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In vitro inhibitory potential of avocado fruits, *Persea americana* (Lauraceae) against oxidation, inflammation and key enzymes linked to skin diseases

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ABSTRACT

Introduction: Avocado (*Persea americana* Mill.) is a member of Lauraceae with one-seeded berry fruit and cultivated in all tropical, subtropical regions in the world and in the Southern coast region of Turkey. Oxidative damage caused by UV can trigger inflammation, resulting in serious inflammatory skin diseases including eczema, seborrheic dermatitis, hyperpigmentation and ageing. Enzyme inhibitors involved in melanogenesis, such as tyrosinase, have been used recently for hyperpigmentation and skin diseases in cosmetic products. **Objective:** This study aimed to evaluate the antioxidant, anti-inflammatory, anti-tyrosinase activities and total polyphenolic contents of the different parts of *P. americana* fruit. **Methods:** The fruit was divided into exocarp, mesocarp, seed, and then methanol and *n*-hexane extracts were prepared. DPPH and ABTS free radical scavenging capacities and inhibitory potentials on lipid peroxidation were determined to investigate the antioxidant potentials of the extracts. Anti-inflammatory activities of the extracts were evaluated by measuring the stabilization level of the human red blood cell membrane. The tyrosinase inhibitory activities of the samples were determined using mushroom tyrosinase. **Results:** In general methanol extracts possessed remarkable higher DPPH free radical scavenging activities than *n*-hexane extracts. The highest activity was determined in methanol extracts of seed (4.17 ± 0.04 mg/mL) followed by exocarp (5.25 ± 0.05 mg/mL). Overall methanol extracts possessed higher ABTS free radical scavenging activities than *n*-hexane extracts. The greatest ABTS free radical scavenging activity was obtained in methanol extracts of seed (0.03 ± 0.01 mg/mL). In the anti-lipid peroxidation assay, the greatest activity was noticed in methanol extracts of seed (7.71 ± 0.36 µg/mL) followed by exocarp (12.12 ± 0.34 µg/mL), while all *n*-hexane extracts were inactive. Overall methanol extracts exhibited higher anti-inflammatory and antioxidant properties than *n*-hexane extracts. However, the maximum anti-tyrosinase activity was determined in *n*-hexane extracts of exocarp (0.40 ± 0.01 mg/mL) followed by seed (0.46 ± 0.01 mg/mL). **Conclusions:** These extracts are promising candidates for use as natural products-based antioxidant and anti-inflammatory properties in inflammation-related disease, and also anti-tyrosinase properties in dermatological applications.

Key words: anti-inflammatory; antioxidant; anti-tyrosinase; avocado; *Persea americana.*

Lauraceae is a tropical and subtropical family that includes evergreen, leathery trees, and shrubs. The family has 50 genera and about 3 000 species (Evans, 2002). *Persea americana* Mill. (Lauraceae) cultivated in tropical, subtropical regions of the world and in the Southern coastal regions in Turkey (Kendir & Köroğlu, 2018). *P. americana* fruits contain lipids (13.5-24 %), carbonhydrate (0.8-4.8 %), protein (1-3 %), additionally, phytosterols, terpenoids (monoterpenes, sesquiterpenes, triterpenes), flavonoids, carotenoids, and alkaloids (Araújo, Rodríguez-Jasso, Ruiz, Pintado & Aguilar, 2018; Dabas, Shegog, Ziegler, & Lambert, 2013). Lipids are of great importance in the chemical content of avocado. Fruits are known to be rich in polar lipids, and avocado oil has been reported to be rich in monounsaturated fatty acids (71 %), polyunsaturated (13 %) and saturated fatty acids (Araújo et al., 2018). By virtue of this rich content, it can help to regulate lipid profiles and cardiovascular risks and also used in dermatological applications (Dreher & Davenport, 2013). Bioactivities of *P. americana* has been reported such as antidiabetic, antihypertensive, hypocholesterolemic, antifungal, antiprotozoal, antibacterial, antioxidant and larvicidal (Antasionas, Riyanto, & Rohman, 2017; Leite et al., 2009; Lu, Chang, Peng, Lin, & Chen, 2012; Monika & Geetha, 2015; Vinha, Moreira, & Barreira, 2013). Exocarp and the avocado seed contain great concentrations of bioactive phytochemicals including polyphenols, phenolic acids, procyanidins, flavonols, and fatty acids (Rodríguez-Carpena et al., 2011). The seed of *P. americana* exhibited high antioxidant antimicrobial, antibacterial, insecticidal and fungicidal activities (Cardoso et al., 2017; Rodríguez-Carpena et al., 2011). Dabas, Shegog, Ziegler, & Lambert (2013) reported that seed of *P. americana* can help to improve the conditions in hypercholesterolemia, hypertension, diabetes and inflammation related diseased. Methanol extracts were subjected to evaluate the presence of flavonoids, alkaloids, anthocyanins, condensed tannins and triterpenoids while hexane extracts were triterpenes and sterols (Leite et al., 2009).

