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Comparative Analysis on the Physico-Chemical and Mechanical Properties of Agricultural Seeds Oil Modified Alkyd Resin

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Authors' contributions

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

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ABSTRACT

Alkyd resins are essential raw materials used in the surface coatings and paints industry. In any case, in Nigeria today, alkyd resins are still to a great extent imported partly due to the non-accessibility of a portion of the traditional seed oils that are utilized for alkyd production. The decision of oil is one of the essential contemplations in alkyd resin production. This paper considers the possibilities of using non-traditional seed oil of oilbean from our locally-accessible tropical plants of oilbean, compares it with breadfruit and the most broadly used soybean seed oil for alkyd resin preparation. The physico-chemical and mechanical properties of the alkyd resins synthesized by alcoholysis process gave better results when compared with some conventional alkyd resins. The utilization of oilbean and breadfruit seed oils for alkyd resin synthesis established new process that uses locally accessible crude materials for alkyd production both for modern, structural, industrial and architectural coatings and hence improves the Nigerian economy.

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1. INTRODUCTION

The advancement in natural science, due to better and enhanced diagnostic gear, has made it conceivable to perform far reaching examination of chemical composition, the structure and the property of natural products such as vegetable oils. Change and utilization of enhanced consumer based products has constantly advanced [1]. This progressive increment in different uses of fats and oils has set off the development of planted zones of these products. As of late, development by methods of genetic engineering to grow high oleic acid soy bean and rapeseed oil and in addition new oil seeds, is persistently being examined and created to meet developing requests [2,3]. In Nigeria, vegetable oil subordinate ventures depend for the most part on imported oils like linseed and soybean oil which are exceptionally costly. The locally accessible oils like oilbean seed oil, breadfruit seed oil [4], palm oil, palm part oil, groundnut oil and coconut oil are hard to find [5].

The utilization of petroleum based monomers in the production of oil based items is relied upon to decrease in coming years in light of the ceaseless ascent in oil based commodities and the high rate of oil exhaustion of known oil saves [6]. This combined with strict administrative enactment everywhere throughout the world on ecological insurance against debasement, has motivated the examination of sustainable normal assets as a practical option [7,8]. Along these lines, plants and animal oils have for quite some time been recognized as conceivable substitute for petrochemical subsidiaries in the generation of polymers, for example, resins, paints and vanishes [6].

Recently, production has been intensified due to the possibility of utilization of these agricultural materials as a biodiesel. Most of the vegetable oils can be utilized in the alkyd resin formulation. Among them, the most explored is the soybean oil in the alkyd resins formulation. The decision of seed oils utilized for generation of alkyd resins is affected by particular attractive properties of the alkyd resin to be delivered. The reason being that execution of the alkyd resin produced to a great extent relies upon the decision of oil utilized for its generation. The fundamental attractive properties comprise: the speed of drying, gloss retention, colour retention, abrasion resistance and hardness [4]. Alkyd resins have remained the most broadly utilized set of binders in surface coatings because of their unique properties such as gloss retention, colour, film flexibility, durability and compatibility with other resin systems [9].

The level of unsaturation of the oil is an essential thought in the creation of drying alkyds. The higher the nearness of unsaturation, the higher will be the drying execution of the comparing alkyds arranged from the oil. Alkyd resins are not only the major important binders but also they are the largest volume based coatings and paints utilized especially for decoration [10] both for interior and exterior applications [6]. The sort or class of alkyd resin to be delivered is another primary thought for the decision of modifying oil [11].

In order to improve economical generation of alkyd resin in Nigeria, there is a need to build the production of locally accessible conventional oils, for example, oilbean seeds oil which fills the double need of nourishment and non-sustenance uses, and supplement the current supplies by setting up other lesser-known non-conventional seeds oil that have comparable properties, as crude materials. This will go far to support the constrained indigenous alkyd resin ventures.

The usage of oil depends chiefly on its qualities which are dictated by its composition [12]. The regular oil utilized for alkyd resins in the business today depends on the unsaturated fat composition of the semi-drying and drying oils. The oils incorporate linseed oil, soya oil, sunflower oil and dehydrated castor oil. Linseed oil is largely grown overseas in temperate environments while the use of soya oil as an industrial raw material really contends with nourishment source.

