Trends in Medical Research

ISSN 1819-3587

Academic Journals Inc.

www.academicjournals.com

OPEN ACCESS Trends in Medical Research

ISSN 1819-3587
DOI: 10.3923/tmr.2020.14.21

Research Article
Health Effect of Lipid Components Extracted from Avocado Pear *(Persea americana)* Pulp and Seed

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Abstract

Background and Objective: Avocado pears (*Persea americana*) are tropical fruits. They are very nutritious foods and regular consumption of the fruits has been associated with the reductions of cardiovascular and circulatory diseases. The extracts from fruit pulp and seeds can be used as an alternative dietary supplement. In addition, they have been extensively used in traditional medicine for the treatment of various diseases. This study examines comparatively the levels of fatty acids, phospholipids and phytosterols in the samples of *Persea americana* pulp and seed. **Materials and Methods:** The fatty acid, phospholipid and phytosterol compositions were determined from the pulp and seed samples prepared from the fruits of *Persea americana* using the gas chromatography method. **Results:** The levels of saturated and unsaturated fatty acids in the pulp and seed samples were: total SFA (33.74 and 22.29%); total UFA (66.27 and 77.71%); PUFA/SFA (0.71 and 1.83%); total EFA (25.50 and 40.51%), respectively. The total phospholipids present in the pulp and seed were 851.47 and 117.30 mg/100 g, respectively. The concentrations of phytosterols were of low values except in sitosterol (373.55 and 37.79 mg/100 g) and stigmasterol (45.61 and 5.59 mg/100 g) for the pulp and seed samples, respectively. **Conclusion:** The result revealed that the seed sample was richer in EFA and PUFA/SFA ratio compared to that of pulp while the values recorded for phosphatidylserine for the two samples were too low and do not meet USFDA standard.

Key words: Avocado, pulp, seed, health, fatty acids, phospholipids, phytosterols

Citation: Aremu, M.O., M.A. Odey, L. Labaran, C.C. Nweze, R.B. Salau and S.C. Ortutu, 2020. Health effect of lipid components extracted from avocado pear (*Persea americana*) pulp and seed. Trends Med. Res., 15: 14-21.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

A large number of plant species are cultivated worldwide as ornamentals, living fences and firebreaks. Plants serve as a primary source of food, fiber, medicines, shelters and other items used in everyday life by humans with roots, stems, leaves, flowers, fruit and seeds providing food for humans[1,2]. They serve as an indispensable constituent of the human diet supplying the body with mineral salts, vitamins and certain hormone precursors, in addition to protein and energy[3]. Nutritive and calorific values of seeds make them necessary in diets[4]. They represent a major direct source of food for man and livestock and make a critical contribution to the increased food security of subsistence farmers. In time past, food insecurity was a fundamental problem confronting most developing countries of the world. Access to adequate food has been a challenge because of the high level of poverty in developing nations of the world. As a result of this, there are concerted efforts to improve food production in some of these countries, but the populace still suffers from malnutrition due to certain constrained factors[5]. Research has shown that compared with individuals who eat less than three servings of fruits and vegetables each day, those that eat more than five servings have approximately 20% lower risk of developing CVD or stroke[6]. Since good nutrition is a basic human right, there is a need for the exploitation of available local resources in order to satisfy the needs of the increasing population in developing countries which is characterized by abject poverty. Studies on wild edible fruits and vegetables indicate that they are good sources of human nutrition since they contain essential minerals and vitamins in addition to proteins, fibers, fats and carbohydrates which are very significant for healthy growth and development of the human body[7,8].

Avocado (*Persea americana*) fruit has great nutritional importance as a source of carbohydrate, protein and fiber and it contains essential micronutrients for human consumption such as vitamins, minerals and polyphenols[9,10]. The consumption of 3-4 fruit portions per day is recommended. The regular consumption of fruit[11] has been associated with the reduction of degenerative, cardiovascular[12,13] and circulatory diseases[14]. These effects have been attributed to the presence of phenolic compounds such as flavonoids, especially in fruit peels, which have antioxidant properties[15]. There is a lack of knowledge about fruit and vegetable nutrients, as well as their skins and stems, generating waste in tons that could be used as food. The same true for the avocado, because tons of this fruit, discard in trash in Brazil. The oil of avocado has medicinal properties[16] and its peel contains a significant amount of minerals, in addition to compounds that prevent lipid oxidation[17].

