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Bioactive Potentials of *Dacryodes edulis* and *Persea Americana* Seeds

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Abstract

This study compared the phytochemical composition, detected volatile constituents, and *in vitro* antioxidant activities of aqueous seed extracts from *Dacryodes edulis* and *Persea americana*. Total phenolic and flavonoid contents were determined using the Folin–Ciocalteu and aluminium chloride colourimetric methods, respectively. Antioxidant activity was assessed using nitric oxide, 2,2-diphenyl-1-picrylhydrazyl (DPPH), and hydrogen peroxide (H_2O_2) scavenging assays, while dichloromethane extracts were analysed by gas chromatography–flame ionisation detection (GC-FID). *Persea americana* contained more flavonoids (1.862 mg/mL) but fewer phenolics (0.645 mg/mL) than *Dacryodes edulis*, which contained 1.516 mg/mL flavonoids and 0.825 mg/mL phenolics. GC-FID detected 29 compounds in *Dacryodes edulis*, predominantly fatty acid methyl esters, and 12 compounds in *Persea americana*, with butylated hydroxytoluene as the predominant peak. Both extracts showed concentration-dependent scavenging activity. *Persea americana* produced lower IC_{50} values than *Dacryodes edulis* in the nitric oxide (4.045 vs 12.319 mg/mL), DPPH (17.93 vs 41.03 mg/mL), and H_2O_2 (5.229 vs 17.866 mg/mL) assays. Ascorbic acid showed lower IC_{50} values than both extracts in all assays. These findings indicate that both seed wastes contain measurable phytochemicals and detected volatile constituents with *in vitro* antioxidant activity. *Persea americana* showed stronger

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scavenging activity under the tested conditions, whereas *Dacryodes edulis* showed a more diverse detected compound profile. Replicated analyses and confirmatory GC-MS identification are required before practical applications can be established.

Keywords: Dacryodes edulis; Persea americana; seed waste; phytochemicals; total phenolic content; total flavonoid content; volatile constituents; GC-FID; antioxidant activity; radical-scavenging assays

1. Introduction

The growing prevalence of oxidative stress-related disorders has intensified the search for natural bioactive compounds capable of mitigating cellular damage and supporting human health (Bouyahya *et al.*, 2024). Plant-derived phytochemicals, antioxidants, and essential oils have attracted considerable scientific interest because of their roles in neutralising free radicals, modulating metabolic pathways, and potentially reducing the risk of chronic diseases (Hossain *et al.*, 2025). In this context, underutilised plant materials, particularly seed wastes from commonly consumed fruits, represent a potentially important and sustainable source of bioactive compounds for health-related and industrial applications.

Dacryodes edulis (African pear) and *Persea americana* (avocado pear) are widely consumed fruits in tropical regions, especially in sub-Saharan Africa (Fotouo Makouate & Dongmo Lekagne, 2022). Although their pulps are valued for their nutritional and medicinal benefits, the seeds are commonly discarded as agricultural waste, despite evidence that they contain phytochemicals and lipid-derived bioactive compounds (Akpan & Owhoeke, 2020). Previous studies have identified phenolic compounds, flavonoids, fatty acids, and volatile constituents in these seeds, suggesting potential antioxidant, anti-inflammatory, and protective properties (Emmanuel *et al.*, 2025; Fotouo Makouate & Dongmo Lekagne, 2022). However, comparative information on the phytochemical composition, essential oil profiles, and antioxidant activities of *Dacryodes edulis* and *Persea americana* seed wastes analysed using a unified approach remains limited. Consequently, their relative bioactive properties have not been adequately characterised. Assessing antioxidant activity using complementary in vitro models, such as nitric oxide, 2,2-diphenyl-1-picrylhydrazyl (DPPH), and hydrogen peroxide scavenging assays, provides insight into the capacity of plant extracts to neutralise reactive species through different mechanisms. In addition, chromatographic profiling of volatile constituents helps to characterise their chemical diversity.

Recent studies have reported bioactive constituents and antioxidant activity in avocado seeds and seed-derived fractions (Bahru *et al.*, 2019; Miramontes-Corona *et al.*, 2024; Nascimento *et al.*, 2025; Onyedikachi *et al.*, 2024). Broader characterisation of avocado seed powder also supports the relevance of this waste material for value-added utilisation (Okey-Onochie *et al.*, 2026).