Breadfruit seed oil modified alkyd resin was reported by [4]. The outcome demonstrated low acid value and iodine estimation of 107.30 mg I/g a characteristic of semi-drying oil. Cassava seeds have been accounted for [13] to be a potential crude material (semi-drying oil) for alkyd resin readiness. The prevailing unsaturated fat substance being linoleic unsaturated fats with its content up to 47%.

The iodine estimation of 141 g I2/100 g [13] proposes cassava seed oil as great oil for alkyd resin preparation. The oil was accounted for to have great oxidative dependability as the peroxide esteem was not more than 6.3 mequiv/kg.

Moreover, sandbox seed oil has been reported to have a virtuous potential as industrial raw material for solvent based paints [14] and surface coatings [15]. The iodine estimation of 177 g I2/100 g was reflective of the comparatively high level of unsaturation (66.5%) of the fatty acid found in the oil. The most plenteous unsaturated fatty acid present in the oil was oleic acid (63.2%). The oil yield of 53.6% [14] attained for Hura crepitan is additionally promising towards its use as industrial oil. Obidiegwu et al., [15] also reported iodine value of 20.928 mmg Iodine/g for sandbox seed oil which suggests a non-drying oil.

This study is aimed to synthesize, develop and established new processes that utilizes locally available and renewable raw materials like oilbean seeds oil for alkyd resin production both for industrial and architectural coatings and thus enhances the Nigerian economy.

2. MATERIALS AND METHODS

2.1 Materials

The vegetable seed oils, oilbean seed oil (Pentaclethra Macrophylla Sedinst) utilized in this work was sourced locally from Ideato South Local Government, within the South-Eastern district of Nigeria. Soyabean Oil (Glycine Soja) was gotten from Taraku Factories Restricted, Benue State, Nigeria. The Fuller's Earth was a product of Fulmont Ltd, Britain which comprises chiefly of alumina silica ($Al_2O_3.2SiO_2.2H_2O$) impregnated with iron, magnesium and calcium. Metallic Driers used were obtained from Ebony Paints (Nig.) Ltd, South East, Nigeria. The following analytical grade solvents and chemicals: Xylene (MERCK), Benzene (MERCK), N-hexane (Qualikems, India), Conc. H_2SO_4 (Qualikems, India), Na_2CO_3, NH_3 (Qualikems), NaOH, Glacial acetic acid (Qualikems), $Na_2S_2O_3$, $K_2Cr_2O_7$, Paraffin oil, Methanol (Qualikems), Phenolphthalein, Iodine trichloride, Iodine crystal, Starch (Qualikems, India), Toluene (MERCK), Glycerol (BDH) were used without further purification. The oilbean seed oil was compared with breadfruit (Treculia Africana) and soybean seed oils [4].

2.2 Extraction of the Vegetable Oils

The technique utilized by Uche et al. [4] was employed. In this method, the vegetable oils were separated from their oil bearing seeds by soxhlet extraction utilizing n-hexane. The oil-bearing seeds were shelled, and sun dried. The dried seeds were ground to fine particles utilizing a processor. Measured amounts of ground vegetable seeds were put in a 500 cm^3 round-bottomed flask. 150 cm^3 of n-hexane was introduced into the flask which was later set on a heating mantle. The soxhlet apparatus was set-up for the extraction of oil from the beginning. The separated oil was weighed, and the oil yield was noted.

2.3 Alkali Refining of Oils

The separated oils were alkali refined to lessen the level of free unsaturated fats they contain. The strategy for Cocks and Rede [16] was adopted for the alkali refining of the oils. The measure of NaOH utilized in the refining procedure was in 10% abundance of that really required to neutralize the free unsaturated fats in the oils. This was determined utilizing the Cocks and Rede equation.

$$1\text{M NaOH required} + 10\%\ \text{excess} = \frac{\text{Weight of oil taken x \% FFA x 1.1 x 1000cm}^3}{100 \times \text{Mw} \times 1\ (\text{molarity of NaOH})} \quad (1)$$

Where, Mw = weight normal atomic weight of oil, %FFA = Level of free unsaturated fat present in the oil.