The objective of this study was to assess the levels of fatty acids, phospholipids and phytosterols of avocado pear (*Persea americana*) pulp and seed and health implications of these components in human consumption.

MATERIALS AND METHODS

Sample collection: The fresh samples of ripe avocado pear (*Persea americana*) were purchased from New Market Wukari in Wukari local government area, Taraba Sate, Nigeria in the month of January, 2019. The samples were identified by an Agronomist in the Department of Crop Production, Federal University Wukari, Nigeria.

Sample treatment: The succulent fleshy part of *Persea americana* was washed in distilled water and sliced with a sterilized kitchen knife to separate the pulp from the seed. The samples were then placed on two separate trays and sun-dried for five days. During this sun-drying, the samples were covered with fine meshes to trap particles of dirt or foreign bodies that may contaminate them. The dried samples of both pulp and seed of *Persea americana* were further oven-dried (between 75 to 105°C) in the laboratory to constant weight for 72 hrs in order to completely get rid of any moisture. These moisture-free samples were first pounded using pestle and mortar then ground with a grinder, sieved through a sieve of size 0.5 µm and stored in two separate well labeled air-tight plastic containers before finally taken to the laboratory for analyses.

Extraction of oils: The method described by Aremu *et al.*[18] is employed. The extraction flask of 250 mL capacity was dried in the oven at 105°C, transferred to the desiccator to cool to the laboratory temperature and the weight of the flask was measured. About 2.0 g of the sample was weighed into the labeled porous thimble. 200 mL of the petroleum ether was measured and then added to the dried 250 mL extraction flask. The covered porous thimble with the sample was placed in the condenser of the Soxhlet extractor arrangement that has been assembled. The sample was extracted for 5 hrs. The porous thimble was removed with care and the petroleum ether in the top container (tube) was collected for the recycling for reuse. The extraction flask was removed from the heating mantle arrangement when it was almost free of petroleum ether. The extraction flask with the oil was oven-dried at 105°C for a period of 1 h. The flask containing the dried oil was cooled in the desiccator and the weight of the cooled flask with the dried oil was measured.

Preparation and analysis of fatty acid methyl esters: The extracted fat content (50 mg) of the sample was saponified (esterified) for 5 min at 95°C with 3.4 mL of the 0.5 M KOH in dry methanol. The mixture was neutralized by using 0.7 M HCl. 3 mL of the 14% boron trifluoride in methanol was added. The mixture was heated for 5 min at the temperature of 90°C to achieve the complete methylation process. The fatty acid methyl esters were extracted from the mixture with redistilled n-hexane in triplicate. The content was concentrated to 1 mL for GC analysis and 1 µL was injected into the injection port of GC. The injection port and the detector were maintained at 310°C and 350°C, respectively while the initial column temperature was 250°C rising at 5°C/min to a final temperature of 310°C. A polar (HP INNO Wax) capillary column (30 m ' 0.53 mm ' 0.25 µm) was used to separate the esters. The peaks were identified by comparison with standard fatty acid methyl esters obtained from Sigma Chemical Co. (St. Louis MO, USA). However, the quantitative evaluation was carried out on the base of GC peak areas of the different methyl esters. The heptadecanoic ester was used to calculate the response factor for FAs which was found to be 0.96. Three (3) determinations were made for each sample[18].

Phospholipids analysis: The modified method of Aremu *et al.*[18] was employed in the analysis of the extracted oil for phospholipids content determination. The extracted fat (0.01 g) was added to the test tubes. To ensure complete drying of the oil for phospholipids analysis, the solvent was completely removed by passing the stream of the nitrogen gas on the oil. 0.4 mL of chloroform was added to the content of the tube and it was followed by the addition of 0.10 mL of the chromogenic solution. The content of the tube was heated at the temperature of 100°C in a water bath for about 1 min 20 sec. The content was allowed to cool to the laboratory temperature and 5 mL of the hexane was added and the tube with its content shaken gently several times. The solvent and the aqueous layers were allowed to be separated. The hexane layer was recovered and allowed to be concentrated to 1.0 mL for GC analysis using the pulse flame photometric detector[18].