Therefore, this study investigated the bioactive potential of aqueous seed extracts of *Dacryodes edulis* and *Persea americana* by evaluating their phytochemical composition, essential oil profiles, and antioxidant activities. The study aimed to provide comparative evidence that may support further investigation into the valorisation of these seed wastes as potential sources of bioactive compounds.

2. Materials and Methods

2.1 Plant Sample Collection and Identification

Fresh fruits of *Dacryodes edulis* and *Persea americana* were purchased from Mile 1 Market in Port Harcourt, Rivers State, Nigeria, and authenticated by Dr Chimezie Ekeke at the Reference Herbarium for Research and Germplasm Conservation, Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt, Nigeria. Voucher specimens were deposited under herbarium numbers UPH/P/486 (*Dacryodes edulis*) and UPH/P/485 (*Persea americana*).

2.2 Preparation of Plant Materials

The fruits were cleaned, washed with purified tap water, and deseeded. The seeds were then washed to remove residual pulp, oven-dried at 40 °C, and ground to a fine powder using a clean grinding machine. The powder

was homogenised to obtain a uniform particle size, increase the surface area, and facilitate efficient extraction. It was sealed in polyethylene bags and stored at 4 °C until analysis.

2.3 Preparation of *Dacryodes edulis* and *Persea americana* Aqueous Extracts

The powdered seed samples of *Dacryodes edulis* and *Persea americana* were extracted with distilled water to obtain aqueous extracts for phytochemical determination and antioxidant assays. Approximately 1,500 g of each powdered seed sample was macerated in 6 L of hot distilled water for 1 h, with occasional stirring to enhance extraction. The mixtures were allowed to cool to room temperature before filtration and centrifugation at 3,000 rpm. The resulting supernatants were collected and used to determine total phenolic content, total flavonoid content, and antioxidant activities.

2.4 Determination of Total Phenol Content (TPC)

The total phenolic content (TPC) of *Dacryodes edulis* and *Persea americana* seed waste extracts was determined using the Folin–Ciocalteu method described by Singleton *et al.* (1999). A 1.0 mL aliquot of each aqueous extract was mixed with 0.4 mL of 10% Folin–Ciocalteu reagent (FCR; 1:10, v/v). After 5 min, 2.0 mL of 7.5% sodium carbonate solution was added, and the mixture was thoroughly mixed. The reaction mixture was made up to a final volume of 100 mL with distilled water and incubated for 90 min at room temperature in the dark. The absorbance of the resulting blue-coloured solution was measured at 750 nm using a UV-Vis spectrophotometer. Total phenolic content was expressed as milligrams of catechol equivalents per gram of dry weight (mg CAE/g DW) using a catechol calibration curve.

2.5 Determination of Total Flavonoid Content (TFC)

The total flavonoid content of *Dacryodes edulis* and *Persea americana* seed waste extracts was assessed using the modified aluminium chloride colourimetric method described by Liu *et al.* (2008), with quercetin as the reference standard. Briefly, 2.0 mL of each extract was transferred into a 10 mL volumetric flask and mixed with 4.0 mL of distilled water. After 5 min, 0.3 mL of 10% aluminium chloride ($AlCl_3$) and 0.3 mL of 5% sodium nitrite ($NaNO_2$) were added and mixed thoroughly. Following incubation for 6 min at room temperature, 2.0 mL of 1 M sodium hydroxide (NaOH) was added. The reaction mixture was then made up to a final volume of 10 mL with 50% ethanol, which also served as the blank. Absorbance was measured at 510 nm using a UV-Visible spectrophotometer. Total flavonoid content was calculated from a quercetin calibration curve and expressed as milligrams of quercetin equivalents per 100 g dry weight (mg QE/100 g DW).

2.6 Essential Oil Analysis

Volatile compounds from *Dacryodes edulis* and *Persea americana* were extracted by solvent maceration and analysed using gas chromatography–flame ionisation detection (GC-FID). Approximately 500 g of powdered seed waste was macerated in 1.25 L of dichloromethane at room temperature for 72 h, with intermittent stirring. The extracts were filtered and concentrated at 70 °C to remove the solvent.

