COMPARATIVE PHYSIOCHEMICAL PROPERTIES AND FATTY ACIDS PROFILE OF SEED OILS OF AVOCADO PEAR AND RIPE PAWPAW

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Abstract

The extracts of avocado and ripe pawpaw seed oils and their physiochemical and gc/ms were obtained. The physiochemical properties shows that pawpaw seed oil has slightly higher fatty acid than avocado seed oil suggesting that the pawpaw seed oil will be more stable to oxidation than avocado seed oil. The iodine values suggest that fatty acids in the oil are saturated acid which will be good for soap making. Their peroxide values are also very low suggesting good auto-oxidation stability and long shelf life. The gc/ms chromatogram indicates that there are twenty nine chemical components in the avocado seed oil and only fourteen components in ripe pawpaw seed oil. The two seed oils have good nutritional qualities and many fatty acids which can be trans- esterified to make both to be good candidates for use as a biofuel. However extensive and expensive cleanup will have to be done on the oils because of the presence of other chemical components in the oil before it can be a good biofuel. Soft ionization gc/ms methods needs to be done to further characterize the components of the seed oil and clean up methods will also be needed for the oil.

Introduction

The avocado pear, *Persea americana M,* is a flowering plant in the family of Lauraceae (Orhevba et al, 2011), The edible part of the avocado pear is its yellow-green flesh, which has a luscious, creamy, buttery consistency and a subtle nutty flavor. Avocados are good source of Vitamin K, dietary fiber, Vitamin B6, Vitamin C, Folate and copper, potassium (they are higher in potassium than a medium banana),

Avocado also contains essential nutrients such as carbohydrates, sugar, soluble and insoluble fiber and also it is also good source of oil containing monounsaturated fat its oil and a rich source of mineral (Batista *et al*, 1993). Avocados have a high fat content of between 71 to 88% of their total calories about 20 times the average for other fruits. High avocado intake has been shown to have a beneficial effect on blood serum cholesterol levels (USDA, 2009). The avocado oil is good nourishment for the skin and is widely used in the cosmetics industry (Le poole, 1995). The nutritional composition of the avocado seed found in the literature is shown in table 1 below (Weatherby, 1934)

Table 1 Composition of Avocado Seed (Water – 50.4%)

Nutritional Component	Wet Basis (%)	Dry Basis (%)
Ash	1.3	2.7

Protein	2.5	5.0
Reducing Sugar	1.6	3.2
Common Sugar	0.6	1.2
Starch	29.6	60.0
Pentosans	1.6	3.3
Arabinose	2.0	4.1
Ether Extract	1.0	2.0
Fiber	3.7	7.2
Undetermined	5.6	11.3

Increase in human population and our new quest for industrialization made it imperative for renewable energy (biofuel) as an alternative to petroleum products. The biofuel must be suitable, acceptable, economically competitive, environmentally acceptable, and easily available. Increasing environmental concern, diminishing petroleum reserves, and agriculture based economy of our country are the driving forces to promote biodiesel as an alternative fuel Biodiesel can be produced by transesterification, which is a catalyzed chemical reaction involving vegetable oil and an alcohol to yield fatty acid alkyl esters (i.e., biodiesel) and glycerol. (Rachimoellah, 2009) The fatty acid composition of avocado seed oil reported so far include Palmitic Acid C16 : 1, Palmitoleic Acid C16 : 1, Stearic Acid C18 : 0, Oleic Acid C18 : 1 7, Linoleic Acid C18 : 2, Linolenic Acid C18 : 3, Arachidic Acid C20 : 0, Eliosenoic Acid C20 : 1, Behenic Acid C22 : 0, Lignoceric Acid C24 : 0 (Anonym Oil, 1987)
Carica papaya (Family Caricaceae) has many biologically active compounds. Two important compounds are chymopapain and papain, which are supposed to aid in digestion (Brocklehurst et al, 1985). The high level of natural self defence compounds in the tree makes it highly resistant to insect and disease infestation (Bouanga-Kalou et al, 2011, Peter, 1991). The seed is used to treat intestinal worms, and it helps to clear nasal congestion (Elizabeth, 1994). In this paper, the physiochemical, chemical fatty acid composition of avocado and ripe pawpaw seed oils will be examined in order to their suitability as a biodiesel fuel.