Inflammation is a complex response of the body against several reactions including injury, infection, irritation, allergy and also pathogens. Free radicals from endogenous and exogenous sources may cause inflammation by activating various genes involved in the inflammatory pathways. They stimulate oxidative stress inducing degradation of essential cellular elements altering lipids, proteins, and DNA structure resulting in inflammation-related diseases (Munn, 2017; Sarıaltın & Çoban, 2018). Steroidal and non-steroidal anti-inflammatory drugs are used to treat these inflammation-related diseases including arthritis, gout, psoriasis, asthma, vasculitis, and even cancer. However, there are some common side effects related to these drugs, especially on the gastrointestinal system such as bleeding, ulcers, and also in the cardiovascular system such as stroke and heart attack (Günaydın & Bilge, 2018). Therefore, recent studies have focused on alternative, plant-derived anti-inflammatory agents with lower side effects (Okur et al., 2018; Adedapo, Adewuyi, & Sofidiya, 2013; Badilla, Mora, & Poveda, 1999).

Tyrosinase is a multifunctional copper-containing monooxygenase enzyme that catalyzes the production of melanin and other pigments, using molecular oxygen. This enzyme is found in human, animal, plant, bacteria, and fungi tissues. Biosynthesis and activation of this enzyme induce pigmentation in two cell types; one are the melanocytes present in skin, hair, eye and the others are epithelial pigment cells (Ramsden & Riley, 2014). Activation of tyrosinase may cause hyperpigmentation reactions in human and animal skin via oxidation of melanocytes and browning reactions in fruits and vegetables via oxidation of phenolic compounds (Lobo, Patil, Phatak, & Chandra, 2010; Olivares, & Solano, 2009). Increased *production* of *free radicals* and other reactive species can initiate and progress these reactions and disrupt the homeostasis. Tyrosinase inhibitors have been used in cosmetics like sunscreen,

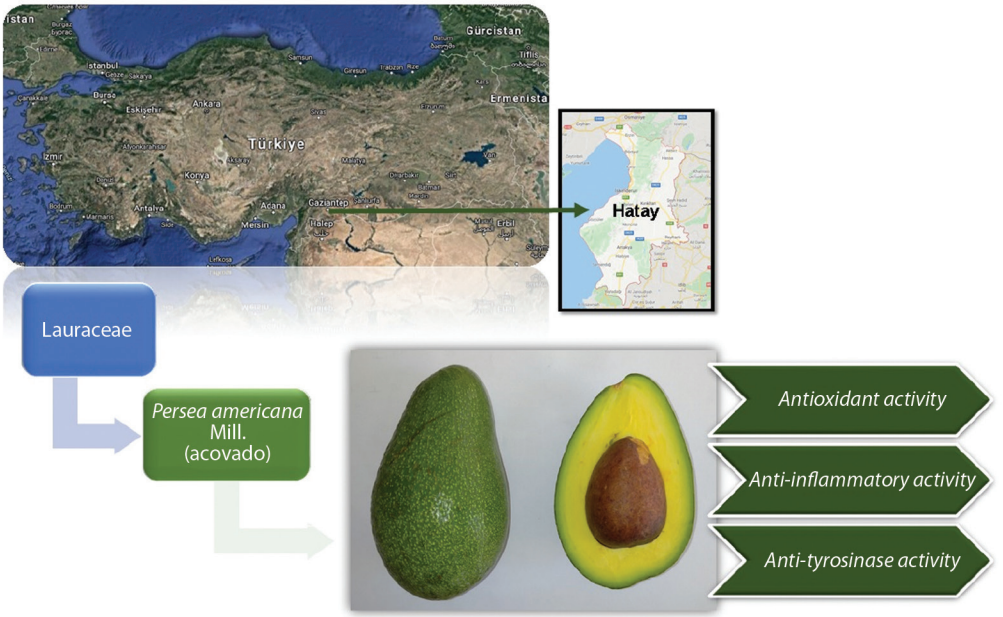

Fig. 1. The graphical abstract of the present study.