GC-FID analysis was performed using a Buck M910 Scientific gas chromatography system equipped with a capillary column. Helium was used as the carrier gas at a flow rate of 1.2 mL/min, with a split ratio of 1:30. The oven temperature programme began at 50 °C, was held for 1 min, and increased to 280 °C at 5 °C/min. The injector and detector temperatures were maintained at 280 °C and 300 °C, respectively. Hydrogen and compressed air were supplied to the detector at flow rates of 30 mL/min and 300 mL/min, respectively. A 1 µL aliquot of each concentrated extract was injected for analysis.
Compound quantification was performed using calibration curves prepared from standard solutions, whereas identification was based on comparison of retention times with authentic reference standards.

2.7 Preparation of Extract Solutions for Antioxidant Assays

The aqueous extracts were reconstituted in distilled water to prepare a stock solution. Appropriate serial dilutions were then prepared to obtain the required concentrations for the antioxidant assays. The extract

concentrations used ranged from 0.125 to 5.0 mg/mL, whereas ascorbic acid was prepared at the concentrations specified for each assay and served as the reference standard.

2.7.1 Nitric Oxide Free Radical Scavenging Activity Assay

The Griess reagent procedure described by Marcocci *et al.* (1994) was used to determine the nitric oxide radical-scavenging activity of the aqueous extracts of *Dacryodes edulis* and *Persea americana* seed wastes. A 10 mM sodium nitroprusside (SNP) solution was prepared in phosphate-buffered saline (PBS; pH 7.4) to generate nitric oxide. Subsequently, 0.6 mL of this solution was combined with 1 mL of each seed extract and incubated for 150 min at 25 °C. The reaction was terminated by adding 1 mL of Griess reagent containing 1% sulfanilamide, 2% HCl, and 0.1% N-(1-naphthyl)ethylenediamine dihydrochloride. Absorbance was measured at 546 nm, providing an estimate of the nitric oxide generated in the solution.

The scavenging activity was expressed as the percentage inhibition of nitric oxide radicals using the following equation:

$$\% \text{ Inhibition} = \frac{\text{Acontrol} - \text{A sample}}{\text{A control}} \text{ x } 100$$

where:

"A control" is the absorbance of the control (SNP solution without extract); and
"A sample" is the absorbance of the extract.

2.7.2 DPPH (2,2-Diphenyl-1-picrylhydrazyl) Free Radical Scavenging Activity Assay

Antioxidant activity was assessed by measuring the capacity of the extracts to scavenge the stable 1,1-diphenyl-2-picrylhydrazyl radical, following the methods described by Brand-Williams *et al.* (1995) and Dehpour *et al.* (2009), with slight modifications. Extract concentrations ranging from 0.125 to 5 mg/mL were prepared together with ascorbic acid standards ranging from 20 to 100 µg/mL. A 2 µL aliquot of each solution was combined with 2 mL of a 0.1 mM DPPH solution in methanol (0.004 mg DPPH in 100 mL methanol), producing a light-purple solution. The reaction mixture was kept in the dark at room temperature for 30 min. Absorbance was measured at 517 nm using a UV-Vis spectrophotometer after zero adjustment with methanol. Ascorbic acid (0.01 g in 100 mL) served as the positive control. The IC_{50} was defined as the concentration required to achieve 50% inhibition and was determined graphically by plotting percentage inhibition against the concentration of the extract or standard. Radical-scavenging activity was calculated as follows:

$$\% \text{ Inhibition} = \frac{\text{A control} - \text{A sample}}{\text{A control}} \text{ x } 100$$

where "A control" is the absorbance of the control (DPPH solution without extract); and
"A sample" is the absorbance of the extract or standard.

2.7.3 Hydrogen Peroxide (H_2O_2) Free Radical Scavenging Activity Assay

The hydrogen peroxide-scavenging activity of *Dacryodes edulis* and *Persea americana* seed waste extracts was assessed following the method described by Ruch *et al.* (1989). A 40 mM H_2O_2 solution was prepared in phosphate buffer at pH 7.4. A 1 mM extract solution was mixed with 0.6 mL of hydrogen peroxide solution and incubated for 10 min at room temperature, allowing the extract to interact with hydrogen peroxide. The reaction was terminated by adding 2 mL of 0.1 M potassium iodide solution, and absorbance was measured at 480 nm using a UV-Vis spectrophotometer. Ascorbic acid was used as the standard for determining percentage inhibition. The absorbance of each sample was compared with that of a blank containing hydrogen peroxide without extract. Scavenging activity was calculated as follows:

$$\% \text{ inhibition} = \frac{(\text{A1 Blank} - \text{A1 Sample})}{\text{A1 Blank}} 100$$

where A1 Sample is the absorbance measured for the extract-containing sample, and A1 Blank is the absorbance measured for the blank (control). A higher percentage inhibition indicates greater hydrogen peroxide-scavenging activity.