Result and Discussion

The physiochemical properties reported in the literature and our laboratory is shown Table 2 below. **(**Rachimoellah et al, 2009). The two oils from our laboratory have almost the same specific gravity (0.90) which is comparable to values earlier reported in the literature below **(**Rachimoellah et al, 2009). The color of the avocado seed oil is orange while that of the pawpaw seed oil is pale yellow. Both oils have similar fruity smell. Pawpaw seed oil from our laboratory has higher free fatty acid than that reported in the literature. This might be due to the effect of different geographical location where the pawpaw is grown. Also pawpaw seed oil has slightly higher fatty acid than avocado seed oil suggesting that the pawpaw seed oil will be more stable to oxidation than avocado seed oil. The saponification value of the ripe pawpaw seed oil however is higher than that of the avocado seed oil and much lower than reported in the literature **(**Rachimoellah et al, 2009). The iodine values of the avocado seed oil is about five times higher than the pawpaw seed oil and about half the value reported in the literature **(**Rachimoellah et al, 2009). The values are however low suggesting that the oils are highly saturated and will be a good material for soap making. The peroxide values of the two oils obtained are also very low which suggests that they are stable to auto-oxidation and will have a long shelf life. But that of pawpaw seed oil is much lower than that of the avocado seed oil implying that the pawpaw seed oil will be more stable to auto-oxidation than the avocado seed oil

Table 2 Physiochemical Properties of Avocado and Pawpaw Seed Oil

Physiochemical Property	Avocado (Literature)	Avocado (Our Laboratory)	Pawpaw (Our Laboratory)
Specific Gravity (25^0C)	0.915-0.916	0.91	0.90±0.05
Melting Point (^{0}C)	10.5		
Flash Point	245		
Refractive Index	1.462		
Viscosity	0.357 poise		
Free Fatty Acid	0.367-0.82 %	2.26	3.81±0.12
Saponification (mg/KOH g)	246.840	35.76	49.71±0.075±
Iodine (mg Iodine/g)	42.664	23.5	4.95±0.02
Acid Value (mg KOH/g)	5.20	4.5	1.8±0.012
Ester number	241.6	31.26	48.17±0.01
Peroxide Number(mgO2/g)	3.3	24.0	0.5±0.01
Unsaponifiable Matters	15.250%		
Color		Orange	Pale yellow
Odor		fruity	fruity
% Yield		8.1	33

Figure 1 shows the gas chromatograms of the seed oils of avocado and ripe pawpaw. Figure1a. shows that there are twenty nine chemical components in the avocado seed oil whereas there only fourteen components in that of ripe pawpaw seed oil. The chromatogram are individual components separated in increasing molecular weight similar to what was obtained for PEG dimethyl oligomers in one of our previous papers[12]. Table 3 includes the fatty acid obtained for the two oils by EI gas chromatography/mass spectrometry. The table shows that there are twelve (12) fatty acids in the seed avocado oil and thirteen (13) in red pawpaw seed oil. The fatty acids include C_{15}-C_{23} fatty acids which are more than what is reported in other papers (Anonym Oil, 1987). The EI mass spectra obtained for Pentadecanoic acid, 14-methyl, methyl ester ($C_{17}H_{30}O_2$) Pentadecanoic acid, 14-methyl, methyl ester ($C_{17}H_{30}O_2$) in the two oils is shown in Figure 2. There are other compounds apart from fatty acids present in the two oils. They include sesquiterpene hydroperoxides, terpenes, triterpenes, fatty alcohols, ketones, alkyl aromatic hydrocarbons, glucosides, piperidine analogs and unsaturated long chain alkenes and fragments of unknown high mass compounds (unknown).Soft ionization methods like chemical ionization will be obtained for these two oils to properly identified the components,

