IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 16, Issue 3 Ser. I (March 2023), PP 18-27
www.iosrjournals.org

A Review of Fatty Acid Components in Avocado

Sylvia A. Opiyo[1], Beatrice Mugendi[2], Peter W. Njoroge[1], Samuel N. Wanjiru[1]
[1]*Department of Physical and Biological Sciences, Murang'a University of Technology, Kenya*
[2]*Department of Food and Nutrition, Murang'a University of Technology, Murang'a, Kenya*

Abstract:
Avocado is one of the world's most economically significant tropical fruit crops. In recent years, there has been a lot of interest in avocado as a natural functional food in due to its excellent nutritional value and several health advantages. Avocados are rich in unsaturated fatty acids, fat-soluble vitamins like vitamin E and vitamin B6, alpha-carotene, sterols, fiber, protein, magnesium and potassium. Fatty acids play crucial structural and functional roles in biological systems and are a significant source of energy. The essential polyunsaturated fatty acids such as linoleic acid and the α-linolenic acid cannot be synthesize by human body hence must be obtained from food. This study reviewed the fatty acid composition of avocado. Peer-reviewed articles were retrieved from Scopus, Science Direct, SciFinder and Google Scholar. The most common fatty acids were determined to be oleic, linoleic, palmitic, palmitoleic, stearic and linolenic, myristic, arachidic, behenic, eicosenoic, myristoleic and tetraeicosanoic acid. The predominant fatty acids were oleic, palmitoleic, linoleic, linolenic, palmitoleic and arachidic acid, occurring in concentration ranges of 10.88-74.32, 7.70-55, 5.25- 38.2, 0.03-24.17, 0.16-19.78, 0.45-18.55 and 0.07-10.95% respectively. Hass, Quintal, Fortuna and Margarida avocado cultivars were found to contain docosahexaenoic acid, an omega-3 amino acid which is mainly obtained from fish. The type of fatty acids and their percentage composition in the avocados differed depending on the cultivar, plant part, ripening stage, geographical location and sample processing method. Results from this study have confirmed that avocado is a rich source of essential fatty acid. Further research on methods of enhancing fatty acid content is necessary. It is also necessary to determine the bioactivities of the fatty acids present in avocado.
Keywords*: Avocado; Fatty acids; Composition; Cultivars*

Date of Submission: 01-03-2023 Date of Acceptance: 13-03-2023

I. Introducción

For ages, humans have relied on plants for their basic needs, including for food and medicine[1-9]. Plants offer a genuine substitute for primary healthcare services in under developed nations in sub-Sahara Africa[10-13]. The potential of plants extracts in managing infections and pests has been demonstrated in previous studies[14-25]. Plants are known to produce important secondary metabolites which are toxic to infectious pathogens[26-32]. The search for natural substitutes for the synthetic chemicals frequently employed in the food, pharmaceutical, and cosmetic industries has gained momentum in recent years[33-39]. Plant extracts are preferred for the control of diseases since they are non-toxic to non-targeted organisms and are benign to the environment. In addition, the likelihood of harmful germs acquiring resistance to botanical medicines is extremely low[40].

Avocado is one of the most economically important fruit crop in the world[41]. The fruit has generated great interest in recent years as a natural functional food due to its high nutritional value and health benefits[42- 43]. Avocado has a high nutritional value with a high content of unsaturated fatty acids, fat soluble vitamins such as vitamin E, vitamin B6, β-carotene, sterols, fiber, protein, magnesium and potassium[44-45]. Its oil has significant levels of omega-6 and omega-9 fatty acids as well as natural antioxidants that provide health benefits, reducing levels of total cholesterol, triacylglycerol, and LDL-cholesterol, preserving high-density lipoprotein plasma HDL-cholesterol[46-49]. The high amount of digestible oil and low sugar content makes avocado a rich source of energy and an essential component of diabetics' diets[50].Health benefits from the consumption of fruit encompass preventing and managing diet related diseases such as cardiovascular disease, diabetes, high adiposity accumulation, chronic low-grade systemic inflammation, dyslipidemia, hypertension, obesity and cancer[51-58]. The high non-saturated content of avocado fruit lipids provide superior skin permeability and sun screen performance[59-60]. Avocado extracts have shown biological activities including antibacterial, antioxidant and antiviral[61-65].

II. Fatty Acids From Avocado

Fatty acids play crucial structural and functional roles in biological systems and are a significant source of energy. They are critical for mammalian cells in order to perform various biological functions, such as sustaining the structural integrity of cellular membranes and serving as signaling molecules[66 67]. The human body can synthesize many of these fatty acids, except essential polyunsaturated fatty acids (PUFAs): linoleic acid (LA) and the α-linolenic acid (ALA). The human body cannot make these essential fatty acids from scratch but must get them from food[68]. Alpha-linolenic acid (ALA) is found in vegetable oils and nuts (especially walnuts), flax seeds and flaxseed oil, leafy vegetables, and some animal fat, especially in grass-fed animals. Once ingested, short chain PUFAs are converted to long-chain fatty acids. Linoleic acid is the precursor of other omega-6 fatty acids whereas α-linolenic acid is the precursor of other omega-3 fatty acids[66-67]. The two main omega-3 fatty acids namely eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) mainly come from fish and are sometimes referred to as marine omega-3s.

Several researchers have studied the fatty acid composition of various avocado cultivars which has led to identification of saturated, monosaturated and polysaturated fatty acids (Table 1). The saturated fatty acids include myristic (C14:0), palmitic (C16:0), stearic (C18:0), arachidic (C20:0), behenic (22:0) and tetraeicosanoic acid (24:0). The monosaturated fatty acids include myristoleic (C14:1), palmitoleic (C16:1), Oleic (C18:1), eicosenoic (C20:1) and docosenoic (22:1), while the polyunsaturated ones include linoleic (18:2), linolenic (18:3n-3), linolenic (18:3n-6), ecosadienoic (C20:2) and docosahexaenoic acid (22:6n-3). The biological activities of some of the fatty acids have been investigated (Table 1). Fatty acids profile in avocado vary with cultivar, plant part, stage of ripening, geographical location and sample processing methods (Table 2)[69-74].