anti-aging products, skin whitening agents, and food industry as antibrowning agents. Hence, several studies have recently been conducted to develop synthetic and naturally occurring tyrosinase inhibitors (Zolghadri et al., 2019). The objective of this study was to investigate the effectiveness of *n*-hexane and methanol extracts of exocarp, mesocarp, and seed from *P. americana* fruits as antioxidant, anti-inflammatory and anti-tyrosinase as well as total phenolic content. This is the first report demonstrating antioxidant, anti-inflammatory, and anti-tyrosinase potentials of different parts of *P.americana* fruit as well as total polyphenol content together. The graphical abstract of the present study is shown in Fig. 1.

MATERIALS AND METHODS

Plant material: In this study, the "Bacon variety" of avocado was studied. Plant materials were collected from Hatay (Turkey) province. A voucher specimen was recorded with code AEF 26915 and deposited in the Ankara University Faculty of Pharmacy Herbarium (AEF).

Extraction procedure: Four ripe avocado fruits were divided into three sections, exocarp (53 g), mesocarp (121 g) and seed (74 g). These separated parts of the fruits were mashed and dried in the oven at 60° C for 2 days. The dried parts were extracted by shaking maceration with *n*-hexane (exocarp 400, mesocarp 600, seed 400 mL) for 8 h at 60 °C twice. The extracts were filtered and concentrated under reduced pressure at 40 °C. After this process, each remaining plant parts were macerated with methanol (exocarp 400, mesocarp 600, seed 400 mL) for 8 h at 60 °C twice. The extracts were filtered and concentrated under reduced pressure at 40 °C (Güvenç et al., 2012). Hence 6 different extracts (3 *n*-hexane and 3 methanol) were obtained.

Determination of total polyphenols: The total polyphenol content of extracts was determined by Folin-Ciocalteu method, referring to the calibration curve of gallic acid, phenol

compound used as a standard (Güvenç et al., 2012). The results were expressed as mean mg gallic acid equivalent (GAE)/g dry extract.

DPPH$^{\bullet}$ free radical scavenging activity: Free radical scavenging activities of the extracts were evaluated using the two different DPPH assay: qualitative and quantitative methods (Güvenç et al., 2012). Propyl gallate (PG) was assessed as a reference compound in both methods. The scavenging activity on the DPPH radical was expressed as inhibition percentage and the half-maximal inhibitory concentrations (IC_{50}) of the samples were calculated by linear regression analysis.

ABTS$^{\bullet+}$ free radical scavenging activity: The antioxidant activities of the extracts were measured by ABTS$^{\bullet+}$ radical cation decolorization assay (Yalçın, Yılmaz, & Polat, 2020). Trolox was used as a standard compound. The scavenging activity on the ABTS radical was expressed as inhibition percentage and IC_{50} values of the samples were calculated.

Anti-lipid peroxidation activity: Thiobarbituric acid (TBA) test was used to assess the efficacy of the extracts in protecting liposomes from lipid peroxidation (Güvenç et al., 2012). PG was assessed as a reference compound. IC_{50} values of the samples were calculated.

Anti-tyrosinase activity: Tyrosinase inhibitory activity was performed using the methods of Khatib et al. (2005) and Souza et al. (2012) with minor modifications. Ascorbic acid (AA) was used as a reference compound. IC_{50} values of the samples were calculated.

Anti-inflammatory activity: Human red blood cell (HRBC) membrane stabilizing activities of the samples against heat-induced hemolysis were assessed as an indicator of anti-inflammatory activity (Yalçın, Yılmaz & Polat, 2020). The study protocol for the anti-inflammatory activity was approved by the ethics committees of the Faculty of Medicine of Ankara University, Ankara-Turkey (26.10.2015/16-695-15). Acetylsalicylic acid (ASA) was used as a reference compound. IC_{50} values of the samples were calculated.