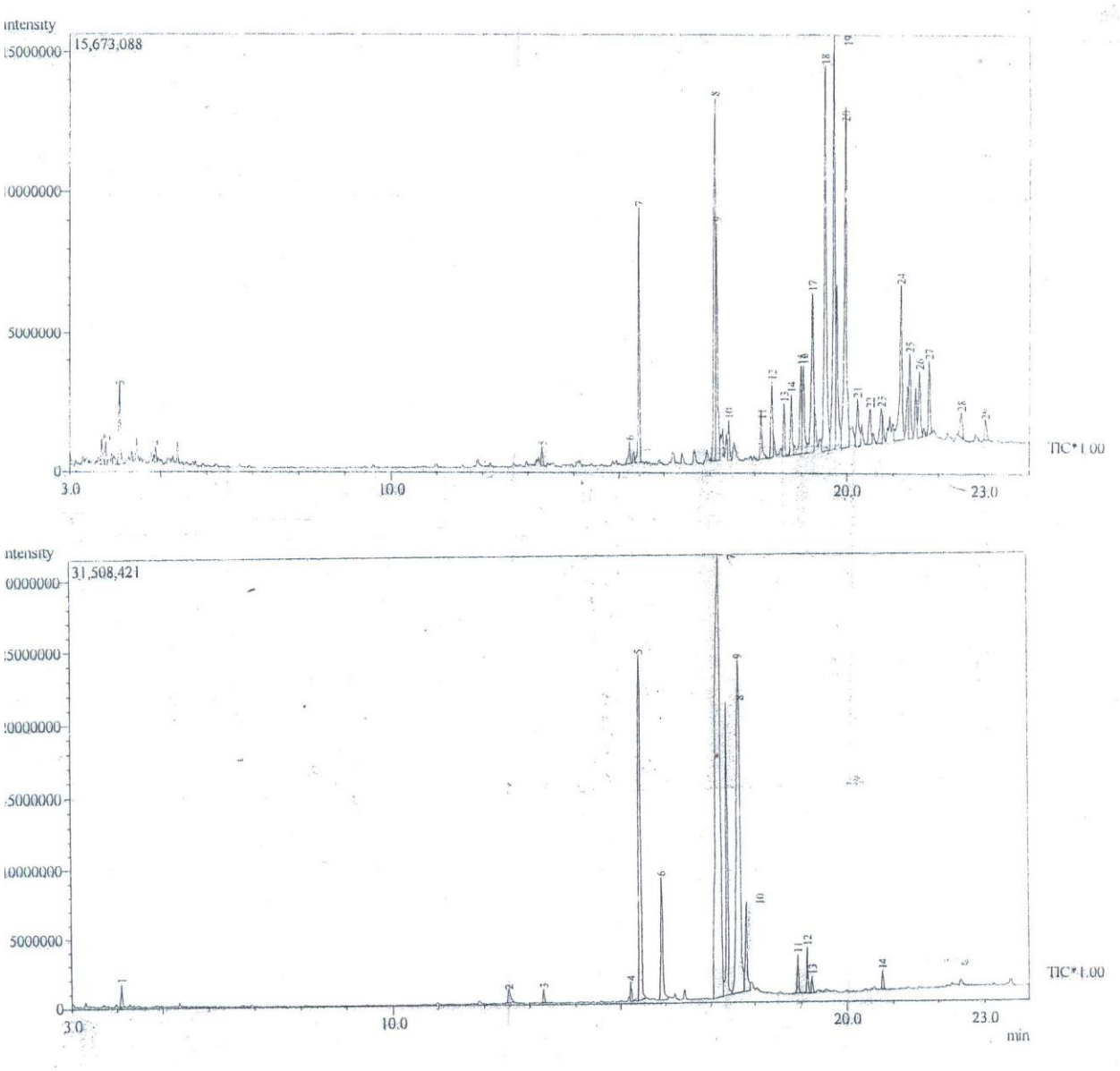

Figure 1 GC/EIMS Chromatogram of (a)Avocado (b) Ripe Pawpaw Seed Oil

Table 3. Fatty Acid Component of Avocado and Ripe Pawpaw Seed Oils

Peak Number	Ret Time (Min)	Components (Avocado Seed Oil)	Peak Number	Ret Time (Min)	Component (Pawpaw Seed Oil (Ripe)
5	13.308	Pentadecanoic Acid ($C_{15}H_{30}O_2$)	3	13.308	Pentadecanoic acid, methyl ester ($C_{15}H_{30}O_2$)
7	15.433	Pentadecanoic acid 14-methyl,methyl ester ($C_{17}H_{34}O_2$)	4	15.225	9-Hexadecenoic acid, methyl ester ($C_{17}H_{30}O_2$)

