International Journal of Chemical Science Online
ISSN: 2523-2843, Print ISSN: 2523-6075 Impact
Factor: RJIF 5.22
www.chemicaljournals.com
Volume 2; Issue 5; September 2018; Page No. 32-40

Synthesis of alkyd resin via alcoholysis-polyesterification process using modified avocado seed oil as a potential source of raw material

Ezeugo JO[1*], Nwabueze CE[2], Aduba CA[3], Ezennagiego EE[4], Iloh EO[5]
[1-4] Department of Chemical Engineering, Chukwuemeka Odumegwu Ojukwu University, Anambra, Nigeria
[5] Department of Pure and Applied Chemistry, Chukwuemeka Odumegwu Ojukwu University, Anambra, Nigeria

Abstract

In this study, the avocado seed oil contents were synthesised according to the alcoholysis-polyesterification process and the fatty acid profile of the raw oil was evaluated using GC-MS while structural elucidation of the raw avocado seed oil (ASO), desaturated ASO and ASO based resin were evaluated using FTIR. The physio-chemical properties of crude Avocado seed modified oil showed that the neutralization process reduced the FFA content of crude oil from 1.85 to 1, with a refractive index of 1.461 from 1.441, acid value increases from 3.92 to 6.28 mg KOH/g, saponification value varied from 38.23 to 143.61. The iodine value showed an astronomical increase from 39.3 g I_2/100g to 125.5 g I_2/100g. Results obtained show that the polyester- based ASO has high drying speed in presence of drying agent. It exhibited excellent adhesion and abrasion qualites and can be used for alkyd resin synthesis.

Keywords: avocado seed oil, Alkyd resin synthesis, alcoholysis-polyesterification, polyester- based

Introduction

The uses of renewable resources in different fields of applications of polymers have been proliferating day by day because of increased worldwide awareness of environmental concerns and depletion of world oil pool (Aigbodion and Okeimen, 2001) [1] Naturally, renewable resources possess many advantages such as availability of feedstock, environment friendly nature, and low cost (Akpabio *et al*., 2011; Aigbodion *et al*., 2001) [2, 3]. The vast forest resources and farmlands in Nigeria yield a variety of oil-bearing seeds. A number of seed oil have been used for the synthesis of various polymeric resins like polyester, epoxy, polyurethane, polyester amide, etc (Boruah *et al*., 2012) [4]. Major seed oil used traditionally for preparation of such resins are linseed, castor, soyabean, sunflower, safflower, tung, coconut, etc. These resins have been used in different fields of application such as paint, coating, adhesives, binder for composites,

Avocados are commercially valuable and are cultivated in tropical Mediterranean climates throughout the world. They have green-skinned, fleshy body that may be pear-shaped, egg-shaped, or spherical. Avocado trees are partially self-pollinating and are propagated through grafting to maintain a predicted quality and quantity of the fruit.

(Gogte α Dabhade,1981) [5]. According to Aigbodion and Okieimen (2001) [15], they are essential raw materials for the manufacture of different types of surface coatings, where they act as binders. In the surface coating industry, the use of vegetable oils in the manufacture of oil modified alkyd resin is common and enormous. Presently, increasing shortage and escalating costs of conventional vegetable oils used in coatings which have partly been responsible for the increases recorded in the cost of finished coating products such as paints and varnishes have forced alkyd chemists to look for alternative but cheaper source of vegetable oils for the surface coating industry (Hlaing α Mya,2008) [6]. The oil chosen for the production of alkyds usually has a profound effect on the properties of the

amount of saturated bond that presumably contribute to their non-dryings properties (Okeimen α Aigbodion,1997 ; Okolie,2012) [15, 16]. This is a major impediment for their use in alkyd resin production. In this research, therefore, an finished alkyds [7, 8, 9] studied on the utilization of Hura crepitane. seed oil in the preparation of alkyd resin, Ikhuoria α Maliki (2008) [11] studied production and characterisation of castor oil-modified alkyd resins, studied synthesis and characterization of palm oil based air drying alkyd resin for surface coatings. To the best of our knowledge there is no literature on the production of alkyd resin from avocado seed oil.

Avocado seed oil have been found to be a sustainable material for alkyd resin synthesis in terms of its marchable,physico-chemical properties,availability, renewability and biodegradability (Menkiti.α Onukwuli; Odetoye *et al*., 2012; Ogunniyi α Odetoye,2008) [12, 13, 14] Avocado seed oil, however, contains reasonable attempt was made to produce alkyd resin from avocado seed oil, using movative approach and realistic condition.

Materials and methods

Materials

Avocado was purchased at Eke Uke market in Idemili North Local Government Area of Anambra state,Nigeria. The pulp was dehulled to obtain the seed. The seeds were sun dried for one week followed by oven drying for two days at temperatures between 70 and 80°C to reduce the moisture content. The dried seeds were milled and the oil extracted by the solvent method using soxhlet extractor. The Avocado seed oil obtained was refined to remove the undesirable impurities by degumming, bleaching, and alkali refining.

Phthalic anhydride (Aldrich), maleic anhydride (Aldrich) and lead monoxide (S.D Fine Chem. Ltd) were commercial grade reagent and used without further purification. Methyl-ethyl ketone peroxide and cobalt-octoate (Aldrich), glycerol and phenolphthalein (Qualigen fine chemicals) were used as received. All the solvents were purified before using by standard method.

Instruments and Methods

The fatty acid profile of the oil were determined with a thermo finnigan trace GC/Trace DSQ/A1300,(E.I Quadropole) equipped with a SGE-BPX5 MS fused silica capillary column (film thickness 0.25μm). For GC –MS detection and an electron ionization system with ionization energy of 700eVwas used. Carrier gas was helium at a flow rate of 10ml/min. Injector and mass transfer line temperatures were at 220^0C and 290^0C respectively. The oven temperature was programmed from 50^0C to 150^0C at 3^0C/min, then held isothermal for 100 min and raised to 250^0C at 10^0C/min. Diluted samples (1/100, v/v, in methylene chloride) of 1.00μL were injected manually in the slitless mode. The identification of the individual component was based on the comparison of their relative retention times with those of authentic samples on SGE- BPX5 capillary column and by matching their mass spectral of peaks with those obtained from authentic samples and / or the wiley 7N and TRLIB libraries spectra and published data. The chemical compositions of the oils and their alkyds were confirmed by SHIMADZU FTIR-84008. Viscosity was determined by Brookfield viscometer RVT Model (Spindle 3, RPM20). The physio-chemical properties of the oil were determined by standard methods (ASTM,1973).