2.3.1 Purification of the alkali refined oils

The oil obtained from the alkali refining process was impure as it contained some soap deposits and unreacted NaOH. The oil was refined by dissolving it in a sensible measure of benzene (b.pt 60-80°C) and sifted utilizing Buckner funnel to remove the soap and other impurities. The oil solution was then subjected to vacuum distilation at a temperature of 50°C in a heating mantle to remove the solvent from the oil. The recouped oil was washed severally with boiling water in an isolating funnel under cautious shaking to maintain a strategic distance from emulsification of the oil. The washing was ceased when the fluid concentrate was clear and neutral to litmus. The washed oil was subjected to vacuum refining at 70°C to evacuate any traces of water in the oil.

2.4 Bleaching of Oils

In this technique, 400 g each of the soluble base refined oil was blended with 60 g of Fuller's earth (15 wt % in light of oil) in a three-necked round bottomed flask. The flask with its contents was dipped in an oil bath maintained at a steady temperature of 80^{o}C, and heated under vacuum. The blend was mixed ceaselessly with an electrical stirrer, and the bleaching lasted for 40 minutes. Toward the end of the bleaching, the contents of the flask were sifted hot under vacuum utilizing a Buckner pipe. Filtration was repeated with a Whatman grade 1 filter paper to get optically clear oil.

2.5 Characterization of Oils

2.5.1 Acid value

This was determined using ASTM method (ASTM D) [17]. In order to aid acid value determination, alcoholic Potassium Hydroxide Solution (0.1 M) was first prepared. In this method, 5.61 g of KOH was dissolved in 1 litre of Methanol. The solution was then standardized using a standard 0.1M HCl to a phenolphthalein endpoint. Neutral Solvent was prepared by mixing equal volumes of 2-propanol and toluene in a 1000 cm^3 conical flask. The mixture was titrated with 0.1M KOH solution utilizing phenolphthalein as indicator until a pink colour which persisted for about one minute was obtained. Phenolphthalein indicator was prepared by dissolving 1 g of phenolphthalein in 100 cm^3 of methanol.

Acid Value Determination: In this method, 0.5 g of the oil sample was dissolved in 50 cm^3 of neutral solvent in a conical flask. 1-3 drops of phenolphthalein indicator was introduced and the mixture was then titrated with 0.1 M KOH until a pink colour which persisted for about 1 minute was obtained.

This was calculated using the formula:

$$\text{Acid Value} = \frac{\text{MV x } 56.1}{\text{W}} \quad (2)$$

Where;

M = Molarity of KOH solution,
V = Volume of KOH solution used in titration (cm^3),
56.1 = Molecular weight of KOH,
W = Weight of oil used in grams.

2.5.2 Iodine Value

The iodine value was determined using ASTM method (ASTM D) [18]. The solutions used in iodine value determination were prepared as follows: Potassium Iodide Solution was prepared by dissolving 150 g of potassium iodide (KI) in water and diluting to one liter. Sodium Thiosulphate Solution (0.1M) was also prepared. In this method, 24.8 g of sodium thiosulphate ($Na_2S_2O_3.5H_2O$) was dissolved in water, and diluted to one liter. Starch indicator solution was prepared by homogenizing paste of 5 g of soluble starch in cold water and adding 500 cm^3 of boiling water. The solution was stirred rapidly, and cooled. WIJ's Solution (0.2 M KI solution) was also prepared. In this method, 8.67 g of iodine was dissolved in 100 g of methanol. A solution of 7.96 g of iodine trichloride (ICl_3) dissolved in a quantity of glacial acetic acid was also prepared. The two solutions were warmed over a water bath ensuring that the solutions did not mix. The solutions were then mixed in a one litre flask and made up to mark with glacial acetic acid.

