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Production and Characterization of Paint Driers From Sand Box Seed Oil (Hura Crepitans)

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ABSTRACT

This project is concerned with production and characterization of paint driers from sand box seed oil (Hura Crepitans). The physicochemical properties and fatty acid composition of the sand box seed oil (Hura Crepitans) were determined. The sand box seed oil was utilized in the preparation of metal soaps (driers) of zinc, copper and nickel. The metallic soap were characterized and applied in gloss paint as driers. The lipid content of sand box seed was found to be 57.2%. The iodine value, saponifiaction value, acid value, free fatty acid, peroxide value, specific gravity and refractive index were determined using standard procedures and the values were 149.64gI_2/100g, 220.19mgkoH/g, 7.09mgKoH/g, 4.612%, 20.01mg/kg, 0.9128 and 1.36 respectively.

Gloss paint was formulated using standard procedure and the metallic soaps were incorporated into the paint as driers. Performance test showed that the metallic soaps acted as a catalyst in the paint matrix, thereby reducing the drying time. The quality control parameters of the gloss paint were compared with industrial commercially available gloss paint. The quality of the prepared metallic soap paint competed favourably with the selected commercial paints.

Keywords: sand box seed (hura crepitans), metallic soap (driers), gloss paint.

1. INTRODUCTION

African and indeed most tropical and sub-tropical countries are blessed with numerous seed and fruit. Many of which are yet to be fully exploited due to a death of information on their chemical, biological and industrial importance. One of such seed bearing plants is HURA CREPITANS commonly referred to as SAND BOX SEED TREE. Over the years, there has been a spectacular increase in the world demand for both oil and oil meals with attending uptrend in prices (Miekel, 1998). Estimates available on future production indicate that this trend will continue (Kaufman, 1990).

During the 20th century, the non-edible uses of oil seed products declined substantially due to the availability of relatively inexpensive oil derived from fossil reserves. It is however now realized that the fossil reserves could be exhausted or becomes shorter in supply and are not renewable (Boelhouwer, 1983). As such, looking into alternative oil sources remain a subject of active investigation, Although, such oils are not expected to replace petrochemicals in their entirety. (Hardwood 1984). But their application as lubricating oils, emulsifiers, retardant agents, or components of cosmetics for example; could be very important.

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Sand box tree seed can be a very good source of industrial oil, but over the years, attention has been more on the ornamental use by the tree. Sand box tree is a member of the family euphorbicaea, the genus hura, it has about six species and this particular species is native to the north and south American Amazon rainforest. The tree is typically planted in towns and villages for shades and is capable of regenerating naturally. It grows up to 16m and about 2.5m in base diameter with a wide spreading crown, branching low and down. The trunk is very thorny with a highly acidic exudates when cut open. This lead to the erroneous belief that the tree is capable of causing epilepsy, but researchers carried out over the years have proved the rural dwellers wrong (Akpan Rasmen E. 1993). According to Onochie F.A. and Keachy R.W.J (1960) Flowering of the tree is usually at the beginning of and the end of the rainy season.

Metal carbohydrates otherwise called metal soap have been described as alkaline – earth or heavy metal longchain carbohydrates (Barth, T.F.W 1982) which are insoluble in water but soluble in non-aqueous solvents. Their solubility in organic solvents on the other hand, accounts for their use in wide range of industrial products (Ekpa O.D, Fubara E.P, Morah E.N. I 1994).

Soaps of barium, cadmium, lead and calcium have found practical applications as thermal stabilizers for polyvinyl chloride (Owen, E.D, Msayib, K.J 1989). Calcium and magnesium soaps are used as corrosion inhibitors in non-polar media, lead, nickel, cobalt and zinc soaps are used in paint to accelerate drying (Salager, J. surfactants, 2002). The paint industry is probably the highest consumer of metallic soaps with the phasing out of lead as the primary drier in paints, metallic soaps have become essential components in the manufacture of both emulsion and gloss paint (Mackey W.M, Ingle, H.C, 1996). Soaps of the transition metals act as driers in paint, while those of aluminum, calcium and magnesium function as flattening or leveling agents (Payne, H. F 1998). Metallic soaps are available commercially and are sold as solids, liquids or powders. They are prepared from fatty acids either by fusion or precipitation process (Morley – smith, C.T 2001).

A number of seed oil have been characterized, but the vase majority have not been explored for the preparation of metal carboxylates despite being the most abundant source of carboxylic (fatty) acids. Sand box seed oil are known to have drying properties, their use in the preparation of metallic soaps required in the paints could greatly reduce the amount of foreign inputs necessary for the production of paint (Addo et al 2009). Hence the aim of this work is to produce and characterize driers from sand box seed oil (Hura crepitans) and evaluate their performance as a drier in gloss paint.

2. PURPOSE OF THE STUDY

The main purpose of the study is to produce and characterize paint driers from sand box seed oil (Hura crepitans) from which the following specific purpose are derived.