Characterization of the avocado seed oil

After refining, some physicochemical properties namely Acid value, Peroxide value, Saponification value, Iodine value, Specific gravity, Viscosity, Refractive index, Moisture content, Ash content and Free fatty acid as well as the fatty acid composition and various pear seed oil samples (crude, neutralized, epoxidized, hydroxylated and dehydrated oil) were determined. The specific gravities were determined using specific gravity bottles at 32^0C while viscosity was determined using suspended level viscometer (type BS/IP/SL). Viscometer flow times are proportional to kinematic viscosity, therefore, the flow times were multiplied by a viscometer constant. Refractive index was determined using a refractometer. The fatty acid composition and functional group present in the oil were determined using GC-MS and FT-IR spectrometer respectively. Drying test was conducted using the ASTM standardized test (ASTM, 1994). The test was performed for surface dry (set-to-touch) and tack-free conditions.

Synthesis of aso oxy-polymerizable alkyd resin

In the progress of the polycondensation reaction, the synthesis of alkyd macromer, was monitored by periodic checking of the acid number of the reaction mixture. A known amount of the sample was dissolved in ethanol–toluene (1:1) and titrated with standardized potassium hydroxide solution using phenolphthalein as indicator. This was according to standard test method ASTM D1980-87. Polyesterification was conducted by heating a mixture of monoglyceride mixture and phthalic anhydride/and maleic anhydride according to the specified formulation and the product obtained from the alcoholysis step until the acid value dropped to about 10. This shows that the acid value decreases gradually with time. The use of maleic anhydride as a polybasic acid introduces an additional complexity to the formulation of an alkyd resins.

Chemical modification of ASO (*desaturation*)

The raw ASO was chemically modified (desaturation) according to the method proposed in (Odetoye *et al.*, 2012) [13].

Alkyd Resin Synthesis

Four different alkyds were prepared with ASO using calcium carbonate as catalyst according to the formulations shown in Table 1. Alkyd-A was prepared from the refined unmodified ASO, Alkyd-B was prepared from modified ASO and phthalic anhydride PA only while Alkyd-C to D was prepared from the modified ASO with varying concentration of phthalic anhydride and maleic anhydride MA table 1. The reactions were carried out in a four necked round bottom flask titled with a motorized stirrer, a dean-stark trap titled with water-cooled condenser and nitrogen in let tube at a temperature of 220-260^0C. Xylene was employed as an azeotropic solvent. During alcoholysis, the triglycerides of ASO were converted to monoglycerides by reaction with glycerol at 180–200°C. PA, glycerol and xylene were then added, and polymerization was carried out at 220–260 °C for more than six hours. The required MA was then added to complete the reaction F. The concentrations of alkyd solutions were determined and finally diluted to 70–75% by addition of xylene.

Table 1: Formulation of the preparation of ASO modified alkyd resin

Resin type	Oil length (%)	Glycerol (g)	PbO (g)	PA (g)	MA (g)
Alkyd-A	50	50	1	50	----
Alkyd-B	50	50	1	50	----
Alkyd-C	50	50	1	25	25
Alkyd-D	50	50	1	12.5	37.5

Results and Discussion

Characteristics of Crude and Modified ASO

The physio-chemical properties of crude modified ASO are shown in Table 2. It can be seen that the neutralization process reduced the FFA content of crude ASO from oil from 1.85 to 1, with a refractive index of 1.461 from 1.441. In neutralization process, the free fatty acid content of oil was converted to oil soluble soaps. Traces of impurities like proteins/proteins fragments, phosphotides and gummy or mucilaginous substances were also removed by the neutralization process. The acid value increases from 3.92 to 6.28 mg KOH/g.

Of particular interest is the changes observed in the properties of the oil as it went through the various modification procedure (epoxidation, hydroxylation and dehydration) to obtain a chemically modified oil. At first, there was increase in the density through epoxidation and hydroxylation, but a seemingly decrease in density after dehydration. The increase in density during epoxidation and hydroxylation indicated increase in mass per unit volume of the oil sample which could be attributed as a result of the reduction of low molecular weight, free fatty acid content in the oil and inclusion of oxygen atom in the fatty acid structure.

The increase in acid value and the decrease in density of the ASO may be attributed to loss of water molecules.

Moreover, the acid value increase during the chemical modification step could be as a result of competing side reactions such as hydrolysis of triglycerides to free fatty acids due to presence of mineral acid (H_2SO_4) during the epoxidation process. The colour of the oil became whitish yellow from golden yellow after the epoxidation and hydroxylation but turned dark brown after dehydration due to the relatively high temperature at which the reaction was carried out.

In addition, the viscosity of the oil slightly increased during the process of the modification. The iodine value showed an astronomical increase (39.3 g I_2/100g to 125.5 g I_2/100g) indicating the increase in the level of unsaturation after the chemical modification process. This trend is expected since epoxidation, hydroxylation and dehydration reactions actually took place at the point of unsaturation Fig (1-4) of the aliphatic chain by ring-opening, addition and elimination reactions respectively.

It is evident from the result that modified ASO is quite suitable in alkyd resin synthesis and its level of unsaturation will accommodate the cross-linking reactions for alkyds to form dry, hard solid film (Ciccarella *et al*., 1993). The oil content of the seed for the crude and modified was found to 55.16 and 40.38% respectively. On the basis of the oil content, avocado seed would be highly suitable economically for industrial applications in surface coating, as any oil bearing seed that can produce up to 30% oil are regarded as suitable. The set to touch time and drying time show the drying properties of the dehydrated ASO sample. The saponification value of crude and dehydrated ASO were 38.23 and 143.61mgKOH/g respectively. The saponification value reveals average molecular weight of fatty acids of triglyceride present in ASO. The iodine value and viscosity of the dehydrated ASO were within limit of ASTM standard. The drying time and set to touch time gave satisfactory result. Therefore these dehydrated oil sample were acceptable to prepare alkyd resin.