Standardization of Sodium Thiosulphate Solution: The method employed by [4] was applied. In this method, 25 cm^3 of standard potassium dichromate solution (containing 4.904 g $K_2Cr_2O_7$/liter of weakened water) was pipette into a cone like cup and weakened with 50 cm^3 refined water. 10% KI was introduced trailed by 10 cm^3 concentrated hydrochloric acid (HCl sp.gr. 1.19), and the solution was shaken to blend. The freed iodine was titrated with $Na_2S_2O_3$ solution while shaking continually until the point when the yellow shading had nearly vanished. 1 – 2 cm^3 of starch indicator solution was included, and titration was proceeded until a point where the blue shading had vanished. The molarity of the $Na_2S_2O_3$ was obtained using the formula below;

$$(\text{Vol. of } Na_2S_2O_3)\text{x}(\text{Molarity of } Na_2S_2O_3) = (\text{Vol. of } K_2Cr_2O_7)\text{x}(\text{Molarity of } K_2Cr_2O_7) \quad (3)$$

Iodine value determination: In this method, 0.15 g of the oil was introduced into a clean conical flask. 20 cm^3 of carbon tetrachloride was also introduced into the flask containing the oil and shaken thoroughly to dissolve the oil. Similar amounts of CCl_4 were added into two additional flasks which served as blanks. 25 cm^3 of Wij's solution was pipette into the flask containing the oil sample, and also into the blanks. The flasks were stoppered and the flask containing the oil

sample was swirled to ensure an intimate mixing. The flasks were stored in a dark place for one hour at room temperature. At the expiration of one hour, the flasks were removed from storage and 20 cm^3 of KI solution and 100 cm^3 of distilled water was added into each flask. The contents of each flask were titrated with $Na_2S_2O_3$ solution at constant and vigorous shaking until the point when the yellow shading had nearly vanished. 1-2 cm^3 of starch indicator solution was introduced, and the titration was continued until the disappearance of blue colour. Iodine value was calculated using the formula:

$$\text{Iodine Value} = \frac{12.69\text{M}\ (V_2 - V_1)}{\text{W}} \quad (4)$$

Where,

M = Molarity of $Na_2S_2O_3$ solution, V_2 = Volume of $Na_2S_2O_3$ solution used in blank titration (cm^3), V_1= Volume of $Na_2S_2O_3$ solution used in sample titration (cm^3), W = Weight of sample (oil) used in grams.

2.5.3 Saponification value

This was determined using the AOCS (American Oil Chemist Society) method (AOCS Cd 3-25, 1966). In this method, 2 g of the oil sample was introduced into a conical flask. 25 cm^3 of 0.5 M alcoholic potassium hydroxide was added. A blank was also prepared, by putting 25 cm^3 of the alcoholic potassium hydroxide in another conical flask. Condensers were fitted to both flasks and the contents were boiled for one hour in a water bath, while swirling the flasks from time to time. The flasks were then allowed to cool a little and the condensers were washed down with a little distilled water. The excess potassium hydroxide was titrated with 0.5 M hydrochloric acid using phenolphthalein indicator.

The saponification value was calculated as follows;

$$\text{Saponification Value} = \frac{28.05 \text{ x (blank titration} - \text{sample titration)}}{\text{Weight of Oil}} \quad (5)$$

Where,

28.05 = the number of milligrams of KOH in 1 cm^3 of 0.5 M KOH

2.6 Synthesis of Alkyd Resins

The details utilized in the blend of long and medium oil length of oilbean seed oil modified alkyd resins are presented in Table 1.

In this technique, 750 cm^3 three necked round bottomed flask heated with a heating mantle was furnished with a variable speed stirrer, a dean and stark water collector, reflux condenser, nitrogen gulf tube, a thermometer and a testing gadget. The kettle which had been flushed with nitrogen was charged with 153.6 g of the refined oil for the synthesis of the long oil modified alkyd resins and 103.4 g of the refined oil for the combination of the medium oil alkyd resins. The oil was heated to the reaction temperature of 245 ± 2^o, 3.84 g of the catalyst, litharge (PbO), was introduced quickly for the synthesis of the long oil alkyds and 2.59 g (PbO) for the synthesis of medium oil alkyds, trailed by 30.7 g of glycerol which was included gradually from a dropping funnel over a time of 2 minutes with overwhelming unsettling. Tests samples were pulled back at interims for methanol resilience test. The alcoholysis process was reached and completed when 1 volume of the alcoholysis blend was soluble in 2 volumes of anhydrous methanol.