III. Effect of Cultivar

In a study of fatty acid content of three cultivars namely *Hass, Breda* and *Margarida*, oleic acid was found to be the major component (50-60%) followed by palmitic acid 21-25%), linoleic acid (12-21%), palmitoleic acid (2-11%), linolenic acid (0.09-0.63%) and stearic acid (0.09-0.17%)[88]. The *Breda* cultivar had the highest content of oleic acid, followed by *Hass* and *Margarida*; while *Margarida* had the highest content of palmitic acid followed by *Hass* and *Breda*[8]. In another study, fatty acid composition of oils from four avocado cultivars namely *Quintal, Fortuna, Margarida and Hass* the major fatty acids were found to be oleic acid (18:1n-9), palmitic acid(16:0), palmitoleic acid (16:1), linoleic acid (18:2n-6), and alpha-linolenic acid (18:3n-3). In the pulps of *Quintal, Fortuna and Margarida* cultivars, oleic acid was the main fatty acid while in the *Hass* cultivar the main fatty acid was palmitic acid[89]. The concentration of oleic acid was highest in *Quintal* followed by *Fortuna, Margarida* and *Hass* while the concentration of linolenic was highest in *Quintal* and *Margarida*, followed by *Fortuna* and *Hass*[89]. Six fatty acids were detected in creole avocados from Nuevo Leon, Mexico namely palmitic, stearic, oleic, palmitoleic, linoleic and linolenic. The results showed that samples with high oleic acid content gave low palmitic and palmitoleic acid contents[90]. In a study the saturated fatty acid (SFA) of the pulp oils accounted for around 22.3, 29.4, and 41.3% of the total fatty acids in the *Fortuna, Collinson* and *Barker* cultivars, respectively, indicating better quality of pulp oil of *Fortuna* and *Collinson* cultivars than that of the *Barker* cultivar[91]. Investigation of the seeds of 16 avocado accessions collected from southern China showed significant differences among the accessions. Seventeen fatty acids were identified which included linoleic (40.14%), palmitic (23.54%), and oleic acids (16.23%) The total contents of unsaturated fatty acids in all the seeds were higher than those of saturated fatty acids[92]. In another study[93], fatty acid composition of three Indonesian avocado oils, namely *Bantul (MAB), Purwokerto (MAP)* and *Garut (MAG)* was determined. The main components were oleic (C18:1), palmitic (C16:0), linoleic (C18:2) and palmitoleic acids (C16:1). The oils had high amounts of total unsaturated fatty acids, 55.73, 62.84 and 68.94% for MAB, MAP and MAG respectively while level of saturated fatty acids were MAB (33.21%), MAP (30.50%) and MAG (27.01%)[93]. Fatty acid composition of three Indonesian avocado cultivars: *Merah bundar, Ijo bundar* and *Ijo panjang* together with imported *Fuerte* and *Shepard* cultivars were determined and all the oils contained palmitic, palmitoleic, stearic, oleic, linoleic and linolenic acids [93]. *Merah bundar* oil contained oleic (43.44%), palmitic (28.45%), linoleic (16.27%) and palmitoleic (9.81%). The *Fuerte* avocado oil contained oleic acid (55.64%), palmitic (22.13%), linoleic (14.18%) and palmitoleic (6.11%) [94]. In *Ettinger, Fuerte, Hass* and *Reed* avocados from Morocco, the predominant fatty acids were oleic acid palmitic and linoleic acid occurring in different proportions depending on the cultiver The *Reed* avocado had the highest concentration of oleic acid (61.18%), followed by *Fuerte* 57.5% while the *Hass* recorded the lowest amount (54.53%). Ettinger gave the highest proportion (84.04%) of unsaturated fatty[95].

IV. Effect of Maturity Stage

The percentage oleic acid varied between 61.1-59.4%, 55.9-45.3% and 53.3-49.2% in *Breda, Margarida* and *Hass* avocados respectively, during a storage period of 22 days while palmitic acid composition varied between 27.0-23.0%, 23.2-19.9% and 22.1-19.3% in *Margarida, Breda* and *Hass respectively*[88]. In *Hass* avocados, a significant increase in monounsaturated and saturated fatty acids contents was observed during avocado ripening, while the polyunsaturated fatty acid content decreased[46]. In another study palmitoleic acid content increased significantly with the maturity stage of the avocados for all of the sapling locations[96]. In a study involving *Fuerte* and *Hass* cultivars oleic acid significantly increased with late harvest while other fatty acids decreased[97]. Statistically significant differences in the fatty acid compositions during the post-harvest ripening period was also recorded[97]. A study was conducted to determine the effect of postharvest ripening strategies based on high temperature (15 and 20 °C) and external ethylene (0 or 100 ppm applied for 24 h). The application of high temperature or ethylene did not have a significant effect on the fatty acid profile or composition and total amount of oil recovered at edible ripeness[98]. However the composition was affected by stage of maturity[99].

;

V. Effect of Region of Production

A study conducted to determine the relationship between fatty acid content and the altitude of orchards of avocados found that the quantities of oleic acid decreased drastically at lower altitudes, while the amounts of palmitoleic and linoleic acids increased. The oleic/palmitoleic, linoleic/palmitoleic, and oleic/linoleic indexes increased significantly at higher altitudes[96]. The fatty acid composition *Fuerte* avocado grown in different regions were found to differ significantly[70, 71, 97]. *Fuerte* avocado oil from Indonesia contained oleic, palmitic, linoleic and palmitoleic acids in concentrations of 55.64, 22.13, 14.18 and 6.11% respectively[94] while in *Fuerte* from Morocco the most abundant fatty acid was oleic acid (57.5%) followed by linoleic (19.84%) and palmitic (15.63%)[95]. Fatty acid profile and composition of *Hass* avocado has also been found to vary with geographical location of cultivation[100-101].

VI. Effect of Plant Part

In a study it was found that pulp oil of avocado had higher percent of stearic, oleic and linoleic acids than seed oil, while the seed oil had higher amount of palmitic, arachidic, eicosenoic and ecosadienoic acids than the pulp oil[62]. Myristic and palmitic acids were detected in the pulp oil but were missing in the seed oil[62]. Pulp oil from *Hass* and *Margarida* avocados were found to contain the highest concentrations of 14:0, 16:0, 16:1, 18:0, 18:1n-9, 18:2n-6, 20:0, 18:3n-3, 20:1, 22:0, 24:0 and 22:6n-3 fatty acids followed by the peel and seed oils[89]. The ratios of PUFA/SFA from Hass avocado were found to be 0.530, 0.860 and 1.340 in pulp, peel and seed oil respectively[89]. Pulp oil from *Quintal* avocado contained the highest concentrations 14:0, 16:0, 16:1, 18:0, 18:1n-9, 18:2n-6 and 20:0 fatty acids followed by the peel and seed oils while the seed oil of *Quintal* avocado had the highest concentrations of 18:3n-6 and 22:1 acids. The ratios of PUFA/SFA were 0.4000, 0.6200 and 1.990 in pulp, peel and seed oils respectively[89]. For the *Fortuna* cultivar, pulp oil contained the highest amounts of 14:0, 16:0, 16:1, 18:0, 18:1n-9, 18:2n-6, 20:0, 18:3n-3 and 22:6n-3fatty acids while the peel oil contained the highest amounts of 22:0 and 24:0 fatty acids. The 22:1 fatty acid was found in seed oils of all the four cultivars; but was missing in pulp and peel oils[89]. In a study by Galvão *et al*. saturated fatty acid (SFA) accounted for 22.3, 29.4, and 41.3% of the total fatty acids in pulp oils of Fortuna, *Collinson* and Barker avocados respectively, indicating better quality of pulp oil of *Fortuna* and *Collinson* avocados[91]. However, monounsaturated fatty acid content of the peel oils from the three cultivars were not significantly different[91].

VII. Conclusion

The most common fatty acids in avocado are oleic, linoleic, palmitic, palmitoleic, stearic, linolenic, myristic, arachidic, behenic, eicosenoic, myristoleic and tetraeicosanoic acid, which were detected in 115, 115, 114, 113, 108, 108, 51, 49, 39, 36, 23 and 21 avocado samples respectively out of the 116 samples whose reports were accessed (Table 3). The major ones were oleic, palmitoleic, linoleic, linolenic, palmitoleic and arachidic acids which were found at concentrations of 10.88-74.32, 7.70-55, 5.25- 38.2, 0.03-24.17, 0.16-19.78, 0.45-18.55 and 0.07-10.95% respectively. These findings are in agreement with previous reports which found oleic acid to be the most abundant fatty acid in most cultivars[42, 49, 62].

The findings from this report have confirmed that avocado is a rich source of fatty acids including the essential polyunsaturated fatty acids such as linoleic acid (LA) and the α-linolenic acid (ALA) which humans must obtain from food to enable then synthesize other omega-6 and omega-3 fatty acids, respectively. Hass, *Quintal*, *Fortuna* and Margarida avocado avocados were found to contain docosahexaenoic acid (DHA), an omega-3s which is known to be mainly obtained from fish[89]. Further research on methods of enhancing fatty acid content is necessary. It is also necessary to determine the bioactivities of the fatty acids present in avocado.