Table 2: The characteristics of the crude and modified avocado seed oil

Properties	Crude oil	Neutralized oil	Epoxidized oil	Hydroxylated oil	Dehydrated oil
Free fatty acid value (%)	1.85	1	-----	------	1
Colour	Light yellow	Golden yellow	Whitish yellow	Whitish yellow	Dark brown
Refractive index (25^{o}C)	1.441	1.465	-----	------	---
Specific gravity (25^{o}C)	0.893	0.899	0.9393	0.9456	0.9012
Viscosity (pa s)	3.336	3.392	--------	------	3.486
Saponification value(mgKOH/g)	38.23	------	--------	-------	143.61
Acid value	3.92	------	------	--------	6.28
Iodine value (gI_2/100g)	34.9	-------	------	--------	125.5
Set to touch(hr)	-------	------	------	------	4
Drying time(hr)	-------	-------	-------	-------	6
Oil content (wt%)	55.16	-------	--------	-------	4.38
Physical state (25^{o}C)	Liquid	Liquid	Liquid	Liquid	------
Ash content (%)	5	------	------	-------	-------

The fatty acid profile of the crude ASO and FTIR spectra of the crude, epoxidized, hydroxylated and dehydrated (modified) ASO are shown in Table 3 and (Figure.2 α 3). The fatty acid profile as analysed by gas chromatography mass-spectrometry (GC-MS) showed abundance of palmitoleate (31.94%wt) and arachidic acid (17.16%wt). The most abundant unsaturated and saturated fatty acids were palmitoleate (31.94%wt) and methyl stearate (14.22%wt) respectively. The oil contains 50.86% saturated fatty acid and 49.10% unsaturated fatty acid. The high saturation in ASO shows that if it is used in the production of alkyd resin, it will produce alkyd of slower drying rate but colour retentive. ASO, therefore, if structurally modified, may give alkyd resin with better performance characteristics. In the spectrum of crude ASO, 3298.02cm^{-1} correspond to the hydroxyl group (O-H) of the unsaturated fatty acid in the oil. The carboxyl group (C=O) is indicated at 1646.3cm^{-1}. The straight chain of –CH- stretch in aliphatic compound is found at the band 2934.18cm^{-1}. Alkene group (CH=CH) is attributed to the band of 3206.78cm^{-1}.

The FTIR spectra of crude ASO shows the peak value at 938.8286cm^{-1}, and 1378.208cm^{-1}which correspond to cyclic ester of saturated oil. IR spectra and functional compounds of desaturated ASO showed the broad band shoulder around 3902.03548 cm^{-1}, 3870.16253cm^{-1} and 37684.2729 cm^{-1} (initially at 3298.02 in the unmodified oil) corresponding to the hydroxyl (OH) of the unsaturated fatty acid in the mixture, which shows an increase of unsaturation as the ASO pass through the various processes of the modification. The peaks of the epoxidized ASO were similar to the crude samples while those due to the hydroxylated ASO were similar to the dehydrated samples.

Table 3: Fatty acid profile of Avocado seed oil.

Carbon molecules	Name	Concentration (ppm)	%wt
C_{10}	Capric acid	0.1415	1.27
C_{11}	Undecyclic acid	1.1689	10.49
C_{12}	Lauric acid	0.6686	6.00
$C_{20:2}$	Arachidic acid	1.9122	17.17
C_{14}	Myristste	0.5115	4.59
$C_{16:1}$	Palmitoleate	3.5592	31.95
C_{17}	Magaric acid	0.5393	4.84
C_{18}	Methyl stearate	1.5846	14.23
C_{25}	Pentacosylic acid	0.4123	3.70
C_{30}	Melissic acid	0.6407	5.75