8	17.092	9,12-Octadecanoic acid methyl ester(Methyl Linolelaidic acid, methyl ester) ($C_{19}H_{34}O_2$)	5	15.458	Pentadecanoic acid, 14-methyl, methyl ester ($C_{17}H_{30}O_2$)
9	17.142	11-Octadecenoic acid, methyl ester) ($C_{19}H_{36}O_2$)	6	25.935	n-Hexadecanoic acid ($C_{16}H_{32}O_2$)
12	18.342	Arachidic ($C_{20}H_{39}O_2$)	7	17.233	11-Octadecenoic acid, methyl ester ($C_{19}H_{36}O_2$)
14	18.775	Docosane ($C_{20}H_{39}O_2$)	8	17.383	Octadecanoic acid, methyl ester ($C_{19}H_{38}O_2$)
15	18.983	Tricosane $(M+H)^+$ ($C_{23}H_{49}$)	9	17.658	Oleic acid ($C_{18}H_{34}O_2$)
18	19.508	n- Hexadecanoic acid $(M-H)^+$($C_{17}H_{35}O$)	10	17.800	Stearic acid ($C_{18}H_{36}O_2$)
21	20.217	(1R,7Z)-1-Methyl-7-Hexadecenyl acetate ($C_{19}H_{37}O_2$)	11	18.933	Oleic acid, isopropyl ester ($C_{21}H_{40}O_2$)
24	21.158	(*Z*)-Docos-13-enoic acid (Euric acid,$C_{22}H_{41}O_2$)	12	19.133	Arachidic acid methyl ester ($C_{21}H_{42}O_2$)
26	21.567	7,10,13,16-docosatetraenoic acid Adrenic Acid ($C_{22}H_{35}O_2$)	13	19.242	11-Octadecenoic acid, methyl ester ($C_{19}H_{36}O_2$)
29	23.01	Oleic acid fragment ($C_{18}H_{33}O_2$)	14	20.767	Hexadecanoic acid($C_{20}H_{39}O_2$)
			14	20.767	Hexadecanoic acid($C_{20}H_{39}O_2$)

Table 4 Other Chemical Components Present In Avocado and Ripe Pawpaw Seed Oils

Peak number#	**Ret Time (Min)**	**Components (Avocado Seed Oil)**	**Ret Time (Min)**	**Component (Pawpaw Seed Oil (Ripe)**
1	3.700	Benzene, 1-ethyl-2methyl (C_9H_{12})	4.092	S)-1-piperideine-6-carboxylate ($C_6H_8NO_2$)
2	3.700	Benzene, 1,23- trimethyl (C_9H_{12})	12.542	Geijerone(3-Isopropenyl-4-methyl-4-vinylcyclohexanone ($C_{12}H_{21}O$)
3	4.100	Benzene, 1,2,3 trimethyl Isomer (C_9H_{12})		
4	4.883	3,7,7 trimethyl 1,3,5, cycloheptatriene, ($C_{10}H_{14}$)		

6	15.225	**(**Sesquiterpene hydroperoxides $C_{15}H_{25}O_2$) 10α-hydroperoxyguaia-1,11-diene		
10	17.408	Unknown ($C_9H_{11}O$)		
11	18.133	Unknown ($C_8H_{17}O$)		
13	18.617	Unknown ($C_{19}H_{37}O$)		
16	19.033	(E)-3,7,11,15- Tetramethylhexadecan -1-ol ($C_{20}H_{39}O$)		
17	19.233	(E)-3,7,11,15- tetramethylhexadec-2-en-1-ol ($C_{20}H_{37}O$) (E)-3,7,11,15-		
19	19.700	12-Tricosanone (M+H) ($C_{23}H_{46}OH$)		
20	19.958	9,12,15-Octadecatrien -1- ol ($C_{18}H_{32}O$)		
22	20.492	Unknown ($C_{19}H_{37}O$)		
23	20.733	p-Coumaroyl glucose , $[M-H]^+$ ($C_{21}H_{41}O_2$)		
25	21.358	Unknown ($C_{21}H_{43}O_2$)		
27	21.783	Unknown ($C_{23}H_{37}O_2$)		
28	22.492	Unknown ($C_{23}H_{31}O_2$)		