Table 1. Some Fatty Acids from Avocado and their Bioactivities

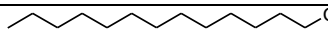
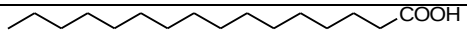
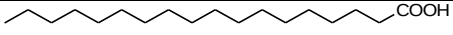
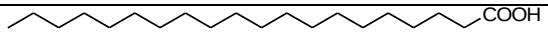
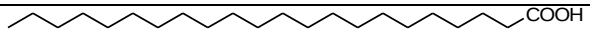
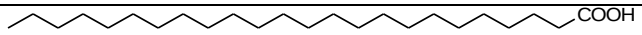
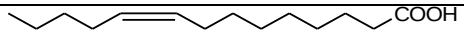
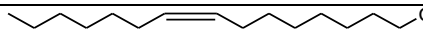
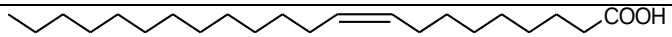
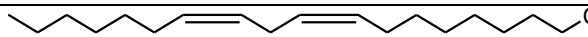
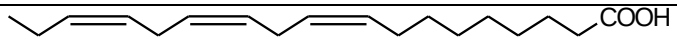
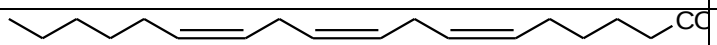
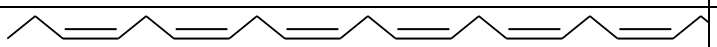
Fatty Acids	Structure	Biological activities
Myristic (C14:0)		Antimicrobial[75-76] Antioxidant[77]
Palmitic (C16:0)		Antimicrobial[75] Antioxidant[75-78]
Stearic (C18:0)		Antimicrobial[75,79-80]
Arachidic (C20:0)		Antimicrobial[81-82] Antioxidant[83]
Behenic (22:0)		
n-Tetraeicosanoic acid (24:0)		
Myristoleic (C14:1)		
Palmitoleic (C16:1)		Antioxidant[78]
Oleic (C18:1)		Antimicrobial[84-75]
Eicosenoic (C20:1)		
Docosenoic (22:1)		
Linoleic (18:2)		Antimicrobial[84-75]
Linolenic (18:3n-3)		Antimicrobial[84]
Linolenic (18:3n-6)		
Ecosadienoic (C20:2)		
Docosahexaenoic acid (22:6n-3)		Anti-inflammatory[85] Antimicrobial[86-87]

Table 2. Fatty Acid Composition of Different Avocado Varieties from Different Locations

Avocado	Part	Unit	Origin	14:0	16:0	18:0	20:0	22:0	24:0	14:1	16:1	18:1	20:1	22:1	18:2	18:3n-3	18:3 n-6	20:2	22:6 n-3	REF
Amarillo	Pulp	%	Mexico		12.32	2.87					1.28	66.37			14.02	0.82				90
Antillana	Pulp	%			18.87	0.59					4.16	63.07			11.83	1.32				102
Bacon	Pulp	%	Japan		18.6	0.8	0.1				4.9	58.2	0.5		10.7	0.8				70
Bacon	Seed	%	Japan	1.3	17.7	1.1	0.8	0.7	0.7		4.4	24.1	2.0		36.1	4.1				70
Bantul	Pulp	%	Indonesia	0.15	30.91	1.17	0.25	0.12	0.15		10.06	34.79	1.14		8.67	0.82				93
Barker	Pulp	%	Brazil	0.31	36.39	2.25	0.25				4.30	32.66	0.53		19.25	2.02				91
Barker	Seed	%	Brazil	0.51	17.87	1.17	2.00		1.45	0.63	6.42	16.09		0.61	25.77	11.72				91
Barker	Peel	%	Brazil	0.53	24.25	1.76	0.30			0.93	6.08	42.87	0.31	0.21	17.99	3.06				91
Breda	Pulp	%	Brazil		18.06						6.56	66.03			9.35					88.
Breda	Pulp	%			19-21						2-7	57-64			10-11	0.4-0.6				103
Calabo	Pulp	%	Mexico		19.48	0.88					5.29	57.34			10.52	0.66				90
Campeon	Pulp	%	Mexico		18.20	1.12					4.39	55.35			15.87	1.18				90
Collinson	Pulp	%	Brazil	0.07	27.47	1.06	0.14	0.45			0.45	51.26	0.21		12.98	0.70				91
Collinson	Seed	%	Brazil		12.64	1.85	1.30	1.09	0.64	0.64	4.25	17.59	2.59		23.95	18.27				91
Collinson	Peel	%	Brazil	0.49	19.79	2.56	0.23	0.07		1.01	5.83	43.01	0.68		22.60	3.78				91
Criolla Mexicana	Pulp	%			28-34	0.2-1					6-8.	40-42			15-18	1-2				104
Criollo-1	Pulp	%	Mexico		15.18	1.46c					3.75	64.47			9.95	0.63				90
Criollo boleado	Pulp	%	Mexico		18.20	0.79					5.45	44.13			20.35	1.60				90
Criollo boleado grande	Pulp	%	Mexico		16.80	0.87					5.06	59.54			11.59	0.74				90
Cuerno	Pulp	%	Mexico		15.90	0.45					5.24	47.64			20.25	3.14				90
De peluqueria	Pulp	%	Mexico		19.70	0.50					5.87	44.85			22.12	2.13				90
DL-1	Seed	mg/100g	China	28.52	328.46	47.15	2.42	11.80		3.37	54.09	202.49			711.32	64.29				92
DL-2	Seed	mg/100g	China	32.37	449.95	51.28	2.48	8.42		4.38	76.72	276.01			966.26	101.35				92
DL-3	Seed	mg/100g	China	45.76	353.04	54.04	2.03	8.17		6.41	56.53	177.53			845.22	109.62				92
DL-4	Seed	mg/100g	China	25.83	244.23	39.90	1.22	3.11		2.58	38.39	139.93			465.78	47.53				92
Ettinger	Pulp	%	Morocco		15.23	0.46					8.64	60.79	0.24		13.31	1.10				95
Fortuna	Pulp	%	Brazil		19.57	0.58					2.36	65.50			11.99					88.
Fortuna	Pulp	mg/100g	Brazil	10.56	3713	140.4	15.39	6.070	10.50		400.7	6695	30.45		1781	134.0			5.23	89
Fortuna	Peel	mg/100g	Brazil	10.41	869.4	55.01	6.740	8.780	12.83		78.21	926.7	3.650		563.2	123.6			0.26	89
Fortuna	Seed	mg/100g	Brazil	2.520	145.7	5.030		3.91	7.670		11.14	116.3	10.66	1.01	204.0	20.40	2.18		0.21	89
Fortuna	Pulp	%	Brazil	0.05	20.51	0.53	0.07			0.01	9.15	51.40	0.15		15.97	0.97				91
Fortuna	Seed	%	Brazil	0.14	22.41	2.66	0.94	2.24	1.96	0.76	4.45	10.88			29.38	9.93				91
Fortuna	Peel	%	Brazil	0.45	28.93	0.94		0.15		1.01	6.75	39.85			17.54	1.91				91
Fortune	%	%			10. 75	0.48					3.14	74.32			10.03	0.85				102
Fuerte	Pulp	%			21.312	0.762					2.391	64.436			9.147	0.467				105
Fuerte	Pulp	%	Indonesia		22.13	0.85					6.11	55.64			14.18	1.11				94
Fuerte	Pulp	%	Morocco		15.63	0.83					2.06	57.50	0.28		19.84	1.57				95
Fuerte	Pulp	%	Turkey		18.7	0.22	0.28				6.00	65.1			9.54	0.03				97
Fuerte	Pulp	%	South Africa		18.03						6.23	59.00								71
Fuerte	Pulp	%	Japan	0.1	19.9	0.7	0.1				5.7	54.4	0.4		11.6	0.8				70
Fuerte	Seed	%	Japan	1.0	17.8	0.9	0.7	0.4	0.4		4.6	24.0	2.0		35.3	5.3				70
Garut	Pulp	%	Indonesia	0.11	25.28	1.09	0.18	0.09	0.12		7.42	47.99	0.35		11.95	1.13				93
GY-8	Seed	mg/100g	China	22.85	221.02	33.47	1.65	7.62		2.06	33.40	109.57			433.65	63.58				92
Hass	Pulp	%	Brazil		21.37	0.69					12.86	53.22			11.86					88.
Hass	Pulp	mg/100g	Brazil	12.19	4398	84.88	9.68	3.920	10.43		2243	4306	24.97		2237	116.6			14.28	89
Hass	Peel	mg/100g	Brazil	6.720	1014	25.97	3.270	3.630	7.600		450.9	1191	5.550		758.1	132.5			0.19	89
Hass	Seed	mg/100g	Brazil	2.180	75.17	2.910		2.02	2.970		11.35	36.45	4.17	0.21	102.6	10.21	0.82		0.10	89
Hass	Pulp	%	Colombia	0.04-0.17	18.14-21.45	0.99-1.91	0.15-0.21				8.45-17.05	42.14-59.19	0.27-0.65		11.60-16.58	0.99-1.62				96
Hass	Pulp	%	Spain		18.62	0.49					8.47	60.17			10.97	0.98				102
Hass	Pulp	%	Chile		13.4	0.6					3.9	65.3			15.2	1.3				100
Hass	Pulp	%	South Africa		17.37	0.63					7.52	62.89			10.64	0.72				106
Hass	Pulp	%	Chile		13.7						3.4	67.4			14.4	1.1				98
Hass	Pulp	%	Australia		25.63	0.45					7.29	42.59			20.87	3.19				101
Hass	Pulp	%	México		22.59	0.24					11.63	49.19			14.72	1.63				101
Hass	Pulp	%	New Zealand		20.61	0.30					10.31	50.97			16.10	1.72				101
Hass	Pulp	%	United State		22.24	0.93					13.14	47.69			14.47	1.54				101
Hass	Seed	mg/100g	China	37.10	1253.96	79.42	6.01	9.54		1.37	580.6	1070.98			1497.57	113.15				92
Hass	Pulp	%	Chile		12.99	0.62	0.12				4.12	71.2			9.32					107
Hass	Pulp	%	Morocco		20.91	0.49					9.82	54.53	0.17		12.93	0.90				95
Hass	Pulp	%	Turkey		20.3	0.16	0.73				10.3	53.1			14.9	0.16				97
Hass	Pulp	%	Mexico		25.0	0.4					11.9	51.3			11.4	0.1				73
Hass	Pulp	%	Chile		17.0	0.3					4.3	63.5			14.0	1.0				73
Hass	Pulp	%	Florida		32.9	0.5					18.2	22.9			24.4	1.1				73
Hass	Pulp	%	South Africa	0.34	24.33						13.01	48.75								71
Hass	Pulp	%	Japan	0.1	20.0	0.4					9.2	45.9	0.4		12.5	1.1				70
Hass	Seed	%	Japan	0.9	19.0	1.5	0.3	0.5	0.8		2.4	22.4	1.8		38.2	5.4				70
Hass	Pulp	%	Mexico		20.10	0.80					10.10	46.30			11.80	0.90				90
Hass C	Pulp	%	Chile		12.79	0.98	0.18				3.34	67.69	0.28		13.54	1.21				108
Hass R	Pulp	%	Chile		13.41	0.63	0.09				3.81	65.43	0.23		15.15	1.26				
Huevo de paloma	Pulp	%	Mexico		17.51	1.13					3.85	58.80			13.97	0.94				90

