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Utilisation of Beniseed Oil for the Production of Alkyd Resin

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Abstract: *Alkyd resins are short branched polyester chains, formed by polycondensation of a di-basic acid and a polyhydric alcohol, in the presence of glyceride oil or oil derived fatty acid. The conventional glyceride oils used for the production of alkyd resin are soya bean, and linseed oil. The most explored is the soya bean oil. Hence, this project explores the possibilities of substituting soya bean oil with beniseed oil for the production of alkyd resin. Alkyd resin was produced using beniseed oil as the source of glyceride oil. Beniseed oil extracted from sesame indicum seed was evaluated for its physicochemical properties. The extracted beniseed oil was converted into alkyd resin for use in surface coatings. The results of the analysis showed thatbeniseed oil has acid value 2.8mgKOH/g, free fatty acid (% Oleic) 1.40, Iodine value 120, density 0.925g/cm^3, refractive index 1.4772. Analyses of the alkyd resin after dilution with kerosene showed the following results: Acid index 8.6mgKOH/g;%Nonvolatile matter 70.4;Color(Gardner)14-15; Viscosity 140 poises;Density0.9902g/cm^3,surface dry(70% solid) within 15 mins. The alkyd resin was found suitable in paint. Based on the results of the study, beniseed oil has shownpotential as a substitute for soya bean oil due to its high oil content and the high degree of unsaturation and consequent ability to polymerisation.*

***Keywords*:** *Beniseed, alkyd resin, alchoholysis, esterification,condensation*

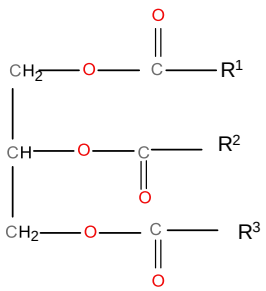
I. Introduction

Beniseed(SesamumIndicum), the oldest edible oil plant known to man, "oil queen" is also known as Gingelly, SimSims,Sesame and Till. It belongs to the family Pedaliaceae. It is amongst the most significant oil bearing seed; grown particularly in the countries of Africa and Asia (Smith, S., 1985). It is said to have originated in Africa, from where it was taken on an early date to India. In Nigeria, it is cultivated in the North Central States around Benue River and its tributaries (FAO, 1992). Nigeria is the 6th largest producer and the 5th largest exporter of beniseed.

Beniseedis a major world oil seed crop; an excellent source of fatty oil approximately 42 – 54% and protein 22 ± 25% (Hui, 1996). It also contains vitamin A, D and E.

The oil is noted for its excellent stability due to the presence of antioxidants such as sesamolin, Sesamine, and sesamol. It is resistant to oxidation, while the seeds are prone to rancidity.Beniseed oil occur as triglycerides of long chain fatty acids (fig.1);which is mostly composed of triglycerides of mono unsaturated oleic acid 40% and the doubly unsaturated linoleic acid 45% beside 10% saturated fats. The absence of triple unsaturated fatty acids and presence of antioxidants give it an excellent shelf life.

Beniseed oil based on the predominant fatty acid belongs to the oleic/linoleic acid group like Soya bean, cottonseed, peanut and sunflower oils. It is classified as a semi drying oil due to its ability to "air dry" forming a coherent film on exposure to the atmosphere;this directly is related to the fatty acid composition (Eckey, E.W., 1954).



Where R^1, R^2, R^3 are the fatty acid residues

Fig. 1. General structure of glyceride oil.

In view of itstheoretical high oil content approximately 55%,this study explores the possibility of substituting soya bean oil with Beniseed oil for the production of alkyd resin.

The high iodine value of beniseed oil classifies it as a semi – drying oil used in alkyd resin formulations for surface coatings.

Alkyd resins are short branched polyester chains, formed by polycondensation of a di-basic acid and a polyhydric alcohol, in the presence of glyceride oil or oil derived fatty acid. Also, an alkyd is called a polymer formed by chemical synthesis of smaller molecules (Panda, H., 2010).They are used for the production of surface coatings: decorative paints, varnishes, printing inks air drying and stoving industrial paints etc. The process of producing alkyd resin involve: alcoholysis, esterification, and condensation (fig. 2). In this study, substitution of soyabean oil withbeniseed oil was investigated.