1. To ascertain suitable procedure for the production and characterization of paint driers.
2. The application of driers from oil of Hura crepitans.
3. To fashion out strategies for reducing over dependence on importation of materials used in paint production

3. MATERIALS AND METHODS.

3.1 MATERIALS

Abbe refractometer ($PZOR_{12}$), garder delta color comparator (CG-6745), mechanical stirrer, thermostatic heating mantle and sand box seed.

3.1.2 REAGENT:

n-hexane, sodium hydroxide, methanol, toluene, potassium hydroxide, hydrochloric acid and phenolphthalem.

3.2 METHOD:

Extraction of Sand Box Seed Oil.

Two methods of oil extraction were employed; mechanical method were sand box seed were winnowed, sundried and reduced to fire meal by the use of a mechanical grinder and solvent extraction method using n-hexane (b.p range 40-60^0C) as solvent to ensure complete extraction of the oil. The oil obtained were processed through degumming Alkali refining and bleaching of refined oil to remove the contaminations that might have occur during extraction of the oil. After that the oil were characterized using standard procedures, the following were determined:

- Refractive density with pycnometer
- Refractive index with Abbe Refractometer at 27^0C.
- Acid value
- Saponification
- Iodine value etc.

The oil obtained were used in the preparation of the metallic soaps/drier. Metallic soaps of nickel, zinc and copper were prepared by methods adopted by Ekpa et al 1995. The properties of the prepared metallic soaps were determined using standard procedures. The parameters assessed were percentages yield, PH, color, texture, moisture content, melting point, apparent bulk density, foaming characteristics, total ash content and solubility in water, kerosene, acetone and methanol.

3.2.1 GLOSS PAINT PRODUCTION

Formulation for paint production were performed by preliminary trails by varying the amounts of each of the components. The quality of components in table 1 gave the best results. The first six components of mixture (Table 1) were stirred for 30 minutes and after switching off the mixer, other components were added and thoroughly stored. The paint so obtained was stirred. The paint was poured into containers and the metallic soap (drier) was introduced in varying amount.

Table 1: **Main Constituents for Making Gloss Paint.**

Components	**Values (g)**
Titaniumdioxide (T_10_2)	40
Alkyd Resin	30
White spirit	10
Easigel	3
Leuthin	3
Kerosene	5
Anti-skin	2
Silico resoultion	2

Source: Flick, F.J. ind.sc 7 (2001) 12

3.2.2 DETERMINATION OF PAINT QUALITY

The quality analysis of the prepared gloss paint was performed using standard procedure. The parameters examined include; viscosity, density, percent solid or non volarity content, drying time, dust free, (DF), full hardness (FH), dry for recoating (DFR), adherent to surface, resistance to water, and heat (Payne, HF 1998).

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RESULTS AND DSICUSSION

The physicochemical characterization of sand box seed oil are presented in table II. The total lipid content was found to be 57.26%. the result for the iodine value, saponification value, specific gravity and refractive index were 149.64gl$_2$/100kg, 220.19mgkoH/g, 7.01mgKoH/g, 4.612, 20.01mg/kg, 0.9128 and 1.36 respectively. The iodine value of hura crepitans oil indicates that the oil is a drying oil. The class of oils whose iodine value is above 130 posses the property to absorbing oxygen on exposure to the atmosphere, they become thicker and remain sticking but do not form hard dry film. They are used in the production of driers while the saponifaction value of 220.18mgKoH suggest that the oil could be good for soap making, paint driers and in the manufacturing of shaving cream. (J.Mater 2012).

Table II: Physicochemical Properties of Sand Box Seed Oil (Hura Crepitans)

TEST	**VALUES**
Specific Gravity	0.9128±0.1
Relative viscosity, NSM^{-2}	5.91±0.2
Refractive Index 25^0C	1.36±0.1
Moisture content %	27.30
PH	4.46
Boiling point ^{0}C	220-330
Saponification value, MgKoH/g	220.19±0.4
Colour	Pale yellow
Acid value MgKoH/g	7.09±0.2
Free fatty acid %	4.612±0.1
Iodine value g/$_2$/100g	149.64±0.2
Lipid content%	**57.26**
Peroxide value Mg/kg	**20.00**±0.3

Table III: Fatty Acid Composition of Sand Box Seed Oil. The fatty acid profile of Hura crepitan seed oil revealed the presence of five fatty acid:

	FATTY ACID	**PERCENTAGE COMPOSITION (%)**
1.	palmitic	10.68
2.	steatric	8.33
3.	oleic	13.75
4.	linoleic	62.23
5.	linolenic	5.39

The fatty acid composition of sand box seed oil (Hura crepitans) is comparable with values obtained in previous studies for other Hura crepitans species of the pure fatty acid. Linoleic acid is the most prevalent with the relative abundance of 62.23% which is reported to be a drying agent in seed oil. The total saturated and unsaturated fatty acids content of hura crepitans seed oil are 18.8 and 81.8% respectively.