Phytosterol analysis: The phytosterol extraction and analysis were carried out by following the modified method AOAC 994.10 and AOAC 970.51 Official Methods[19]. About 5.00 g of the powdered sample was weighed and transferred to a stoppered flask and treated with petroleum ether until the powder was fully soaked. The flask shaken every hour for the first 6 hrs and then it was kept aside and shaken after 24 hrs. This process was repeated for three days and then the extracted was filtered. The extract was collected and evaporated to dryness by using a nitrogen stream. 0.5 g of the extract of the sample was added to the screw-capped test tube. The sample was saponified at 95°C for 30 min by using 3 mL of 10% KOH in ethanol to which 0.20 mL of benzene had been added to ensure miscibility. 3 mL of de-ionized water was added and 2 mL of hexane was used in extracting the non-saponifiable materials e.g. sterols. Three extractions, each with 2 mL of hexane were carried out for 1 h, 30 min and 39 min respectively to achieve complete extraction of the sterols. The hexane was concentrated to 2 mL in an Agilent vial for gas chromatography analysis[18].

Statistical evaluation: The descriptive statistical analysis done was the determination of mean, standard deviation and coefficient of variation percent.

RESULTS AND DISCUSSION

The results of the fatty acid composition of *P. americana* indicate that both the pulp and seed oils have a high content of oleic acid (C18:1) of 39.84 and 35.76%, respectively (Table 1). Palmitic acid (C16:0) was found to be the predominant saturated fatty acid (SFA) in the oil samples with values of 18.759% (pulp) and 11.744% (seed). Palmitic and stearic were the third and forth concentrated fatty acids in both the pulp and seed samples. The value of palmitic acid (18.759 in pulp and 11.744% in seed) and stearic acid (11.856 in pulp and 7.153% in seed) are greater than the reported fatty acid composition in *Buchholzia coriacea* (11.241 and 6.734%)[8], *Artocarpus altilis* (11.412 and 4.723%)[8], raw tiger nut (12.96 and 4.35%)[20] and shea kernel (12.07 and 3.07%)[21] but lower than that of Bambara groundnut (22.38 and 11.20%)[22].

Table 2 presents the distributions of results into TSFA, TMUFA, TPUFA TUFA, TEFA, oleic to linoleic (O/L) and linoleic to α - linolenic. It was generally observed that the percentage of both unsaturated and essential fatty acids in pulp oil was lower than that of the seed oil, whereas the percentage of saturated fatty acid in pulp is higher than that of the seed sample. TSFA was 33.74% in pulp and 22.29% in seed of *P. americana*. These values are lower than TSFA value of 54.51% reported for dehulled African yam been[23] but higher than *B. eurycoma* (17.06)[24] but comparable with *Adenanthera pavonina* (31.98%)[4]. The most abundant PUFA was linoleic acid, C18:2) in both samples.

The phospholipids content of *P. americana* pulp and seed oils are shown in Table 3. From the result, the pulp oil

Table 1: Fatty acid composition of pulp and seed of avocado (*Persea americana*)

Fatty acid (%)	Pulp	Seed	Mean	SD	CV (%)	P-S	Difference (%)
Caprylic acid (C8:0)	0.004	0.010	0.01	0.00	42.86	-0.01	150.00
Lauric acid (C12:0)	0.062	0.167	0.12	0.05	46.09	-0.11	169.36
Myristic acid (C14:0)	0.474	0.991	0.73	0.26	35.33	-0.52	109.07
Palmitic acid (C16:0)	18.759	11.744	15.25	3.51	22.99	+7.02	37.40
Palmitoleic acid (C16:1)	0.386	0.795	0.59	0.21	34.69	-0.41	105.96
Margaric acid (C17:0)	0.221	0.413	0.32	0.10	30.28	-0.19	86.88
Stearic acid (C18:0)	11.856	7.153	9.52	2.35	24.75	+4.70	39.67
Oleic acid (C18:1)	39.841	35.760	37.80	2.04	5.40	+4.08	10.24
Linoleic acid (C18:2)	25.018	39.152	32.09	7.07	22.03	+14.13	56.50
α -linolenic acid (C18:3)	0.485	1.358	0.92	0.44	47.40	-0.87	180.00
Arachidic acid (C20:0)	1.913	0.873	1.39	0.52	37.33	+1.04	54.37
Arachidonic acid (C20:4)	0.132	0.356	0.24	0.11	45.90	-0.22	169.70
Behenic acid (C22:0)	0.103	0.271	0.19	0.08	44.92	-0.19	163.11
Erucic acid (C22:1)	0.403	0.289	0.35	0.06	16.47	+0.11	28.29
Lignoceric acid (C24:0)	0.343	0.668	0.51	0.16	32.21	-0.33	94.752
Total	100	100					

