# Evaluation of the suitability of conophor oil for the production of alkyd resins and surface coatings

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**ABSTRACT**

Oil was extracted from *Tetracaripidum conophorum* nut using solvent extraction method with hexane as solvent. The oil obtained was used to synthesize an alkyd resin, which in turn was utilized in the production of white gloss paints and varnishes. The IR and UV analysis of the oil showed the presence of C=C and C=O, while the Uv and IR examination of the resin revealed the presence of phthalic chain and C=O, C=C bond. The white gloss paint and varnishes produced had the right physical quality such as brushability and good drying time. The oil is a necessary raw material that can be used industrially in the production of essential materials.

**Key words:** Conophor oil, Aklyd resins, surface coatings.

## INTRODUCTION

Scarcity of petroleum products coupled with exhaustible petroleum reserve and fluctuation in their prices have caused uncertainty in the future availability and supply of petroleum products as the major source of raw materials for both domestic and industrial uses[1-3]. Thus there has been renewed interest in the search and development of renewable resources that would serve as valuable alternative[4].

However, despite the apparent popularity of petroleum products as raw materials in different areas of application, fats and oils are being greatly favoured for use in surface coatings, soaps, cosmetics, pharmaceuticals, lubricants, surfactants and polymer processing. Their wide acceptance in these fields of applications is attributable to their being renewable resources and biodegradable, hence environment friendly[5-6].

This development has given rise to a number of investigations on the quality and applications of vast number of African seed oils: the conophor plant (Tetracarpidium conophorum), commonly called African walnut, is a perennial climbing shrub found in the moist zones of sub-Sahara Africa[7] conophor plant is cultivated principally for the nuts which are evoked and eaten in-between meals. The proximate chemical composition of the freshly harvested mature nut according to Enuyiugha[4] contains, on a dry weight basis, 29.09% protein, 6.35% fibre, 48.9% oil, 3.09% ash and 1.2.58% carbohydrate.

Although most oils are obtained from plants (60%), a sizable quantity (36%) comes from animal sources and the rest (4%) from marine life[8]. Examples of animal fats and oils are fallow, lard, butter and cud liver oil. These animals and marine fats and oils are used extensively in industries. Hence, growth of chemical industries has stimulated a simultaneous expansion of the use of fats and oils as raw materials and also as intermediate for sources of new chemicals[9].

Alkyd resin is one of such products from oils used extensively in industries. Alkyd resins are defined as the reaction product of an oil or fatty acid, polyol and polyacid[10]. They are important vehicles for paints, varnishes and other surface coatings. Although other surface coating materials like latex resins and powder coatings were more recently discovered; alkyd resins skill remain a mainstay for a number of applications due to their balance of economies and performance.

However, most of the alkyd resins used in Nigeria for the manufacture of paints, varnishes and other surface coatings are imported alkyd resins from linseed oil and tung. It therefore becomes imperative for a search of a suitable local alternative to foreign resins, which will definitely reduce the cost of imported ones. Above all save production cost and general favourable production economies. It is against this background that conophor oil extracted from its seed was assessed for its suitability in the production of white gloss paint, and varnishes.

## MATERIAL AND METHODS

About 10kg of tetracapidum conophorum nut was bought in a Nigerian (Onitsha) market. The shells were mechanically removed and sundried for three days. The sample was ground into fine particle size and stored for oil extraction. The oil was extracted with hexane as solvent using soxhlet extractor.

The alkyd resin was produced from the oil using three necked flask attached with indirect heating system, fitted with a mechanical stirrer, a reflux condenser, a thermometer, a $CO_2$ inlet tube and sampling device[11].

The flask flushed with $CO_2$ generated by the reaction between $CaCo_3$ and HCl was placed with 25g of oil. While the oil was being heated, 29g of glycerol was slowly added through a dropping funnel for 2 minutes with vigorous agitation[12]. The reaction mixture was a little above 200°C. This was the alcoholysis state. After about 10 minutes, 45g of phthatic anhydride was added and $CO_2$ flow was increased. Stirring was intermittently done. A check on the viscosity of the product was occasionally done. When the resulting solution is fairly viscous (about 45 minutes to 1 hr), the reaction was stopped, cooled to some extent and poured into a storage container, while still hot. The UV and IR analysis were performed on both the resin and the extracted oil.

The produced alkyd resin was further used in the production of white gloss paint and varnishes as formulated below.

### Formulation of white gloss paint

31g of alkyd resin above and 17g of titanium oxide ($TiO_2$) were thoroughly mixed and then 0.3g of lead and cobalt naphthemates was also added with thorough stirring To the mixture, 0.25g of anti skinning agent and 0.25g of xylene were added. Then 2.1g of white spirit was added as solvent and the mixture was stirred thoroughly The viscosity was tested and adjusted with the solvent[11,12].