Statistical analysis: All experiments were performed at least in triplicate and the results were expressed as mean IC_{50} ± standard deviation (SD). Statistical analyses were carried out with SPSS V23.0. Shapiro-Wilk test was used to test the normality of the data. One-way analysis of variance (ANOVA) followed by the Fisher's least significant difference (LSD) test was used for multiple group comparisons. Statistically significant difference was considered at the level of $P < 0.05$.

RESULTS

Antioxidant, anti-inflammatory, and anti-tyrosinase activities and total phenolic content of *P. americana* (avocado) fruit parts were evaluated. *n*-hexane and methanol extracts were obtained from exocarp, mesocarp, and seed. All data is expressed in Table 1. All biological activity results of the extracts and reference compounds were observed statistically significant compared as solvent control ($p < 0.05$).

Folin-Ciocalteu's method was used to determine the total phenolic compounds in the extracts and the results expressed as GAE (Table 1). According to the results obtained, methanol extracts had more phenolic contents than the *n*-hexane extracts. The greatest total phenolic content was fixed in the methanol extracts of the seed (168.33 ± 8.89 mg GAE/g extract) following by exocarp (60.56 ± 5.81 mg GAE/g extract).

The radical-scavenging activities of the extracts were estimated by the DPPH on the rapid TLC screening method (qualitative) and by comparing the IC_{50} values of formation of DPPH radicals by the extracts and PG. In the qualitative DPPH test, yellow zones were very prominent for methanol extracts of exocarp and seed whereas, *n*-hexane extract of exocarp gave only a faint yellow zone. Besides, both *n*-hexane extracts of mesocarp and seed parts

TABLE 1

Biological activities and total phenolic contents of the extracts of *P. americana* fruit parts and reference compounds

Fruit parts	mg GAE/g dry extract		Antioxidant activity						Anti-tyrosinase activity		Anti-inflammatory activity	
			IC_{50} (mg/mL)				IC_{50} (µg/mL)		IC_{50} (mg/mL)		IC_{50} (mg/mL)	
	Total phenolic content		DPPH free radical scavenging assay		ABTS free radical scavenging assay		Anti-lipid peroxidation assay		Anti-tyrosinase assay		HRBC membrane stabilizing assay	
	Hexane	Methanol	Hexane	Methanol	Hexane	Methanol	Hexane	Methanol	Hexane	Methanol	Hexane	Methanol
Exocarp	7.50±4.75	60.56±5.81	10.31±0.10	5.25±0.05	3.98±0.42	0.06±0.02	Inactive	12.12±0.34	0.40±0.01	0.89±0.06	9.96±1.03	2.01±0.06
Mesocarp	6.94±3.99	21.39±1.40	18.27±0.18	11.34±0.11	19.88±0.27	0.65±0.08	Inactive	627.86±0.50	1.49±0.44	1.02±0.04	5.89±0.89	2.22±0.15
Seed	4.44±2.80	168.33±8.89	19.80±0.19	4.17±0.04	0.75±0.02	0.03±0.01	Inactive	7.71±0.36	0.46±0.01	1.82±0.70	7.73±0.09	2.03±0.06
Reference Compounds												
PG	-		1.73±0.02		-		0.11±0.03		-		-	
Trolox	-		-		0.02±0.01		-		-		-	
AA	-		-		-		-		0.02±0.0003		-	
ASA	-		-		-		-		-		0.27±0.02	

Each result expressed as mean±SD.

and also methanol extract of mesocarp showed no activity (Fig. 2).

In general methanol extracts showed higher DPPH free radical scavenging activities than *n*-hexane extracts. In the quantitative DPPH method, the major activity was determinated in methanol extracts of seed followed by exocarp parts (Table 1). The ability to scavenge DPPH free radical of fruit parts was in the order of seed > exocarp > mesocarp for methanol extracts and exocarp > mesocarp > seed for *n*-hexane extracts.