SD : Standard deviation, CV: Coefficient of variation, P: Pulp, S: Seed

Table 2: Quality parameter of pulp and seed of avocado pear (*Persea americana*)

Parameter (g/100 g)	Pulp	Seed	Mean	SD	CV (%)	P-S	Difference (%)
Total SFA	33.74	22.29	28.01	5.72	20.43	+11.45	33.93
Total MUFA	40.63	36.84	38.74	1.90	4.91	+3.79	9.32
Total PUFA	25.64	40.87	33.25	7.62	22.91	-15.23	59.42
DUFA	25.02	39.15	32.09	7.07	22.03	-14.13	56.50
Total UFA	66.27	77.71	38.98	1.78	4.57	+3.56	8.74
MUFA/SFA	1.20	1.65	1.43	0.23	15.75	-0.45	37.29
PUFA/SFA	0.71	1.83	1.27	0.56	44.18	-1.12	158.17
Total EFA	25.50	40.51	33.01	7.50	22.74	-15.01	22.74
O/L	1.59	0.91	1.25	0.36	28.81	+0.68	42.65

SD: Standard deviation, CV: Coefficient of variation, P: Pulp, S: Seed, SFA: Saturated fatty acid, MUFA: Monounsaturated fatty acid, SFA: Saturated fatty acid: MUFA: Monounsaturated fatty acid, UFA: Unsaturated fatty acid, TEFA: Essential fatty acid, O/L: Oleic/Linoleic ratio, PUFA: Polyunsaturated fatty acid; P/S = Polyunsaturated fatty acid

Table 3: Phospholipid composition of pulp and seed of avocado pear (*Persea americana*)

Phospholipid (mg/100 g)	Pulp	Seed	Mean	SD	CV (%)	P-S	Difference (%)
Phosphatidylethanolamine (PE)	289.77	26.14	157.96	131.82	83.45	+263.63	90.98
Phosphatidylcholine (PC)	379.46	11.29	195.38	184.08	94.22	+368.17	97.02
Phosphatidylserine (PS)	10.25	18.71	14.48	4.23	29.22	-8.46	82.54
Lysophosphatidylcholine (LC)	3.12	8.35	5.74	2.62	45.67	-5.23	167.63
Sphingomyelin (SM)	$6.49e^{-3}$	$2.38e^{-2}$	0.02	$9.92e^{-3}$	49.60	-0.02	266.72
Phosphatidylinositol (PI)	143.76	43.64	93.70	50.06	53.48	+100.12	69.64
Phosphatidic acid (PA)	25.11	9.16	17.14	7.98	46.54	+15.95	63.52
Total	851.48	117.31	484.42	378.18	402.18	761.58	936.03

SD: Standard deviation, CV: Coefficient of variation, P: Pulp, S:Seed

contained the highest concentration of total phospholipids, 851.48 mg/100 g as compared to 117.31 mg/100 g for seed oil. Phosphatidylcholine (PC) and phosphatidylethanolamine (PE) had the highest value of 379.46 and 289.77 mg/100 g in the pulp sample, respectively. Phosphatidylinositol (PI) also showed a greater concentration with the value of 143.76 mg/100 g in pulp sample. The values of PE, PC and PI in the pulp are far greater than that of seed with percentage differences of 90.98, 97.02 and 69.64, respectively. These three phospholipids are important lipids and integral components of the lipoproteins especially the high density lipoprotein[25].

The results of phytosterols are in agreement with that recorded for many oils where β-sitosterol (373.55% and 37.79%) constitute the major phytosterol followed by stigmasterol (45.61 and 5.59%)[20,26]. In the same way, the total phytosterols (468.09 mg/100 g) for pulp of *P. americana* is similar to those of other edible oils[27,28]. This result showed that the pulp of *P. americana* can be regarded as a better source of phytosterols when compared to its seed (Table 4). The total phytosterol concentrations of the studied samples were 468.09 and 55.32 mg/100 g for pulp and seed oils, respectively. Pulp sample was more concentrated in all the

Table 4: Phytosterol composition of pulp and seed of avocado pear (*Persea americana*)