Toward the completion of the alcoholysis stage, 74 g of phthalic anhydride was introduced at the same time, and the nitrogen stream was expanded. The blend was heated and mixed at the reaction temperature. The advancement of the reaction was trailed by a continuous observation of the acid number of the reaction blend. The reaction was halted on accomplishment of acid number of under 10, and the substance permitted cooling by dropping the reaction kettle in a bath of chilly paraffin oil.

Table 1. Formulations for the synthesis of alkyd resin

S/N	Ingredients(g)	Long oil length alkyd resin	Medium oil length alkyd resin
1	Vegetable Oil	153.6	103.4
2	Litharge (PbO)	3.84	2.54
3	Glycerol	30.7	30.7
4	Phthalic Anhydride	74	74

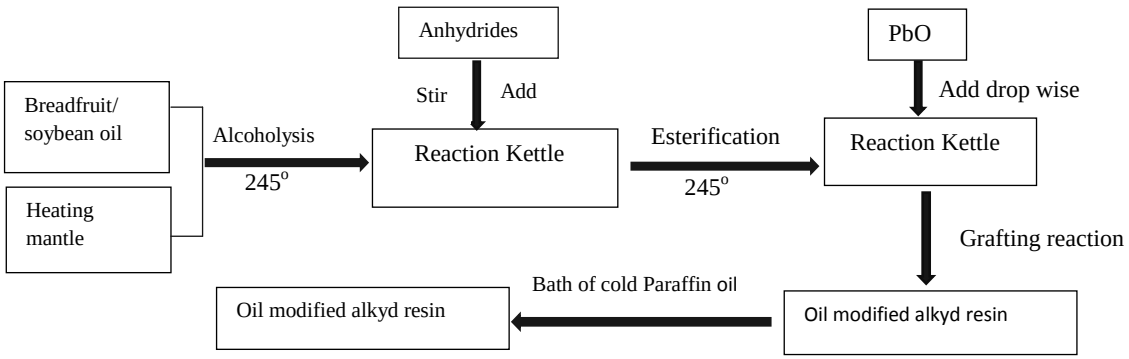

Fig. 1. Schematic diagram for the experimental set up of the alkyd resin synthesis

2.7 Evaluating the Performance of Oilbean Seed Oil Alkyd Resins

2.7.1 Drying Studies

I. Preparation of Resin – Drier Mixture: 119 g of the produced long oil alkyd resin and 84 g of the combined medium oil length alkyd resin were precisely weighed out into a 500 cm^3 measuring beaker and disintegrated in 70 g and 139 g by weight of xylene separately. This gives a resin solution of 64% and 38% solid correspondingly. 1.75 g lead naphthanate and 0.9 g cobalt naphthanate driers for long oil length alkyd resin and 1.2 g lead naphthanate and 0.6 g cobalt naththanate driers for medium oil length alkyd resin were introduced. The resin – drier mixture was blended completely utilizing a mechanical stirrer. The measure of driers introduced signify 0.50 wt. % Pb and 0.05 wt. % Co which are the measures of these metals typically utilized in the surface coatings industry.

II. Preparation of Coating Surfaces; Glass was used as the coating surface for the casting of resin – drier mixtures. Four glass plates were cut to dimensions of approximately 16 cm x 9 cm. and were taped to various thicknesses for the casting of the resin drier-mixtures depending on the film thickness of resin-drier mixture required. Tape thicknesses ranged from 0.10 mm to 1.0 mm, obtained by applying one or more layers of tape of thickness, 0.10 mm. The resin drier wet film thickness was assumed the same as the thickness of tape layer(s) used.

Property Determination: The alkyd resins synthesized were assessed for their drying times, resistance to chemicals using the following codes, 0: no change, 1: very slight change, 2: light effect, 3: definite and 4: bad effect [6], adherence to surface, mildew formation using international standard methods.

3. RESULTS AND DISCUSSION

3.1 Characterization of the oils

Oil Yields: The oil yields of oilbean and breadfruit seed are presented in Table 2.