Overall methanol extracts possessed better ABTS free radical scavenging activities than *n*-hexane extracts. Extracts with the greatest ABTS free radical scavenging activity were obtained in methanol extracts of seed with IC_{50} value of 0.03±0.01 mg/mL which was comparable to reference compound trolox with 0.02±0.01 mg/mL. This was followed by methanol extracts of exocarp and mesocarp with IC_{50} values of 0.06±0.02 and 0.65±0.08 mg/mL, respectively. The maximum activity among *n*-hexane extracts was found in the seed part followed by exocarp and mesocarp similar order to methanol extracts.

The antioxidant activities of the avocado fruit parts on liposomes obtained from the anti-lipid peroxidation assay are given in Table 1. Generally, methanol extracts showed higher activity than *n*-hexane extracts. In the TBA method, the highest activity was observed with seed and exocarp methanol extract, also *n*-hexane extracts of three parts of avocado were determined as inactive.

The results of anti-tyrosinase activity *showed* that hexane *extracts displayed higher inhibitory potential*

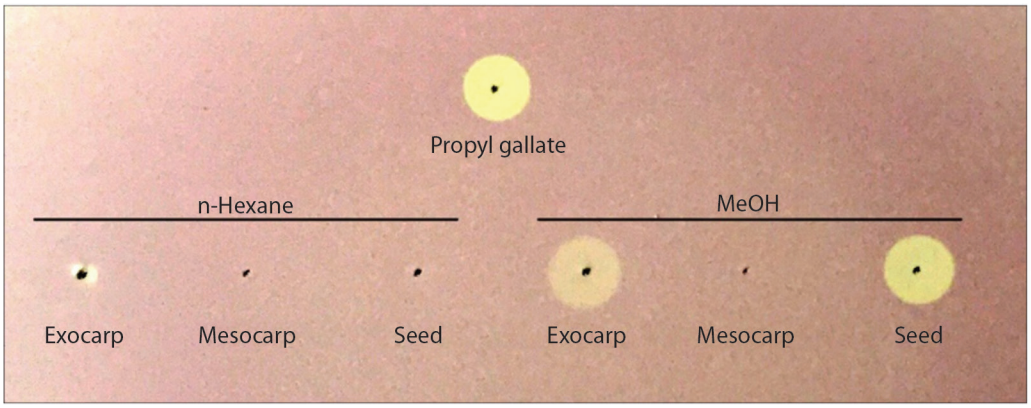

Fig. 2. Antioxidant activity by qualitative DPPH of the extract.

compared to the methanol *extracts*. The highest anti-tyrosinase activity was found in hexane extracts of exocarp followed by seed (IC_{50} = 0.40±0.01 and 0.46±0.01 mg/mL, respectively). *Methanol extracts of exocarp showed the most* potent anti-tyrosinase activity among *methanol extracts similar to the results of n-hexane extracts.* Chai et al. (2015) reported that proanthocyanidins, isolated and purified from avocado, were irreversibly and competitively inhibited the tyrosinase.

Methanol extracts has been generally found to be more efficient in stabilization of HRBC membrane than *n*-hexane extracts as shown in Table 1. The highest HRBC membrane stabilization potential was determined in methanol extracts of exocarp with IC_{50} value of 2.01±0.06 mg/mL followed by methanol extracts of seed with 2.03±0.06 mg/mL. The membrane stabilizing capacities of the extracts was in the following order: methanol extracts of seed > exocarp > mesocarp and then *n*-hexane extracts of mesocarp > seed > exocarp.

All biological activity results of the extracts and reference compounds were found statistically significant compared to control ($P<0.05$).

DISCUSSION

The fruits of *P. americana* consist of high concentrations of vitamins, minerals, dietary fibers, saturated, and unsaturated fatty acids (Dreher & Davenport, 2013). Because consumption of *P. americana* is considered to be beneficial for human health, especially for cardiovascular system diseases and dermatological applications. In the food industry pulp of the fruit is consumed, while exocarp and seed are discarded. In our study, overall methanol extracts exhibited higher anti-inflammatory and antioxidant properties than *n*-hexane extracts. The total phenolic content of methanol extracts was also greater and it is thought that the phenolic compounds might be responsible for these activities. The highest DPPH and ABTS free radical scavenging and anti-lipid peroxidase activity were observed in methanol extracts of seed, followed by exocarp. The maximum total phenolic content among all extracts was also found in methanol extracts of seed followed by exocarp. The inhibition of lipid peroxidation may be owing to the electron transfer and hydrogen donating abilities of phenolic compounds and subsequent ABTS and DPPH free radical stabilization. Supporting this data methanol extracts of exocarp and seed exhibited the greatest HRBC membrane stabilization activity. Bioactive phytochemical compounds of exocarp and seed obtained from *P. americana* by methanolic extraction could be responsible for the higher anti-inflammatory activity registered in the HRBC membrane stabilization assay and also antioxidant activity in