Phytosterol (mg/100 g)	Pulp	Seed	Mean	SD	CV (%)	P-S	Difference (%)
Cholesterol	$1.41e^{-4}$	$6.71e^{-5}$	$1.04e^{-4}$	$3.69e^{-5}$	35.48	$+7.39e^{-5}$	52.41
Cholesterol	$4.68e^{-4}$	$4.71e^{-4}$	$4.70e^{-4}$	$1.58e^{-6}$	0.34	$-3.00e^{-6}$	0.64
Ergosterol	$2.59e^{-5}$	$1.16e^{-5}$	$1.89e^{-5}$	$7.15e^{-6}$	37.83	$+1.43e^{-5}$	55.21
Campesterol	38.67	9.37	24.02	14.65	60.99	+29.30	75.77
Stigmasterol	45.61	5.59	25.60	20.01	78.16	+40.02	87.74
5-avenasterol	10.26	2.57	6.42	3.85	59.97	+7.69	74.95
Sitosterol	373.55	37.79	205.67	167.88	81.63	+335.76	89.88
Total	468.09	55.32	261.71	206.39	354.40	412.77	436.60

SD: Standard deviation, CV: Coefficient of variation, P: Pulp, S: Seed

avocado sterols than the seed oil. The concentrations of stigmasterol (5.59%), sitosterol (37.79%) and campesterol (9.37%) in the seed sample are greater than that of raw sample of tiger nut (1.34, 17.21, $9.39e^{-3}$%)[20], respectively. This is in agreement with a report that stigmasterol, sitosterol and campesterol are the most abundant plant phytosterols[29].

The linoleic acid (C18:2) value in both samples (25.018% and 39.152%) are comparable with *Brachystegia eurycoma*[24]. The value of (C18:2) in the seed (39.152%) is greater than that of pulp (25.018%) by 56.50% while the value of alpha-linolenic acid (C18:3) in seed (1.358%) is higher than that of pulp (0.485%) by 180.0% (Table 1). Linoleic acid plays a significant role in the skin. The ALA and LA have critical roles in the membrane structure and as precursors of eicosanoids, which are highly reactive compounds and potent. Since they compete for the same enzymes and have different biological roles, the balance between the LA and ALA fatty acids in the diet can be of considerable importance[30]. The CV (%) is highly varied and ranged from 5.40 in (C18:1) to 47.40 in (C18:3). Lignoceric, behenic, margaric, myritic, lauric and caprylic acids are all saturated fatty acids that were present in small quantities with none of them recording up to 1.0% in both samples. The % difference of caprylic acid content between the pulp and seed in this study was 150 in favour of seed (Table 1). Therefore, as the seed oil contained higher PUFA than the pulp oil, it is clear that the cholesterol of the pulp oil could be very low and this will make it very useful for food preparation to reduce the incidence of heart attack (atherosclerosis) caused by high intake of cholesterol. The total EFA in seed (40.51%) is much higher than TEFA in rice, sorghum, millet[31] and Bambara groundnut[22]. The P/S index ratio is higher than that of seed oil. The total unsaturated fatty acids (TUFA were 77.71% in seed and 66.07% in pulp oils. The extracted oil from the pulp sample contained high concentration of MUFA, PUFA, TUFA, TEFA and O/L (%) which differ positively or negatively by 9.32%, 59.42%, 8.74% and 22.74%, respectively; from that of the seed oil, while the TSFA of the seed oil sample varies by 33.93% from the pulp sample (Table 2).

The inositol phospholipids (such as phosphatidylinositol) are the main source of diacylglycerols that serve as signaling molecules in animal and plant cells, through the action of a family of highly specific enzymes collectively known as phospholipase C. They regulate the activity of a group of at least a dozen related enzymes known as protein kinase C, which in turn control many key cellular functions, including differentiation, proliferation, metabolism and apoptosis. In addition to that, inositol phospholipid plays an important part in protein regulation and interfacial binding at the cell interface[32].

