composition, phenolic composition, Maillard reaction degree and antioxidant attribute of almond (Prunus dulcis) kernel. Food Chem. 190, 520–528. doi:10.1016/j.foodchem.2015.06.004
78. Jan, K., Ahmad, M., Rehman, S., Gani, A., and Khaqan, K. (2019). Effect of roasting on physicochemical and antioxidant properties of kalonji (Nigella sativa) seed flour. Food Meas. 13 (2), 1364–1372. doi:10.1007/s11694-019-00052-4.
79. Morais, D.R., Rotta, E.M., Sargi, S.C. et al. (2015). Antioxidant activity, phenolics and UPLC–ESI (–)–MS of extracts from different tropical fruits parts and processed peels. Food Research International, 77, 392–399.
80. Calderon-Oliver, M., Escalona-Buendía, H. B., Medina-Campos, O. N., Pedraza- Chaverri, J., Pedroza-Islas, R., & Ponce-Alquicira, E. (2016). Optimization of the antioxidant and antimicrobial response of the combined effect of nisin and avocado byproducts. LWT - Food Science and Technology, 65, 46–52
81. María Elena Pahua-Ramos, Alicia Ortiz-Moreno, Germán Chamorro-Cevallos, María Dolores Hernández-Navarro , Leticia Garduño-Siciliano, Hugo Necoechea-Mondragón, Marcela Hernández-Ortega (2012). Hypolipidemic Effect of Avocado (Persea americana Mill) Seed in a Hypercholesterolemic Mouse Model. Plant Foods Hum Seedr (2012) 67:10–16 DOI 10.1007/s11130-012-0280-6.
82. Ogbuagu ,Adaora Stella Marris., Ukachukwu, Chidimma Esther and Okoye Chinedu Innocent (2021). Proximate, elemental composition and antimicrobial analysis of avocado (Perseaamericana) SEED. J.Bio.Innov 10(4), pp: 1035-1043, 2021 |ISSN 2277-8330 (Electronic) https://doi.org/10.46344/JBINO.2021.v10i04.10.
83. Colombo, R., Papetti, A. (2019). Avocado (Persea americana Mill.) by-products and their impact: from bioactive compounds to biomass energy and sorbent material for removing contaminants. A review. International Journal of Food Science & Technology, 54(4), 943-951. https://doi.org/10.1111/ijfs.14143.
84. Guil-Guerrero, J.L., Ramos, L., Moreno, C., Z_u~niga-Paredes, J.C., Carlosama-Yepez, M. & Ruales, P. (2016). Antimicrobial activity of plant-food by-products: a review focusing on the tropics. Livestock Science, 189, 32–49..
85. Paula Jimenez, Paula Garcia, Vilma Quitral, Karla Vasquez, Claudia Parra-Ruiz, Marjorie Reyes-Farias, Diego F Garcia-Diaz, Paz Robert, Cristian Encina & Jessica Soto-Covasich (2020): Pulp, Leaf, Peel and Seed of Avocado Fruit: A Review of Bioactive Compounds and Healthy Benefits, Food Reviews International, DOI: 10.1080/87559129.2020.1717520.
86. Gustavo R. Velderrain-Rodríguez a,b, Laura Salvia-Trujillo a, Gustavo A. Gonz´alez-Aguilar b, Olga Martín-Belloso a,* (2021). Interfacial activity of phenolic-rich extracts from avocado fruit waste: Influence on the colloidal and oxidative stability of emulsions and nanoemulsions. Innovative Food Science and Emerging Technologies 69 (2021) 102665
87. Carvalho, S. S. De, Ribeiro, P., & Forim, M. R. (2021). Avocado kernels , an industrial residue : a source of compounds with insecticidal activity against silverleaf whitefly. Environmental Scince and Pollution Research, 28, 2260–2268..