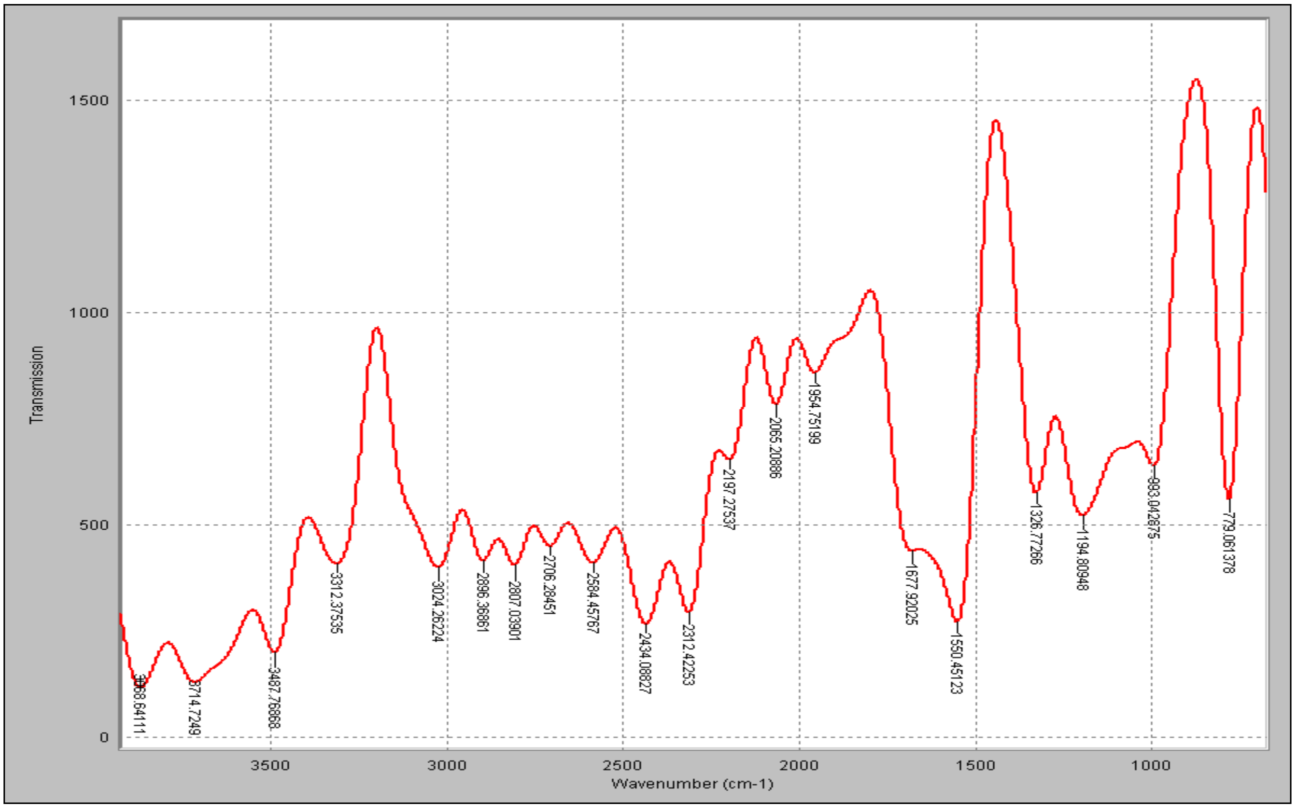

Fig 1: FTIR spectrum of avocado seed oil

Wave band 3868.641, 3714.725, 3487.769 represent O-H free bond of alcohol and phenols. 3312.375, 3024.262 indicates the presence of N-H stretch of primary amines. 2896.369, 2807.039 represents C-H stretch bond of alkyl groups. Peak 2584.458, 2197.275, 2065.209 is assigned to C=N of Nitrile; 1954.752 indicates C=O bond for anhydride. Peak 1677.92 shows C=C stretch of alkene, 1550.451 represents N-H bond of amine and amides. Wave number 1326.773 indicates variable Ø-O-R Aromatics. Peak 779.061 indicates C=C-H, Ar-H bend out of plane