Table IV: Properties of the Prepared Metallic Soaps/Driers.

TEST	NICKEL SOAP	COPPER SOAP	ZINC SOAP
PH Range	6.72-6.87	4.97-6.81	**5.30-6.70**
Colour	Green	Blue green	White
Texture	Powder	Powder	Powder
Moisture content (%)	0.40	0.41	0.48
Melting point	115	110	120
Apparent bulk density	0.81	0.77	0.77
Total ash content	17.82	15.46	17.50
Yield %	45%	50%	55%
Metal content	6.20	14.21	12.20
Foaming characteristics	Does not foam in water	Does not foam in water	Does not foam in water
Solubility	Insoluble in H_20 and soluble in kerosene and acetone	Insoluble in water and soluble in kerosene, acetone and methanol.	Insoluble in H_2O and soluble in kerosene, acetone and methanol.

The properties of the metallic soaps of N_I, Cu, Zn as presented in table IV above, shows that the yield ash contents and melting point of N_I soap, Cu soap and Zn soap respectively are comparable with the data reported for metal soap prepared from palm kernel oil (Ikpa et al, 1991).

Among the three states metallic soaps, Zn soap exhibited the highest quality value yield 55%, melting point 120^{0}C and moisture content 0.48%, PH range 5.30-6.70 and white powder properties applicable to different shades of paint products.

ANALYSIS OF THE PREPARED PAINTS

The gloss paint formulation were obtained by varying the quantity of metal soaps/driers incorporated into the paint matrix which yielded sample A,B,C and sample D.

(Table V) for optimum result, the metallic soaps were combined to serve as active and auxiliary driers. Cu soap (active or surface driers) combined with Zn soap (auxiliary driers) while N_I soap functioned as stabilizers. (Bennett, E.E 1996).

TABLE V: FORMULATION OF GLOSS PAINT

Component	Sample A (g)	Sample B (g)	Sample C (g)	Sample D (g)
Metallic soap (drier)				
Nickel	2.5	3.0	5.0	
Zinc	3.0	3.5	8.5	
Copper	3.0	4.0	5.8	
Titaniumdioxide	40.0	40.0	40.0	40.0
Alkyd resin	30.0	30.0	30.0	30.0
White spirit	10.0	10.0	10.0	10.0
Easigel	3.0	3.0	3.0	3.0
Kerosene	5.0	5.0	5.0	5.0
$CaCo_3$	8.6	8.6	8.6	8.6

Table VI: Drying Properties of the Paints

Sample	Oil used	Colour of paint	Drying time			
			DF min	TF Min	DFR Min	FH Hrs
A	SBSO	White	12.00	16.00	21.00	7.20
B	SBSO	White	11.00	14.00	19.00	6.40
C	SBSO	White	10.00	12.00	17.00	6.00
D	SBSO	White	1 day	1 day	2 day	none

DF = Dust free

TF = Tact free

DFR = Drying for recoating

FH = Full hardness

SBSO = Sand box seed oil

Table Vii: Adherence to Surfaces of the Paint Samples

Sample	Wood	Metal	Wall	Glass
A	VG	Ex	EX	G
B	VG	EX	EX	G
C	VG	EX	EX	G
D	P	P	G	p

EX = Excellent, VG = Very good, G = Good, P = Poor. Excellent means film did not show any sign of cracking or peeling after few months. Very good indicates no cracking r peeling but required second coating for high gloss. Good indicates film not strongly adhering surfaces and could not peel off when scratched, poor implies no adherence.

Table VIII: Comparison of Quality Parameters of the Paints with those of Industrial Paints.

Quality parameters	Paint Samples			Industrial Paints			
	Sample A	Sample B	Sample C	Saclux	Clover	Kingmos	Rayal
Density, g/m/	1.31	1.33	1.38	1.28	1.26	1.30	1.29
Percent solid content %	66.00	69.00	71.00	72.70	60.00	58.00	70.00
	26.70	27.30	27.50	26.00	25.20	26.00	27.00

DETERMINATION OF PAINT QUALITY

The drying properties and colour of the paint samples are listed in Table VI. The time required for each of the paint samples to attain full hardness (FH) ranged from 6.00-7.20 hours. The fatty acid portion of the metallic soap acted as a plasticizer by solvating the polymer molecules to reduce crystalinity; increase flexibility to prevent cracking and peeling off of the paint after application. All the paints had god adherence properties as presented in Table VII. The metallic property in the soap is responsible for the catalytic process leading to the drying of the paints which includes cross-linking of the fatty acid double bonds. None of the paints treated with the metallic soap showed any signs of chalking, mildew formation, settling or skinning during the period under observation (12 weeks). The quality control parameters of the gloss paint Table VIII were compared with industrial commercially available gloss paint. The quality of the prepared metallic sap paint samples competed favourably with the selected commercial paints.