Huevo de toro	Pulp	%	Mexico		13.75	0.48				3.94	55.75			16.10	2.56				90
Hule	Pulp	%	Mexico		19.21	0.99				4.96	54.25			16.76	1.16				90
Ijo bundar	Pulp	%	Indonesia		31.59	1.04				9.13	35.85			19.56	1.96				94
Ijo panjang	Pulp	%	Indonesia		35.84	0.91				18.55	21.69			20.64	2.24				94
Leonor	Pulp	%	Mexico		14.53	0.95				2.59	64.57			12.33	1.28				90
Mantequilla	Pulp	%	Mexico		24.14	1.09				7.04	37.91			25.49	1.34				90
Margarida	Pulp	%	Brazil		23.26	4.04				4.04	56.32			15.13	0.91				88.
Margarida	Pulp	mg/100g	Brazil	11.85	3925	102.0	11.59	5.02	9.70	591	6126	29.86		2393	147.5			0.27	89
Margarida	Peel	mg/100g	Brazil	4.810	1344	44.05	5.180	3.07	5.52	159.7	2283	7.920		842.2	108.7			0.04	89
Margarida	Seed	mg/100g	Brazil	1.430	61.03	5.10		2.50	3.37	4.870	43.12	4.61	0.15	103.7	13.74	0.31		0.14	89
Margarida	Pulp	%			23.66					3.58	47.20			13.46	1.60				109
Maria Elena	Pulp	%	Mexico		15.52	1.28				2.17	63.69			12.65	1.25				90
Merah bundar	Pulp	%	Indonesia		28.45	0.88				9.81	43.44			16.27	1.17				94
Not identified	Pulp	%			18.74	0.51				7.88	54.40			10.87	0.61				110
Not identified	Pulp	%			12.87	1.45				3.86	57.44			18.70	0.92				98
Not identified	Seed	%	Indonesia								30.43			37.98	24.17				111
Pato	Pulp	%	Mexico		7.70	0.61				1.44	70.30			12.55	1.52				90
Persea americana	Pulp	%	Nigeria	1.68	12.6	19.78	1.25			1.25	43.23	0.12		19.78			0.12		62
Persea americana	Seed	%	Nigeria		55	3.05	10.95				20.67	2.58		5.25			2.45		62
Plátano delgado	Pulp	%	Mexico		14.21	0.61				3.57	57.10			15.21	3.65				90
Platano grueso-1	Pulp	%	Mexico		20.14	0.69				7.06	36.51			27.14	3.17				90
Plátano grueso-2	Pulp	%	Mexico		16.80	0.52				8.76	55.04			10.79	0.65				90
Plátano grueso-3	Pulp	%	Mexico		17.30	1.15				4.25	58.15			14.21	1.07				90
Platano temprano	Pulp	%	Mexico		16.27	0.72				5.10	51.64			18.12	4.15				90
Purwokerto	Pulp	%	Indonesia	0.11	28.73	1.04	0.24	0.06	0.12	7.68	42.77	0.58		10.65	1.00				93
Quintal	Pulp	%	Brazil		16.46					4.36	70.44			8.30	0.44				88.
Quintal	Pulp	mg/100g	Brazil	13.75	5250	212.4	23.51	9.85	15.09	1134	10620	71.73		2318	147.5			0.34	89
Quintal	Peel	mg/100g	Brazil	4.93	485.3	31.50	4.07	4.52	6.15	81.40	665.8	6.740		266.2	57.03			0.37	89
Quintal	Seed	mg/100 g	Brazil	4.440	153.1	12.31		5.75	10.21	12.78	135.8	28.92	14.80	277.2	78.30	6.62		0.17	89
Reed	Pulp	%			18.18	0.40				6.56	60.25			13.03	1.40				102
Reed	Pulp	%	Morocco		18.43	0.49				7.55	61.18	0.23		10.60	0.83				95
RLW-1	Seed	mg/100g	China	20.77	219.77	39.10	1.16	2.85	0.64	52.86	126.29			466.84	51.96				92
RLW-2	Seed	mg/100g	China	21.79	220.61	40.76	0.84	2.44	0.61	55.93	209.35			454.37	60.15				92
RLW-3	Seed	mg/100g	China	20.06	290.48	41.13	1.06	3.34	0.47	73.84	220.10			536.61	64.19				92
RLW-4	Seed	mg/100g	China	18.80	192.67	35.65	1.24	3.85	0.41	40.58	156.33			413.25	68.70				92
RN-1	Seed	mg/100g	China	27.95	337.69	46.32	1.35	4.99	1.88	63.27	179.85			594.92	109.01				92.
RN-11	Seed	mg/100g	China	26.03	492.56	46.32	1.09	2.04	2.56	89.40	342.58			579.50	61.20				92
RN-12	Seed	mg/100g	China	37.39	393.72	66.30	2.35	7.85	2.46	70.37	253.38			687.49	71.52				92
RN-15	Seed	mg/100g	China	28.03	288.07	44.92	1.48	3.42	2.55	54.00	266.08			420.24	74.37				92
RN-16	Seed	mg/100g	China	25.93	359.00	46.31	1.27	6.38	1.15	48.32	174.51			626.84	61.30				92
RN-5	Seed	mg/100g	China	22.00	250.99	42.40	0.59	1.48	0.62	60.44	160.58			354.80	38.83				92
Salvador	Pulp	%	Mexico		15.27	1.57				2.95	63.40			12.20	0.92				90
Shepard	Pulp	%	Indonesia		34.13	0.65				16.71	33.33			14.10	1.10				94
Tamaulipas	Pulp	%	Mexico		18.80	0.55				7.71	54.35			10.54	0.88				90
Todo el año	Pulp	%	Mexico		21.30	0.83				6.41	44.94			20.23	1.46				90