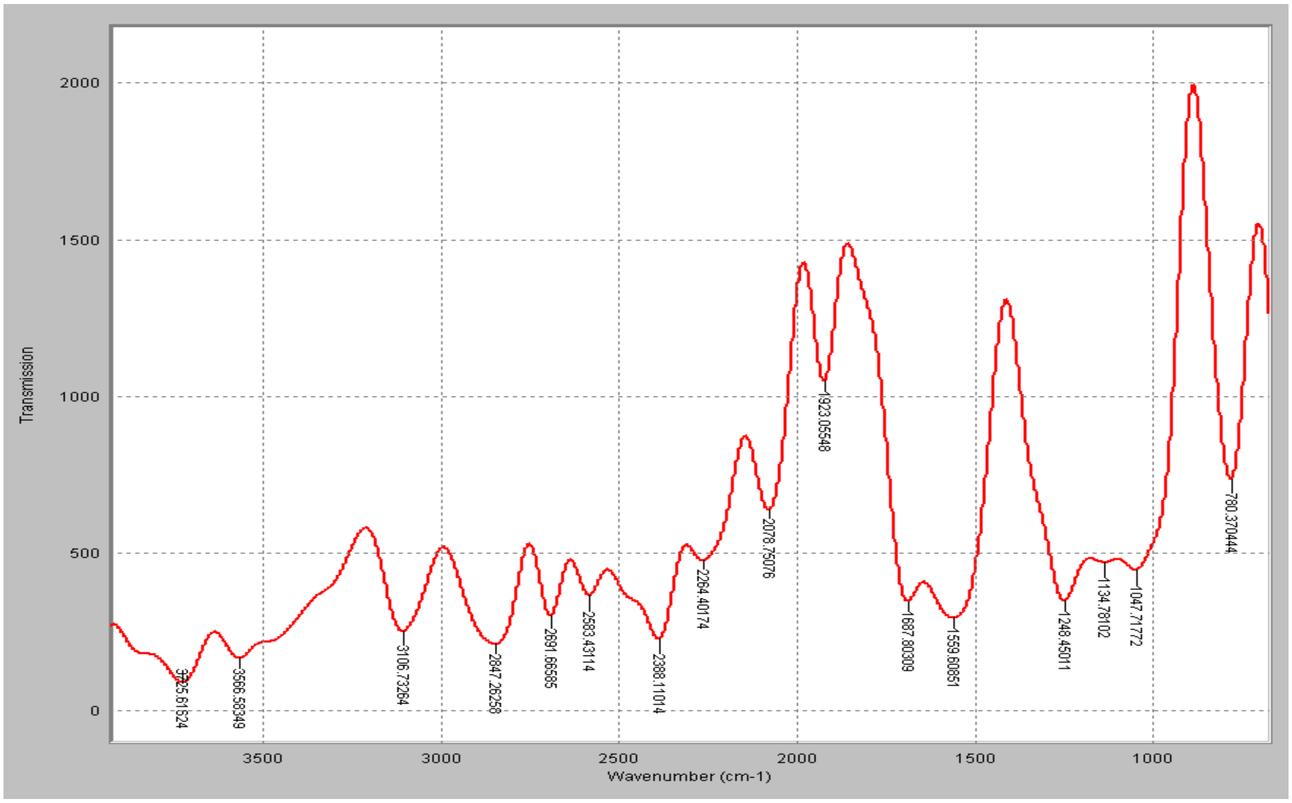

Fig 2: FTIR of spectrum of epoxidized avocado seed oil

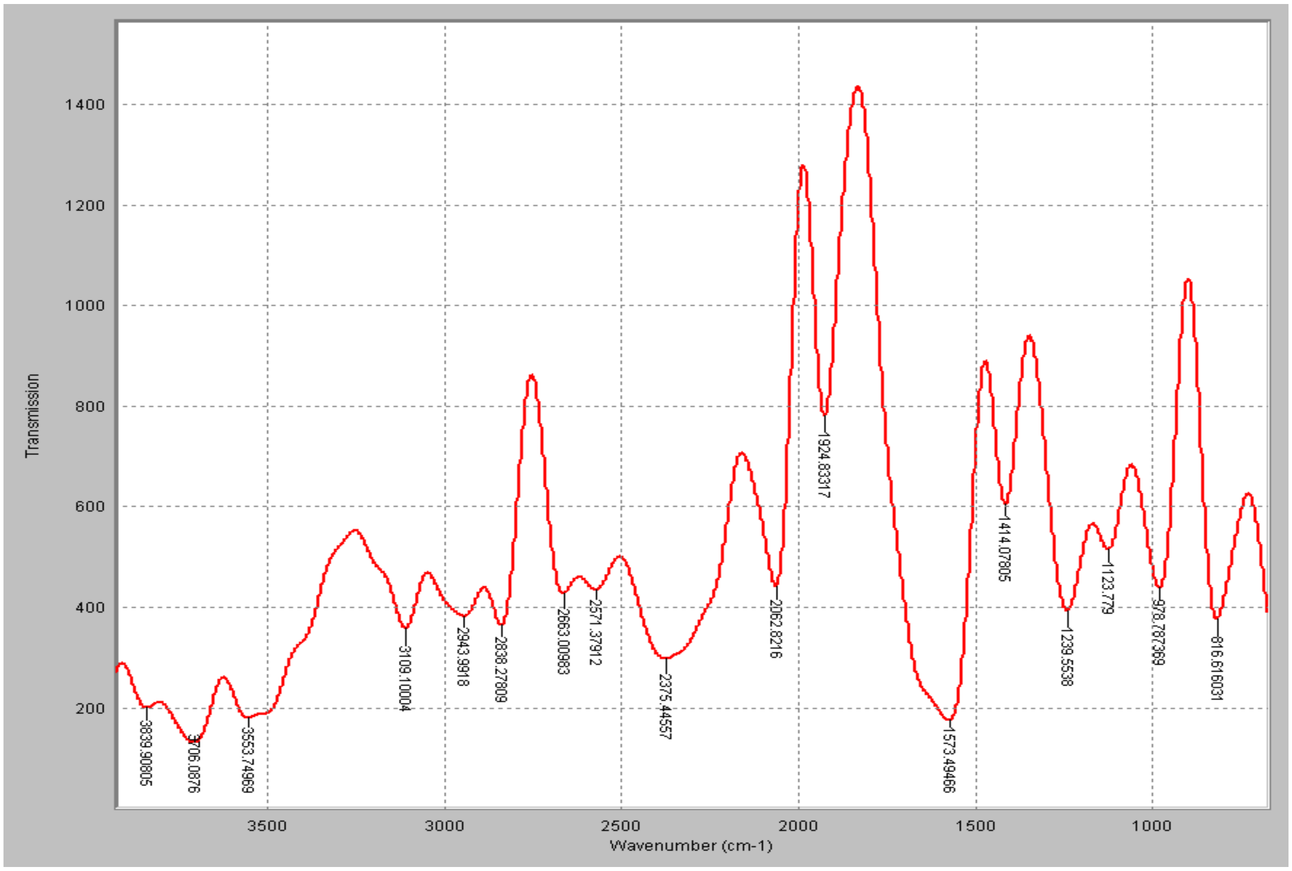

Fig 3: FTIR spectrum of dehydrated avocado seed oil

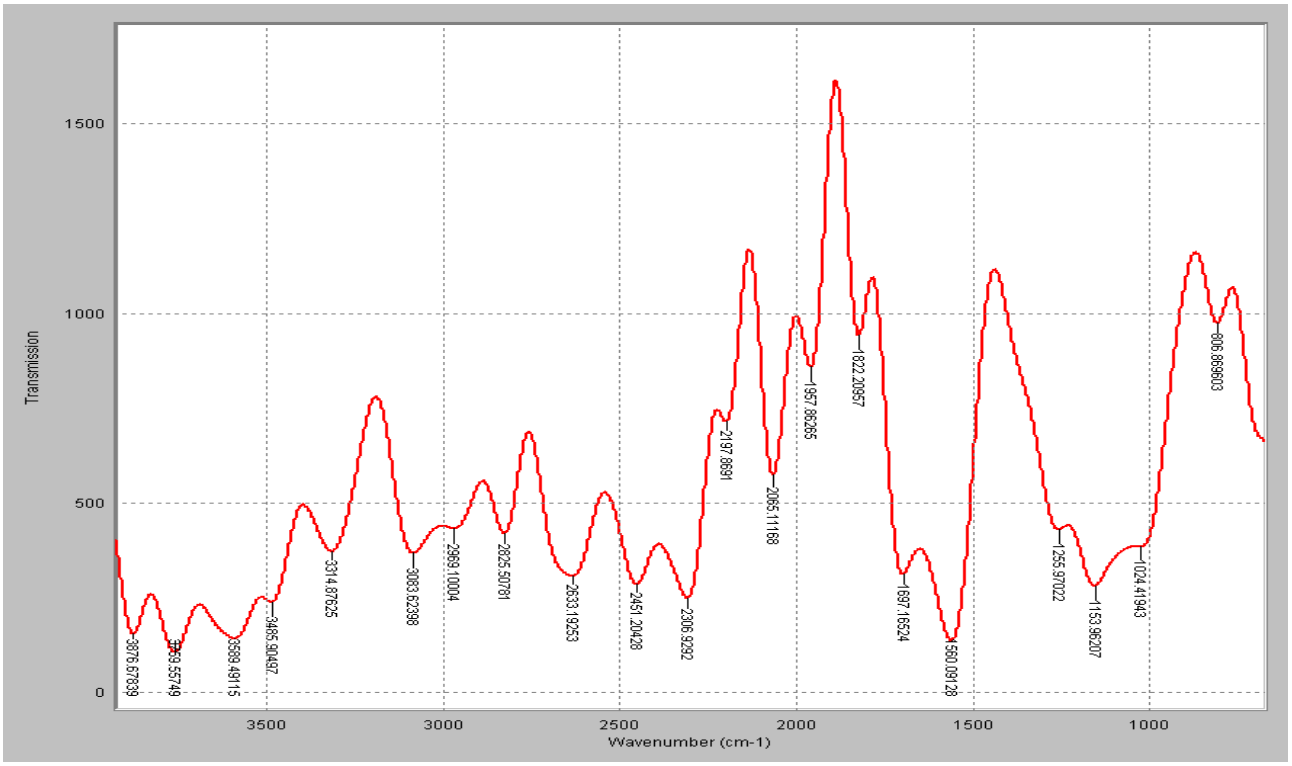

Fig 4: FTIR spectrum of hydroxylated avocado seed oil

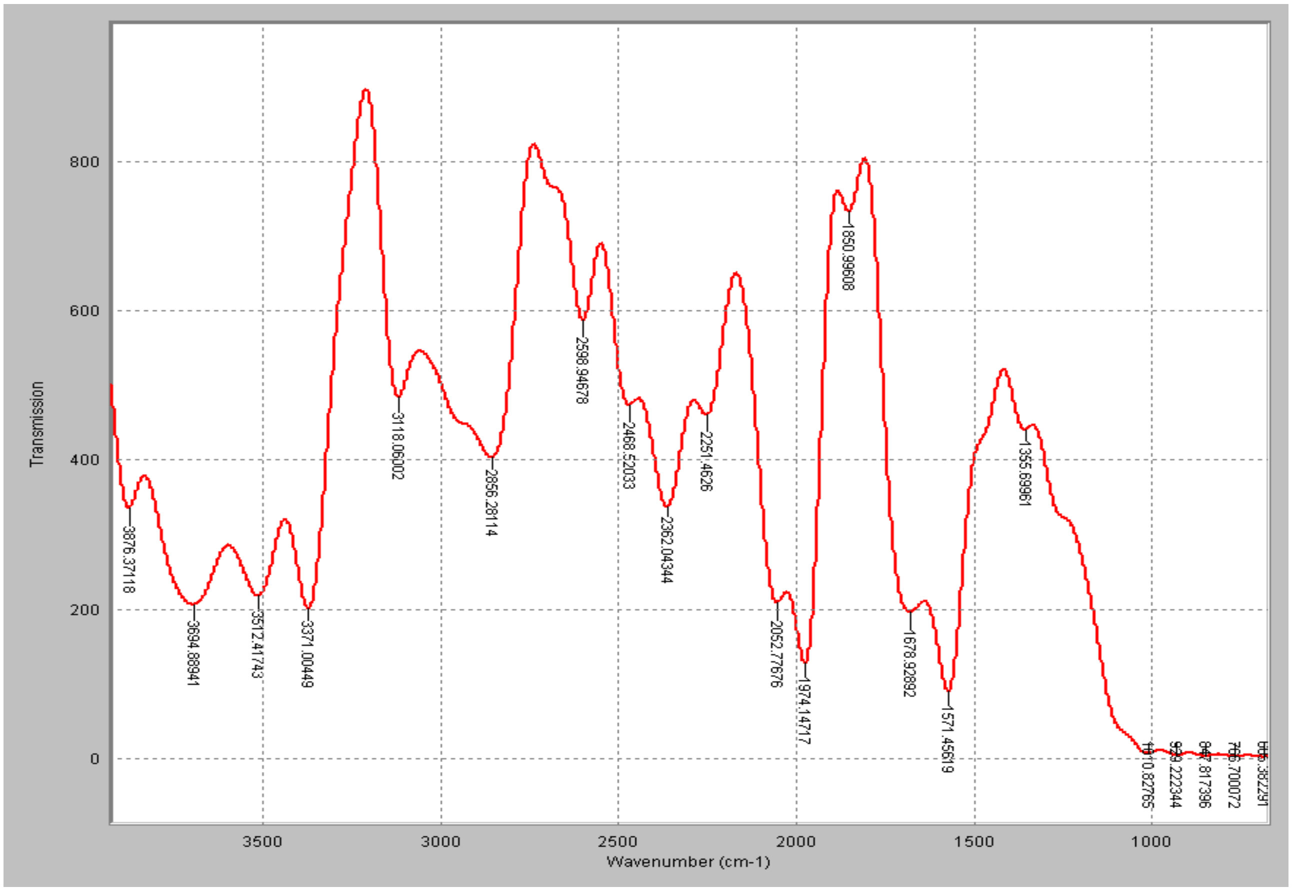

Fig 5: FTIR spectrum of alkyd resin from Avocado seed oil

Synthesis of ASO oxy-polymerizable alkyd resin

In the progress of the polycondensation reaction, the synthesis of alkyd macromer, was monitored by periodic checking of the acid number of the reaction mixture. A known amount of the sample was dissolved in ethanol–toluene (1:1) and titrated with standardized potassium hydroxide solution using phenolphthalein as indicator. This was according to standard test method ASTM D1980-87. Polyesterification was conducted by heating a mixture of monoglyceride mixture and phthalic anhydride/and maleic anhydride according to the specified formulation and the product obtained from the alcoholysis step until the acid value dropped to about 10. This shows that the acid value decreases gradually with time. The use of maleic anhydride as a polybasic acid introduces an additional complexity to the formulation of an alkyd resins. Due to its olefinic unsaturation it forms extra compounds with the unsaturated fatty acids (for example adduct of Diels-Alder synthesis) which become part of alkyd composition along with the common esterification of the two acid groups with a polyhydric alcohol. Xylene was also introduced to form azeotrope with water. Liberated water of esterification is carried off in the xylene under vacuum and generally heat and mass transfer of chemical reaction is greatly increased.