2.8 Statistical Analysis

Data obtained from the experiments were summarised and presented descriptively in tables and graphs. As each analysis was performed as a single determination, inferential statistical analysis and measures of variability were not applicable.

3. Results and Discussion

3.1 Quantitative Phytochemical Analysis

Table 1 presents the quantitative contents of total phenols and total flavonoids in *Dacryodes edulis* and *Persea americana* seed wastes. In *Dacryodes edulis*, the total flavonoid concentration (1.516 mg/mL) was higher than the total phenol concentration (0.825 mg/mL). Similarly, in *Persea americana*, the total flavonoid concentration (1.862 mg/mL) was higher than the total phenol concentration (0.645 mg/mL).

The results show that both seed wastes contained measurable phenolic and flavonoid compounds, with flavonoids present at higher concentrations than phenols in both samples. These compounds may contribute to the observed antioxidant activity. The findings are consistent with Ayele *et al.* (2022), who reported high flavonoid content and antioxidant activity in *Croton macrostachyus* root extracts.

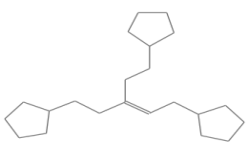
Table 1. Quantitative Phytochemical Concentrations of Total Phenol Contents and Total Flavonoid Contents of *Dacryodes edulis* and *Persea americana* Seed Wastes

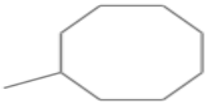
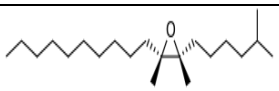
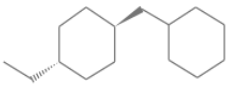
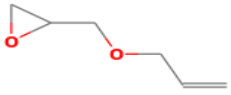
Phytochemicals	*Persea americana* (mg/ml)	*Dacryodes edulis* (mg/ml)
Total Phenol (CAE)	0.645	0.825
Total Flavonoid (QE)	1.862	1.516

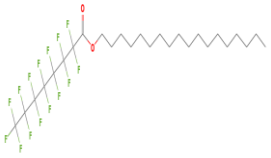
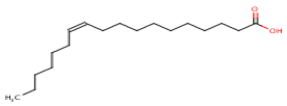
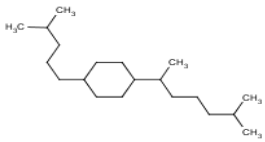
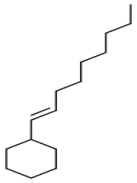
3.2 Essential Oil Composition

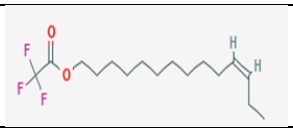
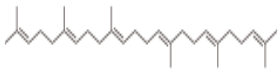
Tables 2 and 3 present the essential oil composition of *Dacryodes edulis* and *Persea americana* seed wastes, expressed as percentages. Twenty-nine compounds were detected in *Dacryodes edulis*. The compound 11-octadecenoic acid methyl ester had the highest percentage composition (33.38%), followed by 9,12-octadecadienoic acid methyl ester (21.45%), whereas acetic acid n-octadecyl ester had the lowest percentage composition (0.08%). Twelve compounds were detected in *Persea americana*. Butylated hydroxytoluene had the highest percentage composition (39.42%), followed by 5-eicosene, (E)- (8.79%), whereas gamma-sitosterol had the lowest percentage composition (0.58%).