Table 3: Distribution and Abundance of Fatty Acids in Avocado Cultivars

Fatty acid	Number Samples/ Cultivas	% Abundance
Oleic (C18:1)	115	10.88-74.32
Linoleic (18:2)	115	5.25-38.2
Palmitic (C16:0)	114	7.70-55
Palmitoleic (C16:1)	113	0.45-18.55
Stearic (C18:0)	108	0.16-19.78
Linolenic (18:3n-3)	108	0.03-24.17
Myristic (C14:0)	51	0.05-1.68
Arachidic (C20:0)	49	0.07-10.95
Behenic (22:0)	39	0.4-2.24
Eicosenoic (C20:1)	36	0.12-2.59
Myristoleic (C14:1)	23	0.01-1.01
n-Tetraeicosanoic (24:0)	21	0.12-1.96
Docosenoic (22:1)	6	0.21-0.61
Linolenic (18:3n-6)	4	0.82-6.62 mg/100g
Docosahexaenoic (22:6n-3	4	0.04000 14.28 mg/100g

Ecosadienoic (C20:2)	2	0.12-2.45

References

[1]. Kokwaro JO. *Medicinal Plants of East Africa*. 3rd ed. University of Nairobi Press; 2009.
[2]. Jeruto P, Arama PF, Anyango B, Nyunja R, Taracha C, Opiyo SA. Morphometric Study of Senna didymobotrya (Fresen.) H. S. Irwin and Barneby in Kenya. *J Nat Sci Res*. 2017;7:54-69.
[3]. Opiyo SA, Manguro LO, Ogur J, Wagai S. Bioactive Constituents of Conyza floribunda. *Res J Pharmacol*. 2010;4(3):55-59. doi:10.3923/rjpharm.2010.55.59
[4]. Ochung' AA, Manguro LAO, Owuor PO, et al. Bioactive carbazole alkaloids from Alysicarpus ovalifolius (Schumach). *J Korean Soc Appl Biol Chem*. 2015;58(6):839-846. doi:10.1007/s13765-015-0100-4
[5]. World Health Organization. *WHO Traditional Medicine Strategy: 2014-2023*. World Health Organization; 2013. Accessed February 27, 2023. https://apps.who.int/iris/handle/10665/92455
[6]. Opiyo SA. Triterpenes and Sterols from Ocimum suave. *IOSR J Appl Chem.* 2022;15(7):1-6. doi:doi:10.9790/5736-1507010106
[7]. McPherson BA, Mori SR, Opiyo SO, Conrad AO, Wood DL, Bonello P. Association between resistance to an introduced invasive pathogen and phenolic compounds that may serve as biomarkers in native oaks. *For Ecol Manag*. 2014;312:154-160. doi:10.1016/j.foreco.2013.10.009
[8]. Opiyo S. Stored Grains Protection Activity of Ocimum Suave Extracts and Compounds on Larger Grain Borer. *IOSR J Biotechnol Biochem*. 2022;8(4):5-10. doi:10.9790/264X-08040510
[9]. Opiyo SA. A review of 13C NMR spectra of drimane sesquiterpenes. *Trends Phytochem Res.* 2019;3(3):147-180.
[10]. Njoroge PW, Opiyo SA. Antimicrobial Activity of Root Bark Extracts of Rhus natalensisa and Rhus ruspolii. *Basic Sci Med*. 2019;8(2):23-28. doi:doi:10.5923/j.medicine.20190802.01
[11]. Opiyo SA, Manguro LOA, Okinda-Owuor P, Ateka EM, Lemmen P. 7α-Acetylugandensolide and antimicrobial properties of Warburgia ugandensis extracts and isolates against sweet potato pathogens. *Phytochem Lett*. 2011;4(2):161-165. doi:10.1016/j.phytol.2011.02.007
[12]. Opiyo SA, Manguro LOA, Owuor PO, Ochieng CO, Ateka EM, Lemmen P. Antimicrobial Compounds from Terminalia brownii against Sweet Potato Pathogens. *Nat Prod J*. 2011;1(12):116-120. doi:doi:10.2174/2210316311101020116
[13]. Ndirangu EG, Opiyo SA, Ng'ang'a MW. Chemical composition and repellency of Nigella sativa L. seed essential oil against Anopheles gambiae sensu stricto. *Trends Phytochem Res*. 2020;4(2):77-84.
[14]. Opiyo SA, Ogur JA, Manguro LOA, Tietze LF, Schuster H. A New Sterol Diglycoside from Conyza floribunda. *Afr J Chem.* 2009;62:163-167.
[15]. Manguro LOA, Opiyo SA, Herdtweck E, Lemmen P. Triterpenes of *Commiphora holtziana* oleo-gum resin. *Can J Chem.* 2009;87(8):1173-1179. doi:10.1139/V09-078
[16]. Ochieng C, Ishola I, Opiyo S, Manguro L, Owuor P, Wong KC. Phytoecdysteroids from the Stem Bark of Vitex doniana and Their Anti-Inflammatory Effects. *Planta Med*. 2012;79(01):52-59. doi:10.1055/s-0032-1327880
[17]. Opiyo SA. Evaluation of Warburgia ugandensis Extracts and Compounds for Crop Protection against Prostephanus truncates. *Adv Anal Chem*. 2020;10(2):15-19. doi:doi:10.5923/j.aac.20201002.01
[18]. Opiyo SA. Insecticidal Activity of Elaeodendron schweinfurthianum Extracts and Compounds against Sitophilus zeamais Motschulsky. *Am J Chem*. 2020;10(3):39-34. doi:doi:10.5923/j.chemistry.2020100
[19]. Ochung AA, Owuor PO, Manguro LAO, et al. Analgesics from Lonchocarpus eriocalyx Harms. *Trends Phytochem Res*. 2018;2(4):253-260.
[20]. Opiyo SA, Muna, KK, Njoroge PW, Ndirangu EG. Analgesic Activity of Conyza Floribunda Extracts in Swiss Albino Mice. *J Nat Sci Res*. 2021;12(12):1-6. doi:10.7176/JNSR/12-12-01
[21]. Makenzi AM, Manguro LOA, Owuor PO, Opiyo SA. Flavonol glycosides with insecticidal activity from methanol extract of Annona mucosa Jacq. leaves. *Trends Phytochem Res*. 2019;3(4):287-296. doi:doi:10.1111/jfbc.12913
[22]. Opiyo SA. Insecticidal Activity of Ocimum Suave Willd Extracts and Compounds against Sitophilus Zeamais Motschulsky. *Basic Sci Med*. 2020;9(2):32-37. doi:doi:10.5923/j.medicine.20200902.03
[23]. Opiyo SA, Njoroge PW, Ndirangu EG. A Review Pesticidal Activity of Essential Oils against Sitophilus oryzae, Sitophilus granaries and Sitophilus Zeamais. *IOSR J Appl Chem*. 2022;15(4):39-51. doi:doi:10.9790/5736-1504013951
[24]. Makenzi AM, Manguro LOA, Owuor PO, Opiyo SA. Chemical constituents of Ocimum kilimandscharicum Guerke acclimatized in Kakamega Forest, Kenya. *Bull Chem Soc Ethiop*. 2019;33(3):527. doi:10.4314/bcse.v33i3.13
[25]. Opiyo SA. Insecticidal Drimane Sesquiterpenes from Warburgia ugandensis against Maize Pests. *Am J Chem*. 2021;11(4):59-65. doi:doi:10.5923/j.chemistry.20211104.01
[26]. Manguro LOA, Opiyo SA, Asefa A, Dagne E, Muchori PW. Chemical Constituents of Essential Oils from Three Eucalyptus Species Acclimatized in Ethiopia and Kenya. *J Essent Oil Bear Plants*. 2010;13(5):561-567. doi:10.1080/0972060X.2010.10643863
[27]. Opiyo SA, Manguro LOA, Okoth DA, Ochung AA, Ochieng CO. Biopesticidal Extractives and Compounds from Warburgia ugandensis against Maize Weevil (Sitophilus zeamais). *Nat Prod J*. 2015;5(4):236-243. doi:10.2174/2210315505666150916000539
[28]. Opiyo SA, Manguro LOA, Owuor PO, Ateka EM. Triterpenes from Elaeodendron schweinfurthianum and Their Antimicrobial Activities against Crop Pathogens. *Am J Chem*. 2017;7(3):97-104. doi:doi:10.5923/j.chemistry.20170703.03
[29]. Manguro LO, Ogur JA, Opiyo SA. Antimicrobial Constituents Of Conyza Floribunda. *WebmedCentral Pharmacol*. 2010;1(9):1-11.
[30]. Njoroge PW, Opiyo SA. Some Antibacterial and Antifungal Compounds from Root Bark of Rhus natalensis. *Am J Chem*. 2019;9(5):150-158. doi:doi:10.5923/j.chemistry.20190905.03
[31]. Opiyo SA. Repellent Effects of Ocimum Suave Extracts and Compounds against Prostephanus Truncatus Horn. *Am J Chem*. 2021;11(2):23-27. doi:doi:10.5923/j.chemistry.20211102.01
[32]. Ndirangu EG, Opiyo SA, Ng'ang'a MW. Repellent Properties of Compounds and Blends from Nigella sativa Seeds Against Anopheles gambiae. *Basic Sci Med*. 2020;9(1):1-7. doi:doi:10.5923/j.medicine.20200901.01
[33]. Opiyo S, Njoroge P, Ndirangu E, Kuria K. A Review of Biological Activities and Phytochemistry of Rhus Species. *Am J Chem*. 2022;11(2):28-36. doi:10.5923/j.chemistry.20211102.02
[34]. Ochieng CO, Opiyo SA, Mureka EW, Ishola IO. Cyclooxygenase inhibitory compounds from Gymnosporia heterophylla aerial parts. *Fitoterapia*. 2017;119:168-174. doi:10.1016/j.fitote.2017.04.015
[35]. Opiyo SA. A Review of Insecticidal Plant Extractsand Compoundsfor Stored Maize Protection. *IOSR J Appl Chem*. 2021;14(10):23-37. doi:doi:10.9790/5736-1410012337
[36]. Kuria KM, Opiyo SA. Characterization of Immunogenic Soluble Crude Proteins from Biomphalaria Pfeifferi Against Schistosoma mansoni. *J Nat Sci Res*. 2020;10(12):28-34. doi:10.7176/JNSR/10-12-03