Performance evaluation of ASO modified alkyd resin

The properties and performance characteristics of the crude ASO alkyd resin (Alkyd-A), modified ASO alkyd resin with PA only (Alkyd-B), modified ASO alkyd resin with PA and MA 1:1 (Alkyd-C) and modified ASO alkyd resin with PA&MA 3:1 (Alkyd-D) of the same class (50% oil) was evaluated in terms of their physico-chemico-mechanical properties (acid value, viscosity, colour, refractive index, chemical and abrasion resistance, drying schedule, adhesion, impact, and scratch hardness test) which are presented in Tables (6,7) and Fig. 10. There is no common standard to compare alkyds resins as each alkyd resin has its own properties. Alkyd resin that has acid number of less than 15 is suitable for application of paint, according to literature (Patton,.; 1962, Mark, *et al.*; 1954). From table 4.4, the acid values (and refractive index) of Alkyd-A to Alkyd-Dare 14.73mg KOH/g oil (and 1.439), 13.18mg KOH/g oil (and 1.427), 12.09mg KOH/g oil (and 1.416) and12.24mg KOH/g oil (and 1.421)respectively with both colours as brown. A higher acid value translates to reduced drying rate, since acid group usually delay drying rate (Hymore and Audu, 1991). In addition, industrial products (such as paints) formulated with alkyd resin with high acid value usually cause rusting or corrosion of substrat surfaces

Table 5: Properties of crude and modified avocado seed oil alkyd resin

Properties	Alkyd-A	Alkyd-B	Alkyd-C	Alkyd-D
Acid value (mgKOH/g)	14.73	13.18	12.09	12.24
Viscosity (cP)	228.4	259.7	278.5	272.2
Colour	Brown	Brown	Brown	Brown
Refractive Index	1.439	1.427	1.416	14.21

Table 6 shows the chemical resistance of the four different medium oil length (crude ASO and modified) alkyd resins determined in three media; distilled water, 0.1 moles of sodium hydroxide and 0.1 moles of hydrochloric acid. From the table, it was observed that the alkyd C and alkyd D has good chemical resistance properties in the three media when compared to the alkyd A and B. It was equally observed that there is no change/ effect on alkyd resin C and D after immersion on distilled water and 0.1moles of HCl for a period of 18 hours unlike alkyd A whose film got whitening after immersion on distilled water after 18 hours. Also, the film of the alkyd A and alkyd B got whitening after 6 and 12 hours, respectively, when immersed in 0.1 moles of HCl. When the four alkyds were in immersed in 0.1 moles of NaOH, alkyds A and B films got whitening after 6 hours whereas alkyds C and D films got whitening after immersion period of 12hours. Alkyd-C showed superior resistant than other resin samples. Resin based on PA only (Alkyd-B) showed excellent resistant for NaOH solution and fairly resistant to HCl solution. This may be due to the presence of aromatic functional group whereas MA-based resin (Alkyd-D) where found fair and poor resistant to the alkali and acid solution, respectively. The poor alkali resistant may be attributed to ester linkages in the alkyd resins which are known to be prone to alkaline hydrolysis. From the result, it shows that none of the alkyds has a perfect resistance to the alkali solution though alkyd C has the best chemical resistance in alkali solution compared to alkyd A, B and C because it takes longer time before its film got whitening. The result shows that alkyd C has a very good chemical resistance.

Table 6: Chemical resistance of the alkyd film as determined after air-dried for24hours

Alkyl Resin	Alkyd A		Alkyd B	Alkyd C	Alkyd D
Media	**Immersion time (hrs)**	**Appearance of the film**	**Appearance of the film**	**Appearance of the film**	**Appearance of the film**
Distilled water	6	4	4	4	4
	12	4	4	4	4
	18	1	4	4	4
0.1moles NaOH	6	1 and 2	1	4	4
	12	3	2	1	1
	18	3	3	1	3
0.1moles HCl	6	1	4	4	4
	12	2	1	4	1
	18	3	3	1	2

Where: 1= Whitening, 2=Blistering, 3=Removal, 4=No effect

The Alkyd-A to Alkyd-D were each, hand coated on the surface of four different aluminium plates which were cleaned with an ethanol to make sure that the surface of the aluminium plates were free from impurities contaminants which might alter the drying test carried on it. The results of the drying time of the alkyd-A to D at indoor temperature of 32°C ± 2 in a dust free environment are shown in Fig.10. It was shown that a tremendous improvement was observed in the both set to touch, surface dry and dry through time from alkyd-C to Alkyd-D. Specifically, alkyd C and D have a better drying schedule compared to the Alkyd A and B, respectively. It can be inferred that alkyd C and D could be used as a binder in surface coating formulations as it showed comparable coating properties (drying time) to other reported oil modified alkyd (Issam, and Cheun, 2009). The acid value and carboxyl functionality (F-COO) have effect on drying time of the resin. As observed from Fig.10, Alkyd-C and Alkyd-D which have relative minimal acid value when compare to Alkyd-A and Alkyd-B have the best drying properties. Fig.10 further disclose that none of the alkyd samples were able to dry hard overnight. However, on addition of nano-Zinc oxide (ZnO) pigment to all the resins, Alkyd-C was able to dry hard overnight (5.5hrs). The drying time reduction of the alkyd film may be due to the increased chemical potential attributable to the nano-ZnO pigment. Contribution of surface energy to total energy content of nano-material, positively influence its chemical energy/reactivity; invariably, leads to extensive acceleration of chemical reactions.