Disparities in oil yields emerge in light of the fact that these oil seeds are characteristic natural materials which are liable to varieties in properties because of components, for example, temperature, soil assortment, seed assortment and development, post-collect stockpiling, among alternate elements.

Acid Value: Acid value is a property that is exceptionally valuable in evaluating the nature of oilseeds at the season of extraction. Along these lines, great stockpiling of oilseeds and sun-drying before extraction of oil is essential to keep the oilseeds from disintegration, and limit the production of free unsaturated fats in oilseeds.

Some literature values of the acid values of the oils are shown in Table 3. The experimental variations in acid values could have emerged from various variables, remarkably, seed assortment and post-gather stockpiling, age of the oil seeds preceding oil extraction.

Iodine Value: The iodine values of the oils shown in Table 4 shows that both oilbean, breadfruit and soybean seed oils are in the class of semi-drying oils having fallen in the range of 90 -130 mg I/g as reported in the literature for semi-drying oils.

The literature values cited above for the oils differed considerably from the values obtained in this study, and this can be credited to the fact that these oils were natural products which are

Table 2. Oil yields of oilbean, breadfruit and soybean seeds

Vegetable Seed	Yield (%)	
	Experimental	**Literature**
Oilbean Seed	42.61	53.66 (Akindahunsi, 2004) [19] 7.50 (Bwai et al, 2013) [20] 32.0 (Amadi et al, 2012) [21] 47.90 (Ikhuoria et al, 2008) [22] 12.23 (Eze, 2012) [23] 46.30 (Ogueke et al, 2010)[24]
Breadfruit	25.73 (Uche et al, 2016) [4]	18.95 (Berezi et al, 2012) [25] 9.71 (Eze, 2012) [23] 20.83 (Ajiwe et al, 1995) [26] 25.73 (Uche et al, 2016) [4]
Soybean seed	24.68	9.71-19.2(Sabinus Oscar, 2012) [27] 15.85% - 19.49% (Farooq et al, 2016) [28]

Table 3. Acid values of oils

Oil	Acid Value (mg KOH/g Oil)		Literature
	Crude	**Refined**	
Oilbean	2.82	0.40	3.62 (Amadi et al, 2012) [21] 7.01 (Odoemelam, 2005) [29] 3.25 (Ikhuoria et al, 2008) [22]
Breadfruit	2.26 (Uche et al, 2016) [4]	0.32(Uche et al, 2016)[4]	7.7 (Bwai et al, 2013) [20]
Soyabean	0.13	0.16	0.34 (Kyenge et al, 2012) [9] 2.81 (Eze, 2012) [23]

liable to variations in composition brought about by a number of factors such as botanical variety, climatic conditions, soil composition, rainfall, temperature and other environmental factors. The table shows that no linolenic acid was present in breadfruit seed oil, while the amount of linolenic acid present in oilbean seed oil was low. Linolenic acid is the reason for yellowing related with alkyds prepared from profoundly unsaturated (oxidizing) oils. It is normal that alkyds arranged from these oils will be shading retentive as a result of the nonappearance of linolenic acid in breadfruit seed oil, or low linonelic acid in oilbean seed oil.

Saponification Value: Saponification value is utilized to evaluate the mean atomic weight (Mw) of the unsaturated fats present in an oil. Saponification value over 200 demonstrates the nearness of unsaturated fats of low or genuinely, low atomic weight, and qualities underneath 190 show the nearness of high sub-atomic weight unsaturated fats [30,4]. The saponification values of the oils showed that soyabean oil contained

Table 4. Iodine value of oils

Oil	Refined	Literature
Oilbean	110.10	121.80 (Amadi et al, 2012) [21] 86.30 (Eze, 2012) [23] 57.60 (Ikhuoria et al, 2008) [22]
Breadfruit	107.30 (Uche et al, 2016)[4]	164.97 (Eze, 2012) [23] 52.64 (Bwai et al, 2013) [20] 44.80 (Berezi et al, 2012) [10]
Soyabean	128.40	123.42 (Eze, 2012) [23]

glycerides with low molecular weight than oilbean and that of breadfruit seed oils as reported by [4]. The later perception was steady with their iodine values. Ikhuria et al. [22] had reported a saponification value of 171.11 for oilbean seed oil which compared favourably with the value determined for the oil in the study.