Table 2. Essential oil composition of *Dacryodes edulis* Seed Wastes

Compound	Retention Time (min)	Percentage Composition	Molecular formula	Molecular Weight (g/ mol)	Structure
Cyclopentane, 1,1'-[3-(2-cyclopentylethyl)-1,5-pentanediyl] bis-	8.000	0.18	$C_{26}H_{48}$	302.5371	

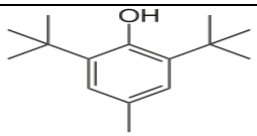
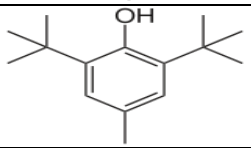
Compound	Retention Time (min)	Percentage Composition	Molecular formula	Molecular Weight (g/ mol)	Structure
Cyclooctane, methyl-	8.732	0.43	C_9H_{18}	126.2392	
Acetic acid n-octadecyl ester	11.859	0.08	$C_{20}H_{40}O_2$	312.5304	
5-Tetradecene, (Z)-	13.397	1.02	$C_{14}H_{28}$	196.3721	
Heptadecyl heptafluorobutyrate	16.273	0.33	$C_{24}H_{39}F_7O_2$	452.4902	
7-Hexadecenal, (Z)-	16.715	0.33	$C_{16}H_{30}O$	238.4088	
Disparlure	17.016	0.16	$C_{19}H_{38}O$	282.51	
Heptadecyl heptafluorobutyrate	17.641	0.15	$C_{24}H_{39}F_7O_2$	452.4902	
1-Octadecene	17.782	1.52	$C_{18}H_{36}$	252.486	
Trichloroacetic acid, tetradecyl ester	18.276	0.45	$C_{15}H_{27}Cl_3O_2$	359.759	
9-Eicosene, (E)-	18.858	0.42	$C_{20}H_{40}$	280.5316	
Cyclohexane, 1-(cyclohexylmethyl)-4-ethyl-, trans-	19.071	0.31	$C_{14}H_{26}$	208.38	
Oxirane, [(dodecyloxy) methyl]-	19.324	0.83	$C_6H_{10}O_2$	114.1424	

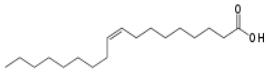
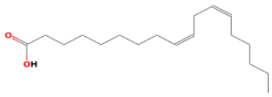
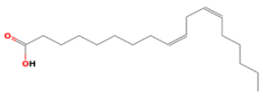
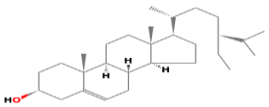
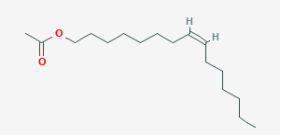
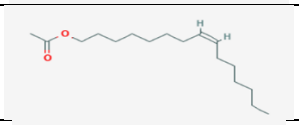
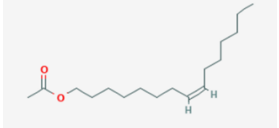
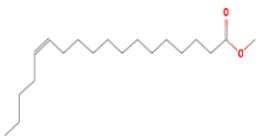
Compound	Retention Time (min)	Percentage Composition	Molecular formula	Molecular Weight (g/ mol)	Structure
Pentadecafluorooctanoic acid, octadecyl ester	19.835	0.44	$C_{25}H_{17}F_{15}O_2$	666.5468	
Heptadecanoic acid, heptadecyl ester	19.974	0.31	$C_{34}H_{66}O_2$	508.902	
Hexadecanoic acid, methyl ester	20.367	14.61	$C_{17}H_{34}O_2$	270.4507	
Heptafluorobutyric acid, pentadecyl ester	21.108	0.68	$C_{14}H_{23}F_7O_2$	424.4371	
cis-Vaccenic acid	21.253	0.93	$C_{18}H_{34}O_2$	282.5	
2-Bromopropionic acid, pentadecyl ester	21.386	1.28	$C_{17}H_{33}BrO_2$	363.373	
1-Octadecene	21.809	6.41	$C_{18}H_{36}$	252.4784	
Cyclohexane, 1-(1,5-dimethylhexyl)-4-(4-methylpentyl)-	22.292	2.20	$C_{20}H_{40}$	280.53	
Acetic acid, chloro-, hexadecyl ester	22.554	1.76	$C_{18}H_{35}ClO_2$	318.922	
1-Cyclohexylnonene	22.964	2.31	$C_{15}H_{28}$	208.38	