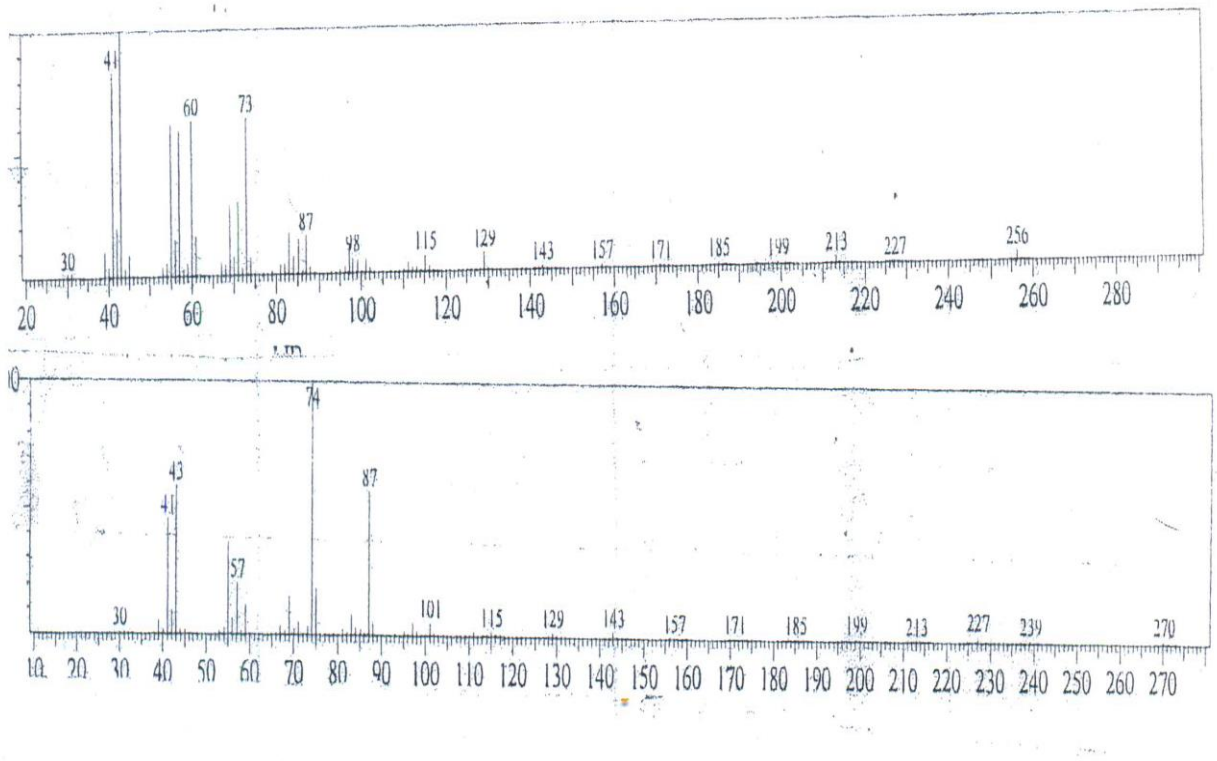

Figure 2 GC/EIMS spectra of Pentadecanoic acid, 14-methyl, methyl ester ($C_{17}H_{30}O_2$) from (a) Avocado seed oil and (b) Ripe Pawpaw seed oil

CONCLUSION

The two seed oils have good nutritional qualities and many fatty acids which can be trans-esterified to make both to be good candidates for use as a biofuel. However extensive and expensive cleanup will have to be done on the oils because of the presence of other chemical components in the oil before it can be a good biofuel. Pawpaw seed oil from our laboratory has higher free fatty acid than that reported in the literature which may be due to the effect of different geographical location where the pawpaw is grown. Also pawpaw seed oil has slightly higher fatty acid than avocado seed oil suggesting that the pawpaw seed oil will be more stable to oxidation than avocado seed oil. The iodine values of the two oils suggest that their acids are saturated acid and will be good for soap making. The peroxide values of the two oils are very low suggesting good auto-oxidation stability and long shelf life. The gc/ms shows that there are twenty nine chemical components in the avocado seed oil and only fourteen components in ripe pawpaw seed oil

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