ABTS and DPPH free radical scavenging and anti-lipid peroxidation assays. The results of a study conducted with fresh avocado fruit are consistent with our results. According to the previous study, the seed (43 %) and exocarp (35 %) were more active than the mesocarp (23 %) (Vinha, Moreira, & Barreira, 2013). According to another study, the IC_{50} value of avocado exocarp methanol extract was found for DPPH and ABTS tests 9.40±0.05 mg/mL and 1.12±0.01 mg/mL, respectively (Antasionas, Riyanto, & Rohman, 2017). According to the results of our study, the IC_{50} value of exocarp methanol extract was found 5.25±0.05 mg/mL for DPPH and 0.06±0.02 mg/mL for ABTS free radical scavenging test. Vinha et al. (2013) used fresh avocado fruit parts and the total phenolic contents were determined as 679.0±117.0 mg/100 g, 410.2±69.0 mg/100 g, 704.0 ± 130.0 mg/100g for exocarp, mesocarp and seed, respectively. The reason for the higher total phenolic content in our current study may be due to our dry extracts, while the others used fresh fruits. It has been previously reported that avocado seeds and peels are rich in polyphenolic compounds (Araújo et al., 2018). Higher polyphenolic content (307.09±14.16 and 254.40±16.36 mg GAE/g extract) and high antioxidant capacity (DPPH: 266.56±2.76 and 221.69±20.12 mg ET/g extract; ABTS: 607.28±4.71 and 516.34±11.81 mg ET/g extract; ORAC: 475.55±47.82 and 495.25±14.52 mg ET/g extract) have been reported from avocado seeds by microwave assisted extraction method using acetone 70 % and ethanol solvents, respectively. This method made it possible to extract compounds with high antioxidant capacity using safe solvents such as ethanol in a short time (Araújo et al., 2020). The total phenolic content and ABTS radical scavenging capacity of methanol and ethanol-water (50:50, v/v) extract obtained from avocado seeds were reported as 25.35±0.77-30.98±0.68 µg GAE/g dw, and 123.74±2.46, 263.58±17.85 µmol TE/g dw, respectively. Additionally, avocado seed oil has been reported to inhibit the oxidation of sunflower oil, which is poor in polyphenolic substances, by 80 % (Segovia, Hidalgo, Villasante, Ramis, & Almajano, 2018). Supporting our data Kristanti, Simanjuntak, Dewi, Tianri, & Hendra (2017) reported that methanol extracts of *P. americana* seed exhibited significant inhibition at the dose of 3.33 g/kg body weight in carrageenan induced mice paw oedema test which is used as to determine anti-inflammatory potential. Similarly, the aqueous extract of *P. americana* leaves possessed significant inhibition of carrageenan-induced paw oedema in a dose dependent manner in rats and 77.1 % inhibition was observed at 800 mg/kg (Adeyemi, Okpo, & Ogunti, 2002). Ethanol/water (80:20, v/v) extracts of *P. americana* fruit peel extract inhibited the release of tumor necrosis factor-alpha, which is a well known pro-inflammatory cytokine, at 495.3 pg/mL as well as nitric oxide at 8.5 µM in activated RAW 264.7 macrophages (Tremocoldi et al., 2018). On the contrary, *n*-hexane extracts exhibited greater tyrosinase inhibitory activities than methanol extracts, which could be due to the nonpolar compounds brought out easily by *n*-hexane. The maximum anti-tyrosinase activity was determined in *n*-hexane extracts of exocarp followed by seed. Tyrosinase is one of the most essential and critical enzymes involved in enzymatic browning and melanin synthesis in mammals (Zolghadri et al., 2019). Therefore, *n*-hexane extracts of exocarp and seed of *P. americana* could be used in dermatological applications as potent tyrosinase inhibitors.