88. Abe, F., Nagafuji, S., Okawa, M., Kinjo, J., Akahane, H., Ogura, T., Martinez-Alfaro, M. A.,

& Reyes-Chilpa, R. (2005). Trypanocidal Constituents in Plants 5 . 1) Evaluation of Some Mexican Plants for Their Trypanocidal Activity and Active Constituents in the Seeds of Persea americana. Pharmaceutical Society of Japan, 28(7), 1314–1317.

89. Thomson, E. L. S., & Dennis, J. J. (2013). Common Duckweed (Lemna minor) Is a Versatile High- Throughput Infection Model For the Burkholderia cepacia Complex and Other Pathogenic Bacteria. 8(11), 1–14. https://doi.org/10.1371/journal.pone.0080102.
90. Kaab, S. B., Rebey, I. B., Hana, M., Hammi, K. M., Smaoui, A., Fauconnier, M. L., Clerck, C. De, Jijakli, M. H., & Ksouri, R. (2020). Screening of Tunisian plant extracts for herbicidal activity and formulation of a bioherbicide based on Cynara cardunculus. South African Journal of Botany, 128, 67–76. https://doi.org/10.1016/j.sajb.2019.10.018
91. Egbuonu AC, Opara IC, Onyeabo C, Uchenna NO. Proximate, functional, antiseedrient and antimicrobial properties of avocado pear (Persea americana) Seeds. J Seedr Health Food Eng. 2018;8(1):00260. DOI: 10.15406/jnhfe.2018.08.00260
92. Neboh EE, Ufelle SA, Anele TI. Effect of methanolic seed extract of (Avocado pear) on prothrombin time and activated partial thromboplastin time in mice Persea americana. An Official Publication of Enugu State University of Science and Technology; 2016. [ISSN: 2315 – 9650].
93. Maes, Chloé. (2017), contribution à l'étude phytochimique des espèces leea guinensis, litchi chinensis et persea americana en vue de valorisations cosmétiques. Mémoire.
94. www.fréquencemédicale.com consulté le 26/12/2024 à 22h.
95. Farzaei, M. H., Abdollahi, M., & Rahimi, R. (2015). Role of dietary polyphenols in the management of peptic ulcer. World Journal of Gastroenterology, 21(21), 6499–6517. https://doi.org/10.3748/wjg.v21.i21.6499.
96. Araujo, R.G., Rodriguez-Jasso, R.M., Ruiz, H.A., Pintado, M.M.E. & Aguilar, C.N. (2018). Avocado by-products: seedritional and functional properties. Trends in Food Science and technology, 80, 51–60. Avhad, M.R. & Marchetti, J.M. (2016). Mathematical modelling of the drying kinetics of Hass avocado seeds. Industrial Crops and Products, 91, 76–87.
97. Yuni Astuti1, Noor Fitri1* (2021). antioxidant activity of avocado seed oil using soxhlet and microwave-assisted extraction techniques. Yogyakarta, 13 Oktober 2021 ISBN: 978-623-6572-45-0
98. Licelander Hennessey-Ramos1, 3 * Walter Murillo-Arango2, 3 and Giovanni Tovar uayabo1(2019). Evaluation of a colorant and oil extracted from avocado waste as functional components of a liquid soap formulation. ISSN 0304-2847 / e-ISSN 2248-7026 doi: 10.15446/rfnam.v72n2.74573
99. Dagde, K K (2019). Extraction of Vegetable Oil from Avocado Seeds for Production of Biodiesel. J. Appl. Sci. Environ. Manage. Vol. 23 (2) 215–221 February 2019.
100. Ikhouria, EU ; Maliki, M (2007). Characterization of Avocado Pear (persea Americana mill) andAfrican Pear (Dacryodes Edulis), Afri. J.Biotechnol. 6 (7), 950-952
101. FAO, (1982). "Fruit Bearing Forest Tree". Technical notes FAO Forestry Food And Agricultural Organization, Rome, PP, 174.