[37]. Opiyo SA, Ateka EM, Owuor PO, Manguro LOA, Karuri HW. Survey of sweet potato viruses in western kenya and detection of cucumber mosaic virus. *J Plant Pathol*. 2010;92(3):798-801.

[38]. Opiyo SA, Ateka EM, Owuor PO, Manguro LOA, Miano DW. Development of a multiplex pcr technique for simultaneous detection of sweet potato feathery mottle virus and sweet potato chlorotic stunt virus. *J Plant Pathol*. 2010;92(2):363-366.

[39]. Opiyo SA. *Detection of sweet potato viruses in western Kenya, development of a multiplex pcr technique for simultaneous detection of major viruses and evaluation of medicinal plants for antifungal and antibacterial activities against the crop pathogens*. Maseno University; 2011.

[40]. Opiyo SA. Chemical Composition of Essential Oils from Ocimum Kilimandscharicum: A Review. *IOSR J Appl Chem*. 2022;15(11):5-11.

[41]. Schaffer BA, Wolstenholme BN, Whiley AW, eds. *The Avocado: Botany, Production and Uses*. CABI; 2013.

[42]. 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

[43]. 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 Nutr*. 2020;150(2):276-284. doi:10.1093/jn/nxz231

[44]. Honarbakhsh S, Schachter M. Vitamins and cardiovascular disease. *Br J Nutr*. 2008;101(8):1113-1131. doi:10.1017/S000711450809123X

[45]. Bhuyan DJ, Alsherbiny MA, Perera S, et al. The Odyssey of Bioactive Compounds in Avocado (Persea americana) and Their Health Benefits. *Antioxidants*. 2019;8(10). doi:10.3390/antiox8100426

[46]. Villa-Rodríguez JA, Molina-Corral FJ, Ayala-Zavala JF, Olivas GI, González-Aguilar GA. Effect of maturity stage on the content of fatty acids and antioxidant activity of 'Hass' avocado. *Food Res Int*. 2011;44(5):1231-1237.

[47]. Pieterse Z, Johann J, Oosthuizen W. Avocados (monounsaturated fatty acids), weight loss and serum lipids. *Energy KJ*. 2003;26:65-71.

[48]. Dreher ML, Davenport AJ. Hass Avocado Composition and Potential Health Effects. *Crit Rev Food Sci Nutr*. 2013;53(7):738-750. doi:10.1080/10408398.2011.556759

[49]. Rodriguez-Carpena JG, Morcuende D, Andrade M, Kylli P, Estévez M. Avocado (Persea americana Mill.) Phenolics, In Vitro Antioxidant and Antimicrobial Activities, and Inhibition of Lipid and Protein Oxidation in Porcine Patties. *J Agric Food Chem*. 2011;59:5625-5635. doi:10.1021/jf1048832

[50]. Adaramola F, Onigbinde A, Oluwatosin S. Physiochemical properties and antioxidant potential of Persea Americana seed oil. *Chem Int*. 2016;2:168-175.

[51]. Salazar M, El-Hafidi M, Pastelin G, Ramirez-Ortega MC, Sánchez-Mendoza A. Effect of an avocado oil-rich diet over an angiotensin II-induced blood pressure response. *J Ethnopharmacol*. 2005;98:335-338. doi:10.1016/j.jep.2005.01.044

[52]. Lu QY, Arteaga JR, Zhang Q, Huerta S, Go VLW, Heber D. Inhibition of prostate cancer cell growth by an avocado extract: role of lipid-soluble bioactive substances. *J Nutr Biochem*. 2005;16 1:23-30.