In animal and plant lipids Phosphatidylethanolamine (PE) is the second most richly available phospholipid[8,33]. The PE values were 289.77 mg/100 g in pulp and 26.14 mg/100 g in seed samples. In animal tissues, PE is especially important in the sarcolemmal membranes of the heart during ischemia, it has functions in membrane fusion and fission and it is involved in secretion of the nascent very-low-density lipoproteins from liver. It also has a functional role in the Ca^{2+}-ATPase in that one molecule of PE is bound in a cavity between two trans-membrane helices, acting as a wedge to keep them apart. This is displaced when Ca^{2+} is bound to the enzyme[34]. Phosphatidylserine (PS), lysophosphatidylcholine (LC) and sphingomyelin (SM) were the minor phospholipids with concentrations ranging between $6.49e^{-3}$ to 10.25 mg/100 g in pulp and $2.38e^{-2}$ to 18.71 mg/100g in the seed. Notwithstanding its capacity as a part of cell films and as an antecedent for different phospholipids, PS is a basic cofactor that ties to and actuates an enormous number of proteins, particularly those with flagging exercises[35]. LC (which is mostly found in trace amounts in most tissues) has pro-inflammatory properties and it is known to be a pathological component of oxidized lipoproteins (LDL) in plasma and of atherosclerotic lesions; it has been shown to promote

demyelination in the nervous system. Recently, specific phospholipase C is activated by lysophosphatidylcholine that is responsibly for releasing inositol triphosphate along with diacylglycerols having an increase in intracellular Ca^{2+} with protein kinase C activation and mitogen-activated protein kinase in different cell types[36]. The CV% varied from 29.22 in PS to 94.22 in PC (Table 3).

Phytosterols are normal parts of plant root, shaping cell film and happen in little amounts in numerous organic products, vegetables, seeds, nuts, vegetables, grains, vegetable oils and different plants. They are plentifully present in the fat solvent portions of the considerable number of plants and nourishment containing plant based crude materials, including essentially oils, oats, beat and dried organic products[22]. Sitosterol has the highest concentrations in both pulp (373.55 mg/100 g) and seed (37.79 mg/100 g) while the least concentration was ergosterol in pulp $2.59e^{-5}$ mg/100 g) and seed ($1.16e^{-5}$ mg/100 g). However, pulp has a total higher concentration of 468.09 mg/100 g) compared with that of seed (55.32 mg/100 g) with a percentage difference of 436.6. The coefficient of variation (CV) varied from 0.34% in cholesterol to 81.63 in sitosterol (Table 4). Plant phytosterols have also been described as anti-inflammatory and anti-cancer compounds[37,38]. Daily intake of phytosterols helps to prevent heart disease by lowering HDL cholesterol levels by as much as 14%[39]. Phytosterols have been found useful in treating other conditions such as rheumatoid arthritis, but their widest application is in protecting the heart. However reports also suggest that over the top admission of dietary phytosterols and stanols in plasma and tissues may add to the expanded circulatory strain [40].

Findings from the research work have shown that consumption of *Persea americana* fruit pulp and seed will adequately supply the body essential fatty acids (linoleic and alpha-linolenic) which are required for physiological functions, growth and body maintenance. The two samples are also adequate in phosphatidylethanolamine, phosphatidylcholine and phosphatidic acid which are the phospholipids that serve as regulatory processes in the body system. Some of the regulatory processes are reduction in mental stress and increase in mental accuracy and stress resistance; responses to hormones in biotic and abiotic stress, signaling partway in cell growth and improvement in brain functioning memory capacity. Therefore medicinal formulation using pulp and seed oils in the treatment of hormonal balance, hypertension, cutaneous candidiasis, cardiovascular disease and other disease-related to atherosclerosis is highly recommended. However, further investigation should be carried out on the anti-nutritional and antioxidant properties of the samples which are not covered in this work.

CONCLUSION

The research work focused on the lipid composition of *Persea americana* fruit pulp and seed. The results showed that the total UFA was higher than the total SFA in both the pulp and seed samples; thereby making the fruit fats good for human health. The quality parameters such as MUFA/SFA, PUFA/SFA and O/L were all observed to be good on health-wise basis. The value recorded for phosphatidylserine (PS) (10.25 and 18.71 mg/100 g) for both samples was too low and do not meet the USFDA standards. However, the result of phytosterol composition showed that both samples may be good sources of phytosterol. This study provides an informative lipid profile that will serve as a basis for further chemical investigations and nutritional evaluation of the pulp and seed oils of *Persea Americana* and will also add to the available food composition table.

SIGNIFICANCE STATEMENT

The high content of unsaturated fatty acids in both the pulp and seed samples has shown that consumption of avocado pear (*Persea americana*) will prevent, particularly cardiovascular disease (CVD), cancer and coronary heart disease. Their oils are good sources of dietary phospholipids and phytosterols, in addition to their cholesterol-lowering properties which can potentially serve as anti-inflammatory, anti-atherogenicity and anti-oxidation activities.

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