3.2 Characterization of Alkyd Resins

Acid Value: The acid value estimation of an alkyd resin is critical in evaluating the steadiness of the synthesized resin. The low acid value (<10 mgKOH/g resin) attained for the resins prepared in this study means that the resins were produced close to termination of the reaction, and subsequently extremely steady.

3.3 Performance Evaluation of Synthesized Alkyd Resins

Drying Properties of Synthesized Alkyd Resins: The drying properties of the synthesized long and medium oil length alkyd resin tests are given in Tables 7 and 8. Film thicknesses of resins examined (in mm) were: 0.10, 0.40, 0.70, and 1.0.

The alkyd resins with film thickness of 0.10 dried satisfactorily and compared favourably with that reported by Uche et al. [4]. For the long oil length alkyd resins, oilbean seed and soyabean seed oil modified alkyd resins dried suitably at film thickness of 0.40 mm while the reverse was the case for those reported in the literature. On the other hand, for medium oil length alkyd resins, only soyabean oil alkyd dried suitably at film thicknesses of 0.40, 0.70 and 1.0 mm and these results were comparable with the literature values.

The drying studies show the superiority of soyabean seed oil/oilbean seed oil. Both oilbean seed oil and soyabean seed oil were semi-drying oils. This result is in agreement with the breadfruit seed oils reported in the literature. The request in the level of their unsaturation as dictated by iodine number is soyabean seed oil > oilbean seed oil. The present investigation demonstrated that the oil length of the alkyd resins synthesized did not show distinct impact on the drying of alkyd resin films.

Table 5. Saponification values of the vegetable oils

Oil	Refined	Literature
Oilbean Seed	174.0	213.10 (Amadi et al, 2012) [21] 171.11 (Ikhuria et al, 2008) [22] 189.85 (Odoemelam, 2005) [29] 221.59 (Eze, 2012) [23]
Breadfruit Seed	161.30 (Uche, at al, 2016)[4]	246.09 (Bwai et al, 2013) [20] 210.50 (Berezi et al, 2012) [10]
Soyabean Seed	191.50	189-195 (Odoemelam, 2005) [29] 195.63 (Eze, 2012) [23]

Table 6. Acid values of alkyd resins

Alkyd resin	Long oil length alkyd resin Acid Value (mg KOH/g resin)	Medium oil length alkyd resin Acid Value (mg KOH/g resin)
OBA	3.17	2.50
BFA	4.50 (Uche et al, 2016) [4]	5.21 Uche et al, 2016) [4]
SBA	1.60	1.01

Abbreviations: OBA = Oilbean Seed Oil Alkyd; BFA = Breadfruit Seed Oil Alkyd; SBA = Soyabean Seed Oil Alkyd

Table 7. Drying properties of long oil length alkyd resins

S/N	Alkyd resin	Film thickness (mm)			
		0.10	0.40	0.70	1.0
1	OBA	S	S	NS	NS
2	BFA (Uche et al, 2016) [4]	S	NS	NS	NS
3	SBA	S	S	NS	NS

Table 8. Drying properties of medium oil length alkyd resins

S/N	Alkyd resin	Film thickness (mm)			
		0.10	0.40	0.70	1.0
1.	OBA	S	NS	NS	NS
2.	BFA (Uche et al, 2016)[4]	S	NS	NS	NS
3.	SBA	S	NS	NS	NS

Note: S= Satisfactory: NS = Not Satisfactory

The film thickness of the alkyd resin was seen to correct a distinct impact on the drying of the alkyd resin tests samples, specifically, diminish in drying properties of the resins with increment in alkyd resin film thickness. For an alkyd resin film to dry adequately, the oxygen activated crosslinking (drying) reaction ought to occur all through the film from the surface to the inside. Since polymerization and drying are identified with oxygen substance, the concentration of which is most prominent at the surface and minimum in the inside, at that point, the thicker the alkyd resin film, the smaller the oxygen content in the inward part of the film which will prompt a general decrease in the level of drying.