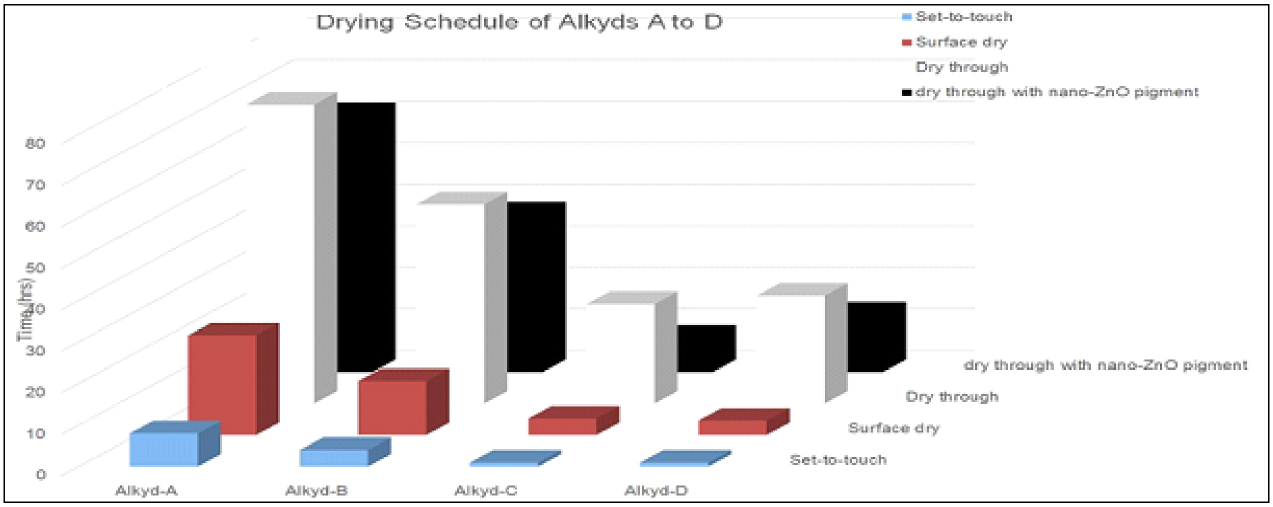

Fig 10: Drying Schedule of Alkyds A to D

From Table 7, it can be inferred that the four medium oil length ASO modified alkyd resin produced exhibits varying mechanical properties when subjected to impact, adhesion and scratch hardness test. Alkyd-A and B show poor hardness and adhesion properties while C and D passed both test. The good hardness property of the Alkyds-C and D might be due to the aromatic moiety presence in maleic anhydride, while adhesion is attributed to the polar ester bond (Uzoh *et al.*, 2013).There were no flakings or ribboning observed after making cuts and applying the adhesive tape. The maleic anhydride on the polymer backbone promotes adhesion. The hydroxyl groups (OH) in the structure of the resins also improved the adhesion to the substrates. The results suggest that these alkyds have potentials in surface coatings.

Table 7: Mechanical Properties of the Alkyd A – Alkyd D

Alkyd Resins	Mechanical Test		
	Impact test	Adhesion test	Scratch hardness test
Alkyd A	Failed	Poor	H Failed, -------
Alkyd B	Passed	Fair	H Passed, 2H Failed
Alkyd C	Passed	Good	H Passed, 2Hpassed
Alkyd D	Passed	Good	H Passed, 2Hpassed

FTIR analysis of the Alkyds

The FTIR spectra of the alkyds are shown in Fig.(5-9) The IR spectra of the resin with PA and PA: MA) have similar peaks. Comparing the spectra of the alkyds and those of the modified ASO (Fig 5 and (6-9)) additional peak/band indicating the presence of ester group 1039.67–1284.65cm^{-1} for PA and 1094.23-1260.55 cm^{-1} for PA:MA (O=C-O-C stretching frequency) were seen, but these were absent in the IR spectrum of the modified ASO. The absorption band in the region of 2034.67cm^{-1}, 2099.84cm^{-1}, 2153.44cm^{-1} and 1977.37cm^{-1}, which corresponds to carbonyl group, is very sharp and strong in alkyd resins. Methylene C-H stretching were seen at 1377.25cm^{-1} and 1377.21cm^{-1} is very conspicuous in both spectra. Aromatic C-O stretching in esters and alkene (C=C) stretch were seen in 1473.60 and 1622.82cm^{-1} regions.

Conclusion

Modified Avocado seed oil can not only replace industrial seed oil that constitutes food sources,but has the suscibility of being used for commercial processing of surface coatings based on its good chemical and mechanical properties. FTIR results showed that the oil is predominantly saturated. The unsaturation in non-drying avocado seed oil was increased through epoxidation, hydroxylation and dehydration. An auto-oxidative alkyd resin was epoxidation epoxidation, hydroxylation and dehydration. An auto-oxidative alkyd resin was synthesized from the chemically modified Avocado seed oil.

References

1. Aigbodion AI, Okieimen FE. An investigation on the utilization of African locust bean seed oil in the preparation of alkyd resins, Industrial Crop and Products. 2001; 13:29-34.
2. Aigbodion AI, Okieimen FE, Obazee EO, Bakare IO. Utilisation of maleinized rubber seed oil and its alkyd resin as binders in water-borne coatings. Progress in Organic Coatings. 2003; 44:28-31
3. Akpabio VD, Akpakpan AE, Mathew IE, Akpan AU. Extraction and Characterisation of Oil from Avocado Pear (Parsia Americana) and Native Pear (Dacryodes edulis) Fruits World Journal of Applied Science and Technology. 2011; 3(2):27-34.
4. Boruah M, Gogoi P, Adhikari B, Dolui SK. Preparation of jatrophacurcas oil based alkyd resin suitable for surface coating. Progress in Organic Coatings. 2012; 74:596-602.
5. Gogte BB, Dabhade SB. Alkyd Based on Non Edible Oils Karanja Oil (Pongamia glabra), Paint India. 1981; pp. 3-5.
6. Hlaing NN, Mya O. Manufacture of alkyd resin from castor oil, World Academy of Science, Engineering and Technology. 2008; 24:115-161.
7. http://www.africanfarming.net/crops/agriculture/avocado-farming-and-markets.
8. http://www.freshplaza.com/article/151032/Peru-Avocado-export-top-280-million-dollars.
9. http://www.statista.com/statistics/262858/change-in-opec-crude-oilprices-since-1960.
10. Igwe IO, Ogbobe O. Studies on the properties of polyester and polyester blends of selected vegetable oil, Journal of Applied Polymer Science. 2000; 75:1441-1446.
11. Ikhuoria EU, Maliki M. Characterisation of Avocado Pear (Persea Americana) and African Pear (Dacryodes edulis) Extracts. African Journal of Biotechnology. 2007; 6(7):950-952.
12. Menkiti MC, Onukwuli OD. Utilization potentials of rubber seed oil for the production of alkyd resin using variable base oil lengths, New York Science Journal. 2011; 4(2):51-58.
13. Odetoye TE, Ogunniyi DS, Olatunji GA. Improving jatrophacurcaslinnaeus oil alkyd drying properties. Progress in Organic Coatings. 2012; 73:374-381
14. Ogunniyi DS, Odetoye TE. Preparation and evaluation of tobacco seed oil-modified alkyd resins. Bioresource Technology. 2008; 99:1300-1304.
15. Okieimen FE, Aigbodion AI. Studies in molecular weight determination of rubber seed oil alkyd resins. Industrial Crops and Products. 1997; 6:155-161.
16. Okolie PN. Extraction and characterization of oil from Jatrophacurcas seed. World J. Agric. Sci. 2012; 8(4):359-365.