### Formulation of wood varnish (dilute)

10g of the obtained alkyd resin, 5g of cobalt naphthenate and 5g of lead napthenate were all thoroughly mixed by continuous stirring. Then 30g of the solvent, methyl isobuthyl ketone was added bit by bit with continuous stirring for about 30 to 50 minutes. The viscosity was adjusted with the solvent.

### Formulation of Wood varnish (Concentrated)

10g of the alkyd resin obtained, 5g each of both lead and cobalt naphthenates were thoroughly mixed as above. Then 20g of methyl isobutyl ketone was added with thorough stirring for 30-45 minutes[11,12].

## RESULTS AND DISCUSSION

Results of the UV and IR analysis of both the extracted oil from tetracarpidium conophorum and the prepared resin are shown in Tables 1-4.

Table 1 showed highly unsaturated olefinic bond in the oil. This indicated why the oil easily formed alkyd resin at 250°C and above. The absorption shift of the oil from 274 to 291, indicated complete condensation reaction between the oil and phthalic anhydride. This shwoed cross linking of side chains of C=C with phthalic anhydride to form polymer matrix.

The 1440- 1460cm$^{-1}$ (table III-IV) showed a shift in the binding due to saturation of the alkene bonds in the oil but a retention of the aryl bonds in the phthalic-beneze ring. This confirmed the condensation reaction between anhydride and the oil. The 3550cm$^{-1}$ absorption band showed the presence of excess glycerol that is unreacted in the condensation reaction of the alcoholysis method of resin production.

**Table 1: Ultraviolet (UV) spectrum of conophor oil**

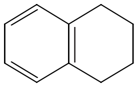
| λmax | Suspected chromophore | Description |
|---|---|---|
| 224 | -(C=C)-$_2$ | Olefin double bond attached to an alkyl chain |
| 274 | -(C=C)$_3$ OR – (C=C)$_4$ | Showing highly unsaturated olefinic bond attached to an alkyl group |
| 314 |  | Shows tocophenol ring in the oil |

**Table 2: UV spectrum of the rsin**

| λmax | Suspected chromophore | Description |
|---|---|---|
| 291 | Benzene ring with attached CO groups and alkyl groups | Phenolic chain coupled to a highly unsaturated group |

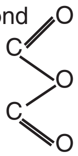
**Table 3: Infra-red (IR) spectrum of conophor oil**

| Wave band (cm$^{-1}$) | Description |
|---|---|
| 2950 | C-H stretch for alkanes attached to alkene bonds and aryl chains |
| 1750 | C= O bond stretch for esters and acid |
| 1440 | C-O stretch for alkenes |
| 1190 | C=O stretch for eseters |
| 740 | C-H bond deformation for alkyl and aryl groups |

**Table 4: IR Spectrum of Resin produced**

| Wave band (cm$^{-1}$) | Description |
|---|---|
| 3550 | O-H Stretch for esters, acids and alcohols |
| 2920 | C-H stretch for alkenes and aryl groups |
| 1730 | C=O for ketones , esters and anhydrids attached to a benzene ring |
| 1730 | C=O for ketones, esters and anhydrids attached to a benzene ring |
| 1440 | C=C attached to aryl group and alkanes |
| 1270 | C-O bond stretch for alcohol, anhydrides and esters |
| 730 | C-H deformation bond for alkyl and aryl groups |

A down shift in the ketonic group of the oil from 1750 to1730cm$^{-1}$ showed that the phthalic condensation first underwent a breakage of the bond which was used for coupling to both oil and glycerol.



From the UV and IR spectra, it was obvious that resin formed from the oil and phthalic anhydride was due to condensation reaction coupling in the presence of inert atmosphere of $CO_2$. The polymer matrix formed was proven to be the correct resins by its usage in the preparation of paint and varnishes. The paint and varnishes made from the resin had the right physical qualities such as brushability, good drying time and good hiding power. i.e. it can coat the surface smoothly.

## CONCLUSION

The uncertainty in the over reliance on raw materials from fossil fuel products has given rise for a search of renewable local alternatives for domestic and industrial uses. From the findings of this work, it is obvious that conophor oil can be used for making alkyd resin, paint and varnishes that are of high quality.

Since conorphor oil is a local drying oil and the oil percentage yield is high, it will go a long way to replace imparted linseed oil and other derivatives from petroleum products, planting harvesting and utilization of conorphor plant is recommended for the Nigerian industries and market.

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