Compound	Retention Time (min)	Percentage Composition	Molecular formula	Molecular Weight (g/ mol)	Structure
(Z)-Tetradec-11-en-1-yl 2,2,2-trifluoroacetate	23.194	2.31	$C_{16}H_{27}F_3O_2$	308.38	
9,12-Octadecadienoic acid, methylester	23.427	21.45	$C_{19}H_{34}O_2$	294.4721	
11-Octadecenoic acid, methyl ester	23.565	33.38	$C_{20}H_{38}O_2$	296.4879	
Methyl stearate	24.165	3.70	$C_{19}H_{38}O_2$	298.5	
Heptafluorobutyric acid, n-tetradecyl ester	25.486	0.22	$C_{14}H_{27}F_7O_2$	410.4105	
9,17-Octadecadienal, (Z)-	34.202	1.03	$C_{18}H_{32}O$	264.4461	
Squalene	35.083	0.33	$C_{30}H_{50}$	410.7	

Essential oils are concentrated hydrophobic mixtures of volatile aromatic compounds extracted from plant materials and contribute to their characteristic aromas and flavours (Falleh *et al.*, 2020; Masyita *et al.*, 2022). They have been reported to possess antimicrobial, anti-inflammatory, and antioxidant properties. In this study, the most abundant detected compounds were 11-octadecenoic acid methyl ester (33.38%) in *Dacryodes edulis* and butylated hydroxytoluene (39.42%) in *Persea americana*. *Dacryodes edulis* also contained several fatty acid methyl esters, including 9,12-octadecadienoic acid methyl ester and hexadecanoic acid methyl ester. *Persea americana* contained 5-eicosene, (E)- and other unsaturated compounds. The present analysis described their occurrence and relative abundance but did not assess the biological activity of individual compounds.

Table 3. Essential Oil Composition of *Persea americana* Seed wastes

Compound	Retention Time (min)	Percentage Composition	Molecular formula	Molecular Weight (g/ mol)	Structure
Butylated Hydroxytoluene	10.133	39.42	C15H24O	220.35	
Butylated Hydroxytoluene	10.798	6.50	C15H24O	220.35	

Compound	Retention Time (min)	Percentage Composition	Molecular formula	Molecular Weight (g/ mol)	Structure
Oleic Acid	21.382	2.48	$C_{18}H_{34}O_2$	282.46	
9,12-Octadecadienoic acid (Z, Z)-	25.762	3.69	$C_{18}H_{32}O_2$	280.4455	
Tricosane	25.980	1.05	$C_{23}H_{48}$	324.63	
9,12-Octadecadienoic acid (Z, Z)-	26.358	2.29	$C_{18}H_{32}O$	280.4455	
Tricosane	28.006	7.53	$C_{23}H_{48}$	324.63	
9,17-Octadecadienal, (Z)-	28.420	2.62	$C_{18}H_{32}O$	264.4461	
Hentriacontane	29.734	6.52	$C_{31}H_{64}$	436.8	
9-Octadecenoic acid (Z)-, 2,3-dihydroxypropyl ester	29.961	1.99	$C_{21}H_{40}O_4$	356.5399	
5-Eicosene, (E)-	31.190	8.79	$C_{20}H_{40}$	280.5316	
gamma - Sitosterol	31.623	0.58	$C_{29}H_{50}O$	414.7067	
Z-8-Pentadecen-1-ol acetate	32.238	2.81	$C_{17}H_{32}O_2$	226.3981	
Z-8-Pentadecen-1-ol acetate	33.871	8.74	$C_{17}H_{32}O_2$	226.3981	
Z-8-Pentadecen-1-ol acetate	34.549	3.65	$C_{17}H_{32}O_2$	226.3981	
13-Octadecenoic acid, methyl ester	36.804	3.27	$C_{19}H_{36}O_2$	296.5	

Compound	Retention Time (min)	Percentage Composition	Molecular formula	Molecular Weight (g/ mol)	Structure
6-Octadecenoic acid, (Z)-	38.125	1.93	$C_{18}H_{34}O_2$	282.4614	

3.3 Antioxidant Activity using Nitric Oxide (NO), DPPH, and Hydrogen Peroxide (H_2O_2) Scavenging Assays

Antioxidant activity is associated with the ability of bioactive compounds to scavenge free radicals and inhibit reactive oxygen and nitrogen species (Lobo *et al.*, 2010). In this study, the antioxidant properties of *Dacryodes edulis* and *Persea americana* seed waste extracts were evaluated using nitric oxide, DPPH, and hydrogen peroxide (H_2O_2) scavenging assays, with ascorbic acid serving as the standard antioxidant (positive control). Antioxidant activity was assessed using percentage inhibition and IC_{50} values, with a lower IC_{50} indicating stronger activity under the assay conditions.