The results of our study indicate that exocarp and seed which are residues and waste of food-processing industries can contribute to the treatment of inflammation-related diseases and skin disorders as an economic option due to their rich phenolic content. These extracts are promising candidates for use as natural products-based antioxidant and anti-inflammatory properties in inflammation-related disease, and also antityrosinase properties in dermatological applications. Moreover, our results could be the basis to search for new nutraceutical and pharmacological agents from *P. americana*. Further studies are needed to identify, then isolate and, purificate the active constituents

by bioactivity-guided isolation which are responsible for these activities, and also obtain novel and specialized compounds in food and pharmaceutical formulations.

Ethical statement: authors declare that they all agree with this publication and made significant contributions; that there is no conflict of interest of any kind; and that we followed all pertinent ethical and legal procedures and requirements. All financial sources are fully and clearly stated in the acknowledgements section. A signed document has been filed in the journal archives.

RESUMEN

Potencial inhibidor *in vitro* de frutos de aguacate, *Persea americana* (Lauraceae) contra la oxidación, inflamación y enzimas clave vinculadas a enfermedades de la piel

Introducción: El aguacate (*Persea americana* Mill.) es un miembro de Lauraceae, es una baya de una semilla que se cultiva en todas las regiones tropicales y subtropicales del mundo y la región costera sur de Turquía. El daño oxidativo causado por los rayos ultravioleta puede desencadenar inflamación, lo que posteriormente da como resultado enfermedades inflamatorias graves de la piel como eccema, dermatitis seborreica, hiperpigmentación y envejecimiento. Los inhibidores de enzimas implicados en la melanogénesis, como la tirosinasa, se han utilizado recientemente para la hiperpigmentación y enfermedades de la piel en productos cosméticos. **Objetivo:** Evaluar las actividades antioxidantes, antiinflamatorias, antitirosinasas y los contenidos polifenólicos totales de las partes del fruto de *P. americana*. **Métodos:** El fruto se dividió en tres partes: exocarpio, mesocarpio y semilla, y se prepararon extractos de metanol y n-hexano. Se determinaron las capacidades de eliminación de radicales libres de DPPH y ABTS y los potenciales inhibidores sobre la peroxidación de lípidos para investigar los potenciales antioxidantes de los extractos. Las actividades antiinflamatorias de los extractos se evaluaron midiendo el nivel de estabilización de la membrana de los glóbulos rojos humanos. Las actividades inhibidoras de tirosinasa de las muestras se determinaron utilizando tirosinasa de hongos. **Resultados:** En general, los extractos de metanol poseían actividades de eliminación de radicales libres de DPPH notablemente más altas que los extractos de n-hexano. La actividad más alta se presentó en extractos metanólicos de semilla (4.17±0.04 mg/mL) seguido del exocarpio (5.25±0.05 mg/mL). En general, los extractos de metanol poseían una mayor actividad de eliminación de radicales libres ABTS que los extractos de n-hexano. La mayor actividad captadora de radicales libres de ABTS se obtuvo en extractos metanólicos de semilla (0.03±0.01 mg/mL). En el ensayo de anti-peroxidación lipídica, la mayor actividad se observó en los extractos metanólicos de semillas (7.71±0.36 µg/mL) seguidos del exocarpio (12.12±0.34 µg/mL), mientras que todos los extractos de n-hexano estaban inactivos. En general, los extractos de metanol exhibieron mayores propiedades anti-inflamatorias y antioxidantes que los extractos de n-hexano. Sin embargo, la actividad anti-tirosinasa máxima se determinó en extractos de exocarpio de n-hexano (0.40±0.01 mg/mL) seguido de semillas (0.46±0.01 mg/mL). **Conclusiones:** Estos extractos son candidatos prometedores como productos naturales debido a sus propiedades antioxidantes y antiinflamatorias para tratar enfermedades relacionadas con la inflamación, y también propiedades antitirosinasas en aplicaciones dermatológicas.

Palabras clave: antiinflamatorio; antioxidante; anti-tirosinasa; aguacate; *Persea americana.*

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