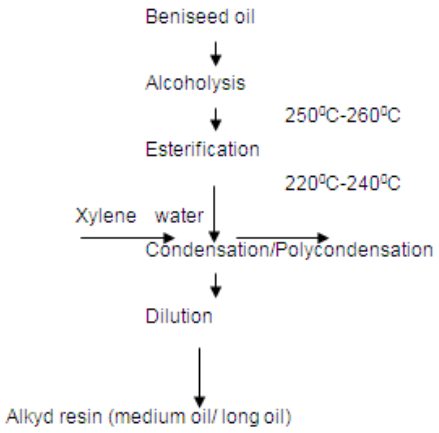


Fig. 2: Production of alkyd resin from beniseed oil.

II. Experimental Procedures

Oil samples were extracted from beniseed using FIIRO fabricated vegetable oilmechanical press. Residual oil was recovered by solvent extraction using a soxhlet (Igbo et al., 2005). The oils extracted were degummed, and characterized according to official standard methods (AOAC, 1980). Some of the physicochemical parameters tested include: density, refractive index, odour, and acid index, and iodine value. The results are shown in Table1.

Alcoholysis

500gm of Beniseed oil was reacted with a combination of 170gm pentaerythritol and 30gm glycerol to give a product capable of taking part in the esterification/condensation reaction. Alcoholysis was carried out at temperature of 250-260^{0}C with the reactor under inert gas pressure to prevent ingress ofair, which would result in discoloration of the product.The progress of the ester interchange was monitored by measuring the tolerance of the reaction mixture towards methanol. Lithium hydroxide catalyst was added to speed up the reaction.At the end of alcoholysis, the reactor was cooled to about 180^{0}C.

Esterification/Condensation

300gm Pthalic anhydride was charged and the reactor heated to 220-240^{0}C for esterification. Water of reaction was removed by azeotropic distillation using xylene. The progress of esterification /condensation reaction was monitored by the increase in viscosity of the resin and by the measurement of the acid value. Acid value and viscosity were measured initially at 30minutes interval and then 15minutes interval until desired acid value for the corresponding viscosity was obtained (fig.3). Reaction was terminated, cooled and diluted with kerosene.

Data presented are average of triplicate determinations(Table 2).

III. Result And Discussion

Result as stated below is an average of triplicate determinations. The course of the reaction was controlled by monitoring the increase in viscosity of the resin (which reflects the increase in molecular weight) and by the determination of acid value.

Table 1: Physicochemical Properties of Beniseed Oil

S/N	Parameter	Oil
1	Oil content (%) Residual oil from press cake	Approx 16 33
2	Colour	Golden yellow
3	Odour	mild
4	Acid Index(MgKOH/g)	2.8
5	Free fatty acid(% Oleic)	1.4
6	Iodine value	120
7	Density(g/cm$^{3)}$	0.925
8	Refractive Index	1.4772

Table 2: Physicochemical Properties of BSO*Modified Alkyd Resin

S/N	**Parameters**	**Result**
1	Acid Index(MgKOH/g)	8.6
2	Non- volatile (%)	70.4
3	Color(Gardner)	14-15
4	Viscosity(poises)	140
5	Density(g/cm^3)	0.9902
6	Surface dry(70% Solid)	15mins
7	Gloss level	Standard

BSO* Beniseed oil

Table 3: Acid index/Viscosity Relationship

ACID INDEX MgKOH/g	VISCOSITY(Poises)
35.24	1.40
25.89	2.20
22.50	3.80
20.50	5.00

The reaction was terminated at 20.5mgKOH/g of the resin and diluted with kerosene.

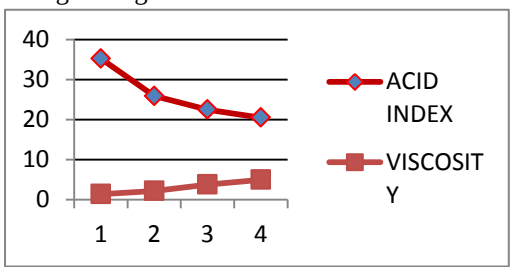


Fig 3: Graph of Acid index/ Viscosity Relationship

From the result obtained (fig.3), acid value reduced with time while viscosity increased rapidly with time. The course of the polymerization reaction of beniseedoil followed the standard plot for alkyd resin production.

IV. Conclusion

The resin produced using beniseed oil has good surface drying properties and gloss retention.Following the result obtained, beniseed oil has good potential as a substitute to soya bean oil in alkyd resin production. This is based on its high susceptibility to polymerization reaction and its suitability in paint.

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