Both seed waste extracts showed concentration-dependent antioxidant activity across all assays. Percentage inhibition increased as extract concentration increased, although the increases became smaller at higher concentrations. This pattern was observed across the tested concentration range.

Tables 4 and 5 present percentage inhibition in the nitric oxide-scavenging assay at various concentrations of *Dacryodes edulis* and *Persea americana* seed wastes and of the ascorbic acid control, respectively. *Persea americana* showed higher percentage inhibition and a lower IC_{50} value than *Dacryodes edulis*. The lower IC_{50} of *Persea americana* indicates that a smaller concentration was required to achieve 50% nitric oxide inhibition under the assay conditions. Ascorbic acid had the lowest IC_{50} value overall.

Similarly, Tables 6 and 7 present DPPH radical-scavenging activity at various concentrations of *Dacryodes edulis* and *Persea americana* seed wastes and of the ascorbic acid control, respectively. Both extracts showed measurable antioxidant activity, with *Persea americana* having higher inhibition percentages and a lower IC_{50} value than *Dacryodes edulis*. This result indicates stronger DPPH-scavenging activity under the tested conditions. Both extracts, however, required higher concentrations than ascorbic acid to achieve 50% inhibition.

Tables 8 and 9 present hydrogen peroxide-scavenging activity at various concentrations of *Dacryodes edulis* and *Persea americana* seed wastes and of the ascorbic acid control, respectively. *Persea americana* again had a lower IC_{50} value than *Dacryodes edulis*, indicating stronger activity under the tested conditions. Ascorbic acid showed the lowest IC_{50} value and therefore the highest scavenging efficiency under the assay conditions.

Table 4. Antioxidant Activity using Nitric Oxide Scavenging Assay at Different Concentrations of *Dacryodes edulis* and *Persea americana* Seed Wastes

Samples	Concentration (mg/ml)	% Inhibition	Absorbance at 540nm	Regression Equation	IC_{50} (mg/ml)
Dacryodes edulis	83.3	89.49	0.189	y = 25.47ln(x) - 13.959	12.319
	41.6	86.45	0.247	R^2 = 0.9195	
	20.8	71.34	0.536		
	10.4	50.10	0.942		
	5.2	19.35	1.53		
Persea americana	83.3	93.25	0.117	y = 16.434ln(x) + 27.033	
	41.6	91.27	0.155	R^2 = 0.8956	
	20.8	83.79	0.298		
	10.4	68.72	0.586		**4.045**
	5.2	47.54	0.991		

Table 5. Antioxidant Activity Assay at Different Concentrations of Control (Ascorbic Acid)

Sample	Concentration (mg/ml)	% Inhibition	Absorbance at 540nm	Regression Equation	IC_{50} (mg/ml)
Ascorbic Acid	1	91.53	0.150	y = 15.357ln(x) + 93.598	0.058
	0.5	85.26	0.270		
	0.25	72.11	0.521	$R^2 = 0.9862$	
	0.125	63.41	0.688		
	0.0625	49.23	0.959		

Table 6. Antioxidant Activity using DPPH Scavenging Assay at Different Concentrations of *Dacryodes edulis* and *Persea americana* Seed Wastes

Samples	Concentration (mg/ml)	% Inhibition	Absorbance at 517nm	Regression Equation	IC_{50} (mg/ml)
Dacryodes edulis	83.3	57.40	0.846	y = 15.242ln(x) - 6.6139	41.03
	41.6	52.11	0.951	$R^2 = 0.9634$	
	20.8	42.30	1.146		
	10.4	31.62	1.358		
	5.2	14.80	1.692		
Persea americana	83.3	80.82	0.381	y = 22.881ln(x) - 16.044	
	41.6	71.95	0.557		
	20.8	57.60	0.842	$R^2 = 0.9783$	
	10.4	38.37	1.224		
	5.2	18.28	1.623		**17.93**