[53]. Li Z, Wong A, Henning S, et al. Hass avocado modulates postprandial vascular reactivity and postprandial inflammatory responses to a hamburger meal in healthy volunteers. *Food Funct*. 2012;4(3):175-191. doi:10.1039/c2fo30226h

[54]. Calder P. Functional Roles of Fatty Acids and Their Effects on Human Health. *JPEN J Parenter Enteral Nutr*. 2015;39. doi:10.1177/0148607115595980

[55]. Pieterse Z, Jerling JC, Oosthuizen W, et al. Substitution of high monounsaturated fatty acid avocado for mixed dietary fats during an energy-restricted diet: Effects on weight loss, serum lipids, fibrinogen, and vascular function. *Nutrition*. 2005;21(1):67-75. doi:10.1016/j.nut.2004.09.010

[56]. Park E, Edirisinghe I, Burton-Freeman B. Avocado Fruit on Postprandial Markers of Cardio-Metabolic Risk: A Randomized Controlled Dose Response Trial in Overweight and Obese Men and Women. *Nutrients*. 2018;10(9). doi:10.3390/nu10091287

[57]. Dabas D, Elias RJ, Ziegler GR, Lambert JD. In Vitro Antioxidant and Cancer Inhibitory Activity of a Colored Avocado Seed Extract. *Int J Food Sci*. Published online May 31, 2019. Accessed March 1, 2023. https://link.gale.com/apps/doc/A612803018/HRCA?u=anon~a6e3add8&sid=googleScholar&xid=0395dedc

[58]. Abozaid OAR, Aziza SAH, Moawed FSM, Kasseb SG. Avocado Oil Attenuates Diethylnitrosamine Induced-Hepatic Carcinogenesis. *Benha Vet Med J*. 2018;35(2):344-353. doi:10.21608/bvmj.2018.96425

[59]. dos Santos MAZ, Alicieo TVR, Pereira CMP, Ramis-Ramos G, Mendonça CRB. Profile of Bioactive Compounds in Avocado Pulp Oil: Influence of the Drying Processes and Extraction Methods. *J Am Oil Chem Soc*. 2014;91(1):19-27. doi:10.1007/s11746-013-2289-x

[60]. Ferreira S, Falé Z, Santos L. Sustainability in Skin Care: Incorporation of Avocado Peel Extracts in Topical Formulations. *Molecules*. 2022;27:1782. doi:10.3390/molecules27061782

[61]. Cardoso P, Scarpassa J, Pretto-Giordano L, et al. Antibacterial activity of avocado extracts (Persea americana Mill.) against Streptococcus agalactiae. *Phyton*. 2016;85:218-224. doi:10.32604/phyton.2016.85.218

[62]. Akusu OM, Obinna-Echem PC, Opurum PCC, Chibor BS. Comparative Analysis of the Physicochemical Characteristics, Phytochemical Components and Fatty Acid Profile of Avocado Pear (Persea Americana L) Pulp and Seed Oil. *Eur J Agric Food Sci*. 2021;3(1):11-17. doi:10.24018/ejfood.2021.3.1.212

[63]. Hernández-Martínez MA, Suárez-Rodríguez LM, López-Meza JE, et al. Antifungal Activity of Avocado Seed Recombinant GASA/Snakin PaSn. *Antibiotics*. 2022;11(11). doi:10.3390/antibiotics11111558

[64]. Méndez-Zúñiga S, Corrales Garcia J, Gutiérrez-Grijalva E, García-Mateos M, Pérez-Rubio V, Heredia JB. Fatty Acid Profile, Total Carotenoids, and Free Radical-Scavenging from the Lipophilic Fractions of 12 Native Mexican Avocado Accessions. *Plant Foods Hum Nutr*. 2019;74. doi:10.1007/s11130-019-00766-2

[65]. Ong ES, Low J, Tan JCW, Foo SY, Leo CH. Valorization of avocado seeds with antioxidant capacity using pressurized hot water extraction. *Sci Rep*. 2022;12(1):13036. doi:10.1038/s41598-022-17326-5

[66]. Glick NR, Fischer MH. The Role of Essential Fatty Acids in Human Health. *J Evid-Based Complement Altern Med*. 2013;18(4):268-289. doi:10.1177/2156587213488788

[67]. Katalin Nagy, Ioana-Daria Tiuca. Importance of Fatty Acids in Physiopathology of Human Body. In: Angel Catala, ed. *Fatty Acids*. IntechOpen; 2017:Ch. 1. doi:10.5772/67407

[68]. Di Pasquale MG. The Essentials of Essential Fatty Acids. *J Diet Suppl*. 2009;6(2):143-161. doi:10.1080/19390210902861841

[69]. Yanty NAM, Marikkar JMN, Long K. Effect of Varietal Differences on Composition and Thermal Characteristics of Avocado Oil. *J Am Oil Chem Soc*. 2011;88:1997-2003.

[70]. Takenaga F, Matsuyama K, Abe S, Torii Y, Itoh S. Lipid and Fatty Acid Composition of Mesocarp and Seed of Avocado Fruits Harvested at Northern Range in Japan. *J Oleo Sci*. 2008;57(11):591-597. doi:10.5650/jos.57.591

[71]. Reddy M, Moodley R, Jonnalagadda SB. Fatty acid profile and elemental content of avocado (Persea americana Mill.) oil –effect of extraction methods. *J Environ Sci Health Part B*. 2012;47(6):529-537. doi:10.1080/03601234.2012.665669

[72]. Qin X, Zhong J. A Review of Extraction Techniques for Avocado Oil. *J Oleo Sci*. 2016;65(11):881-888. doi:10.5650/jos.ess16063

[73]. Pisani C, Ritenour M, Stover E, Plotto A, Alessandro R, Schnell R. Postharvest and Sensory Evaluation of Selected 'Hass' × 'Bacon' and 'Bacon' × 'Hass' Avocado Hybrids Grown in East-Central Florida. *HortScience*. 2017;52:880-886. doi:10.21273/HORTSCI11375-16

[74]. Rodríguez-López CE, Hernández-Brenes C, Treviño V, Díaz de la Garza RI. Avocado fruit maturation and ripening: dynamics of aliphatic acetogenins and lipidomic profiles from mesocarp, idioblasts and seed. *BMC Plant Biol*. 2017;17(1):159. doi:10.1186/s12870-017-1103-6

[75]. Kabara JJ, Swieczkowski DM, Conley AJ, Truant JP. Fatty Acids and Derivatives as Antimicrobial Agents. *Antimicrob Agents Chemother*. 1972;2:23-28.

[76]. Muniyan R, Gurunathan J. Lauric acid and myristic acid from Allium sativum inhibit the growth of Mycobacterium tuberculosis H37Ra: in silico analysis reveals possible binding to protein kinase B. *Pharm Biol*. 2016;54(12):2814-2821. doi:10.1080/13880209.2016.1184691

[77]. Liu C, Yuan C, Ramaswamy HS, Ren Y, Ren X. Antioxidant capacity and hepatoprotective activity of myristic acid acylated derivative of phloridzin. *Heliyon*. 2019;5(5):e01761. doi:https://doi.org/10.1016/j.heliyon.2019.e01761

[78]. Zadeh Hashem E, Khodadadi M, Asadi F, et al. The Antioxidant Activity of Palmitoleic Acid on the Oxidative Stress Parameters of Palmitic Acid in Adult Rat Cardiomyocytes. *Ann Mil Health Sci Res*. 2016;14(3):e11467. doi:10.5812/amh.11467

[79]. Cheung Lam AH, Sandoval N, Wadhwa R, et al. Assessment of free fatty acids and cholesteryl esters delivered in liposomes as novel class of antibiotic. *BMC Res Notes*. 2016;9(1):337. doi:10.1186/s13104-016-2138-8

[80]. Ivanova EP, Nguyen SH, Guo Y, et al. Bactericidal activity of self-assembled palmitic and stearic fatty acid crystals on highly ordered pyrolytic graphite. *Acta Biomater*. 2017;59:148-157. doi:10.1016/j.actbio.2017.07.004

[81]. Eijkelkamp BA, Begg SL, Pederick VG, et al. Arachidonic Acid Stress Impacts Pneumococcal Fatty Acid Homeostasis. *Front Microbiol*. 2018;9. doi:10.3389/fmicb.2018.00813

[82]. Beavers W, Monteith A, Amarnath V, et al. Arachidonic Acid Kills Staphylococcus aureus through a Lipid Peroxidation Mechanism. *mBio*. 2019;10:1-19. doi:10.1128/mBio.01333-19

[83]. Miinea C, Kuruvilla R, Merrikh H, Eichberg J. Altered Arachidonic Acid Biosynthesis and Antioxidant Protection Mechanisms in Schwann Cells Grown in Elevated Glucose. *J Peripher Nerv Syst*. 2003;8:128-133. doi:10.1046/j.1529-8027.2003.03016_11.x

[84]. Galbraith H, Miller TB, Paton AM, Thompson JK. Antibacterial activity of long chain fatty acids and the reversal with calcium, magnesium, ergocalciferol and cholesterol. *J Appl Bacteriol*. 1971;34 4:803-813.