The Media Resistance Tests on Alkyd Resin Films: The media barrier of dry alkyd resins to refined water, 2% NH_3, 2% H_2SO_4, and 2% Na_2CO_3 are presented in Tables 9 and 10. From Tables 9 and 10, it was clear that the water and acid barrier of the prepared alkyd resins were by and large great. All the prepared alkyd resins fizzled the soluble base barrier test. This affirmed the way that alkyds for the most part have low salt resistance. The poor alkali resistance of the alkyds might be clarified on the premise that they contained ester groups, which were known to be vulnerable to hydrolysis by soluble base [31,4].

The influence of alkyd oil length was not detected to have any impact on alkyd resistance to the media investigated.

Adhesion to Surfaces: The dried alkyd films displayed great grip properties (Table 11), and this means that paints prepared with these resins ought to have the capacity to shield substrates from corrosion, and therefore, works as anticorrosive paints. The degree of attachment of the alkyd films to the substrate is generally soyabean oil alkyd > oilbean seed oil alkyd both for the long and medium oil length alkyds. The examined arrangement relates to the order in the level of unsaturation of the oils.

Table 9. Media resistance of long oil length alkyd resins

Alkyd Resin Type	Resistance to			
	Distilled water	2%H_2SO_4	2%H_2SO_4	2%Na_2CO_3
OBA	2	1	3	4
BFA	2	0	3	4 (Uche et al, 2016)[4]
SBA	1	0	3	4

Table 10. Media resistance of medium oil length alkyd resins

Alkyd type	Resistance to			
	Distilled wate	2%H_2SO_4	2%H_2SO_4	2%Na_2CO_3
OBA	1	0	3	4
BFA	1	0	4	4 (Uche et al, 2916)[4]
SBA	1	0	3	4

Table 11. Mildew formation and adhesion properties of synthesized alkyd resins

Alkyd resin type	Long oil length alkyd resin		Medium oil length alkyd resin	
	Adhesion test (%)	Mildew formation	Adhesion test (%)	Mildew formation
OBA	24	Nil	26	Nil
BFA	27	Nil	31	Nil
SBA	32	Nil	32	Nil (Uche et al, 2016)[4]

The present examination demonstrated that the bond properties of soyabean oil alkyd are somewhat more noteworthy than those of oilbean seed both for the long and medium oil alkyds. The oil length of the prepared alkyds applied extremely slight impact on the grip properties of soyabean, and oilbean seeds oil modified alkyd resins. By and large, the alkyds displayed great bond properties. As indicated by Nigerian Industrial Standards (NIS 268: 1989), a great oil paint should display half most extreme deletion of the dry paint film.

The great bond to the substrate of the resins found in this study is credited to the innate compound structure and adaptability of the alkyd resins. It ought to be noted that specific polar groups in a film, for example, carboxylic groups (-COOH) are exceptionally dynamic promoters of attachment, because of their appreciation for the substrate, or by their impact in enhancing the wetting properties. In this manner, great introductory wetting of a substrate by a covering and the upkeep of wetting amid the procedure of film development are basic for good film attachment [4].

Mildew Formation: No mildew was formed on any of the alkyd film samples subjected to mildew test for the period of eight months (Table 11), a sign that the prepared alkyds will perform well in coatings.

4. CONCLUSION

Oilbean seed oil and soybean oil have been effectively utilized in the production of long and medium oil length alkyd resin with enhanced performance qualities. These seeds oil were tantamount with breadfruit seed oil. The present investigation has featured the utility of oilbean, seed oil in the production of long and medium oil length alkyd resins. A definitive use of these oils in the coatings industries will spare the nation the huge assets being spent in importing vegetable oils for the coatings industries, and in addition empowering the development of the trees of the oil-bearing seeds with the ranchers being a definitive recipient.

Most agricultural seeds oil of the Nigerian verdure have for some time been disregarded. Numerous potential seeds oil that have appropriate properties for alkyd resin production are still under-used. These oils ought to be very much tackled in order to extend the present supplies and provide food for the developing requests for vegetable oils. Nigeria and other African nations with positive atmosphere are entreated to put resources into the ranch of these potential oilseeds and work towards building them up as new feedstock for the coatings and the chemical industries at large.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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