Table 7. Antioxidant Activity Assay at Different Concentrations of Control (Ascorbic Acid)

Sample	Concentration (mg/ml)	% Inhibition	Absorbance at 517nm	Regression Equation	IC_{50} (mg/ml)
Ascorbic Acid	1	88.77	0.223	y = 23.151ln(x) + 96.536	0.13
	0.5	81.77	0.362		
	0.25	76.38	0.469	R2 = 0.8979	
	0.125	51.71	0.959		
	0.0625	23.56	1.518		

Table 8. Antioxidant Activity using Hydrogen Peroxide (H_2O_2) Scavenging Assay at Different Concentrations of *Dacryodes edulis* and *Persea americana* Seed Wastes

Samples	Concentration (mg/ml)	% Inhibition	Absorbance at 480 nm	Regression Equation	IC_{50} (mg/ml)
Dacryodes edulis	83.3	73.05	1.547	y = 19.081ln(x) - 5.0091	17.866
	41.6	68.37	1.045	$R^2 = 0.9071$	
	20.8	59.53	0.769		
	10.4	45.00	0.601		
	5.2	18.58	0.512		
Persea americana	83.3	75.58	1.05	y = 10.777ln(x) + 32.173	
	41.6	73.53	0.751		
	20.8	70.11	0.568	$R^2 = 0.8703$	
	10.4	60.47	0.503		
	5.2	44.74	0.464		**5.229**

Table 9. Antioxidant Activity using Hydrogen Peroxide (H_2O_2) Scavenging Assay at Different Concentrations of Ascorbic Acid

Sample	Concentration (mg/ml)	% Inhibition	Absorbance at 480nm	Regression Equation	IC_{50} (mg/ml)
Ascorbic Acid	1	89.55	0.188	$y = 15.386\ln(x) + 91.2$	0.069
	0.5	80.12	0.368	$R^2 = 0.9818$	
	0.25	73.34	0.498		
	0.125	60.11	0.751		
	0.0625	46.23	1.016		

4. Conclusion

This study showed that the seed wastes of *Dacryodes edulis* and *Persea americana* contained measurable amounts of total phenolic and flavonoid compounds. *Persea americana* had a higher flavonoid content, whereas *Dacryodes edulis* had a higher phenolic content. These results indicate differences in phytochemical composition between the two species.

GC-FID profiling detected twenty-nine compounds in *Dacryodes edulis* and twelve compounds in *Persea americana*. The *Dacryodes edulis* profile was dominated by fatty acid methyl esters, particularly 11-octadecenoic acid methyl ester and 9,12-octadecadienoic acid methyl ester. In *Persea americana*, butylated hydroxytoluene was the most abundant detected peak, followed by compounds including 5-eicosene, (E)-. Because compound identification was based on retention-time comparison and the analyses were single determinations, these profiles should be interpreted cautiously.

Both seed waste extracts showed concentration-dependent scavenging activity against nitric oxide, DPPH, and hydrogen peroxide radicals. *Persea americana* had higher percentage inhibition and lower IC_{50} values across all three assays than *Dacryodes edulis* under the tested conditions. Ascorbic acid remained more active than both extracts.

Overall, the results indicate that both seed wastes contain phytochemicals and detected volatile constituents associated with in vitro antioxidant activity. The findings support further investigation of these agricultural wastes as potential sources of natural antioxidant ingredients. Replicated analyses, GC-MS confirmation, and biological validation are required before pharmaceutical, nutraceutical, or functional food applications can be established.

5. Limitations of the Study

Several limitations should be considered. GC-FID was used in accordance with the analytical protocol provided by the accredited laboratory; however, definitive identification of volatile constituents, including butylated hydroxytoluene, requires confirmation by gas chromatography–mass spectrometry (GC-MS). The phytochemical, antioxidant, and volatile-compound analyses were based on single determinations, preventing estimation of variability and inferential statistical testing. Replicated analyses are therefore needed to improve reliability and reproducibility. Further in vivo studies would also be required to evaluate the biological relevance of the observed in vitro activities.

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Declaration of AI Use

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Competing Interests

Authors have declared that no competing interests exist.

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