[85]. Yum HW, Na HK, Surh YJ. Anti-inflammatory effects of docosahexaenoic acid: Implications for its cancer chemopreventive potential. *Semin Cancer Biol*. 2016;40. doi:10.1016/j.semcancer.2016.08.004

[86]. Sun M, Dong J, Xia Y, Shu R. Antibacterial activities of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) against planktonic and biofilm growing Streptococcus mutans. *Microb Pathog*. 2017;107:212-218. doi:10.1016/j.micpath.2017.03.040

[87]. Ribeiro-Vidal H, Sánchez MC, Alonso-Español A, et al. Antimicrobial Activity of EPA and DHA against Oral Pathogenic Bacteria Using an In Vitro Multi-Species Subgingival Biofilm Model. *Nutrients*. 2020;12(9). doi:10.3390/nu12092812

[88]. Alnasan Z. Characteristics of the oil of different varieties of avocado grown in Brazil and a new methodology for extra-virgin avocado oil extraction. In: ; 2019.

[89]. Amado D, Detoni A, Carvalho SLC, et al. Tocopherol and fatty acids content and proximal composition of four avocado cultivars (Persea americana Mill). *Acta Aliment*. 2019;48:47-55. doi:10.1556/066.2019.48.1.6

[90]. Acosta-Díaz E, Álvarez-Ojeda MG, Guzmán-Maldonado SH, Almeyda-León IH. Variability of the total oil content and fatty acid profile of creole avocados from Nuevo Leon, Mexico. *Agron Mesoam*. Published online September 1, 2019:705-719. doi:10.15517/am.v30i3.34490

[91]. Galvão M de S, Narain N, Nigam N. Influence of different cultivars on oil quality and chemical characteristics of avocado fruit. *Food Sci Technol Camp*. 2014;34(3):539-546. doi:10.1590/1678-457x.6388

[92]. Ge Y, Si X, Wu B, Dong X, Xu Z, Ma W. Oil Content and Fatty Acid Composition of the Seeds of 16 Avocado (Persea americana) Accessions Collected From Southern China and Their Application in a Soap Bar. *J Agric Sci*. 2018;10(11):69. doi:10.5539/jas.v10n11p69

[93]. Indriyani L, Rohman A, Riyanto S. Physico-Chemical Characterization of Avocado (Persea americana Mill.) Oil from Three Indonesian Avocado Cultivars. *Res J Med Plant*. 2016;10(1):67-78. doi:10.3923/rjmp.2016.67.78

[94]. Manaf YN, Rahardjo AP, Yusof YA, Desa MN, Nusantoro BP. Lipid characteristics and tocopherol content of the oils of native avocado cultivars grown in Indonesia. *Int J Food Prop*. 2018;21(1):2758-2771. doi:10.1080/10942912.2018.1564761

[95]. Nasri C, Halabi Y, Harhar H, et al. Chemical characterization of oil from four Avocado varieties cultivated in Morocco. *OCL*. 2021;28:19. doi:10.1051/ocl/2021008

[96]. Carvalho CP, Bernal E. J, Velásquez MA, Cartagena V. JR. Fatty acid content of avocados (Persea americana Mill. cv. Hass) in relation to orchard altitude and fruit maturity stage. *Agron Colomb*. 2015;33(2):220-227. doi:10.15446/agron.colomb.v33n2.49902

[97]. Ozdemir F, Topuz A. Changes in dry matter, oil content and fatty acids composition of avocado during harvesting time and post-harvesting ripening period. *Food Chem*. 2004;86(1):79-83. doi:10.1016/j.foodchem.2003.08.012

[98]. Pedreschi R, Hollak S, Harkema H, et al. Impact of postharvest ripening strategies on 'Hass' avocado fatty acid profiles. *South Afr J Bot*. 2016;103:32-35. doi:10.1016/j.sajb.2015.09.012

[99]. Villa-Rodriguez JA, Yahia EM, González-León A, et al. Ripening of 'Hass' avocado mesocarp alters its phytochemical profile and the in vitro cytotoxic activity of its methanolic extracts. *South Afr J Bot*. 2020;128:1-8. doi:10.1016/j.sajb.2019.09.020

[100]. Forero-Doria O, García MF, Vergara CE, Guzman L. Thermal analysis and antioxidant activity of oil extracted from pulp of ripe avocados. *J Therm Anal Calorim*. 2017;130(2):959-966. doi:10.1007/s10973-017-6488-9

[101]. Tan CX, Tan SS, Tan ST. Influence of Geographical Origins on the Physicochemical Properties of Hass Avocado Oil. *J Am Oil Chem Soc*. 2017;94(12):1431-1437. doi:10.1007/s11746-017-3042-7

[102]. Nieto ML, Romero MMV. Changes in the fatty acids of avocado oil during maturation. grasasaceites. *Grasas Aceites*. 1995;46(2):92-95. doi:https://doi.org/10.3989/gya.1995.v46.i2.908

[103]. Krumreich FD, Borges CD, Mendonça CRB, Jansen-Alves C, Zambiazi RC. Bioactive compounds and quality parameters of avocado oil obtained by different processes. *Food Chem*. 2018;257:376-381. doi:10.1016/j.foodchem.2018.03.048

[104]. Xuan T, Chong G hean, Hazilawati H, Mohd Ghazali H. Comparison of subcritical CO 2 and ultrasound-assisted aqueous methods with the conventional solvent method in the extraction of avocado oil. *J Supercrit Fluids*. 2017;135. doi:10.1016/j.supflu.2017.12.036

[105]. Bora P, Narain N, Rocha R, Paulo M. Characterization of the oils from the pulp and seeds of avocado (cultivar: Fuerte) fruits. *Grasas Aceites*. 2001;52. doi:10.3989/gya.2001.v52.i3-4.353
[106]. Retief L, McKenzie JM, Koch KR. A novel approach to the rapid assignment of 13C NMR spectra of major components of vegetable oils such as avocado, mango kernel and macadamia nut oils. *Magn Reson Chem*. 2009;47(9):771-781. doi:https://doi.org/10.1002/mrc.2463
[107]. Li Y, Liu Y, Deng D, et al. Study on Extracting Avocado Oil from Avocado Pulp by Aqueous Extraction. *IOP Conf Ser Earth Environ Sci*. 2019;330(4):042027. doi:10.1088/1755-1315/330/4/042027
[108]. Flores M, Del M, Perez-Camino C, Troca J. Preliminary Studies on Composition, Quality and Oxidative Stability of Commercial Avocado Oil Produced in Chile. Published online January 1, 2014.
[109]. Oliveira A, Franco E, Barreto R, et al. Effect of Semisolid Formulation of Persea Americana Mill (Avocado) Oil on Wound Healing in Rats. *Evid-Based Complement Altern Med ECAM*. 2013;2013:472382. doi:10.1155/2013/472382
[110]. Berasategi I, Barriuso B, Ansorena D, Astiasarán I. Stability of avocado oil during heating: Comparative study to olive oil. *Food Chem*. 2012;132(1):439-446. doi:10.1016/j.foodchem.2011.11.018
[111]. Tambun R, Tambun JA, Tarigan IAA. Fatty acid production from avocado seed by activating Lipase Enzyme in the seed. *IOP Conf Ser Mater Sci Eng*. 2020;725(1):012075. doi:10.1088/1757-899X/725/1/012075

Sylvia A. Opiyo, et. al. "A Review of Fatty Acid Components in Avocado." *IOSR Journal of Applied Chemistry (IOSR-JAC)*, 16(3), (2023): pp 18-27.