International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 10 Issue 6, June 2023

ISSN: 2394-4404

Formulation Of A Semi-Gloss Paint Using Sesamum Indicum Seed Oil- Modified Alkyd Resin As A Binder

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Abstract: ***In this study, Sesamum indicum seed oil-modified alkyd resin was used as a binder in the formulation of a solvent based Semi-gloss paint. The physicochemical characterization of the paint indicates that it's a good paint with relatively very low VOC emission which conformed with the standard of the environmental pollution regulatory bodies in terms of chemical toxicity. The formulated semi-gloss paint at 40%, 50% and 60% oil lengths have a pH of 7.82, 7.80 and 7.83 respectively which met up with the SON standard. The semi-gloss paints densities were 1.31, 1.27 and 1.23 g/cm^3. It was observed that the 40% oil length semi-gloss paint had the shortest drying time of 15-20 and 85-90 minutes for the set to touch and set to hard drying schedules against 20-25 and 90-95 minutes for the 50% oil length and 25-30 and 95-100 minutes for the 60% oil length semi-gloss paint. The formulated semi-gloss paint exhibited good adhesion, tackiness, opacity, flexibility and stability properties. The paint also possesses good resistance to blistering; hence, it indicates that it has good external exposure resistance and thus; can perform well when exposed to environmental conditions such as rain and sun. The refractive indexes were 1.484, 1.470 and 1.450 respectively for the 40%, 50% and 60% oil lengths which contributed in the glossiness of the semi-gloss paint thus formulated. The paint also shows very good resistance to chemical mediums (Ionic, Alkaline and Acidic), hence, the paint possesses good stability and durability properties.***

Keywords: Alkyd resin, Binder, Paint, Semi-gloss

I. INTRODUCTION

Vegetable oils are triglycerides (esters composed of triol and fatty acids) the fatty acids present in a vegetable oil may be saturated or unsaturated depending on the nature of bonds present. In their solid state or room temperature, they are termed as fats and are extracted from the seeds of oil-bearing plant species (Akpan et al., 2006). Sesame (*Sesamum indicum L*), also known as sesamum or benniseed is member of the plant family *Pedaliaceae*, it is one of the most ancient oilseed crops known naturally. The seeds are rich in protein and the protein inherent has amino acid profile with great dietary benefit (National Agricultural Extension and Research Liaison Services, 2010). Sesame is found in tropical, subtropical, and southern mild areas of the world, significantly in China, South America, India and Africa. It is of high economic importance

ISSN: 2394-4404

and primarily grown by small scale farmers in developing countries (Dim et al., 2012)

Paints can be thought of as a colloidal mixture of chemical components that, when applied in a thin layer to a surface, forms a layer that is dense, uniform, and adhering (Ali Mutar et al., 2017). Paints are frequently employed in our daily lives for decorative purposes and to protect surfaces from various environmental influences because they are UV-polymeric in nature and stick to the substrate (Standards Organization of Nigeria (SON), 2006).

These substances, known as diluents or thinners, are typically flammable liquids like mineral turpentine or organic solvents like xylol or acetone. The diluents, however, are categorized as volatile organic compounds, or VOCs, which are known to be harmful to the environment (Osemeahon & Barminas, 2007).

As a result, environmentally safe paint formulation is necessary. Environmentally friendly formulations include dimethyol urea formaldehyde paints, oil modified alkyd paints, and paints using amino resins, among others (Fadawa et al., 2018). Pigments, extenders, vehicles or binders, thinners, and driers make up paints (Lambourne J.R. and Strivens T.A, 1999)

The type of paint, such as gloss paints, semi-gloss paints, eggshell paint, satin or low sheen paint, flat paint or emulsion paint, and latex paint, is determined by the composition of the paint; Virtually all of the solvents or thinners used in paints include VOCs. The weight of the VOC relative to the volume covering is often used to express the amount of VOC (Arișanu, 2013).

The presence of VOCs are unsafe materials to the climate, they pollute the air and cause wellbeing hazard to people. Formaldehyde emanation prompts intense and ongoing wellbeing impacts relying upon the soundness of the person. The normal side effects from intense openness to formaldehyde show as bothering of the throat, eyes, nose and skin. Ongoing openings have the accompanying side effects, for example, constant running nose, persistent bronchitis and blockage (Kasyanenko & Kramarenko, 2018). The essence of this study is to formulate a semi-gloss paint using Sesamum indicum seed oil modified alkyd resin (SISOMAR) as a binder.

II. EXPERIMENTAL PROCEDURES

A. MATERIALS

Sesamum indicum Seed oil modified alkyd resin (SISOMAR) was obtained from Department of Chemistry, Modibbo Adama University of Technology, Yola, Adamawa State. Analytical grades reagents of $CaCO_3$ (Extender), TiO_2 (Pigment), PbO (Drier), Ethylene glycol, Kerosene, Thinner and Stabilizer. The glass wares used were 500 ml and 250 ml beakers, Glass rod, Electric Stirrer, Digital pH meter, Digital Refractometer and Gloss meter.

B. METHODS

The semi-gloss paint was formulated by employing the procedure outlined by Sanyaolu *et al.,* (2019). A portion of 93.75g of pigment was introduced into a containing vessel which was well washed and dried with distilled water, this was followed by the addition of 25g of kerosene which served as solvent; the mixture was stirred for about 5 minutes. This was followed by the addition of 156.25g of alkyd resin and 37.5g of xylene which was stirred continuously for about 30 minutes to ensure proper mixing using a paint stirring machine, 2g of easy-gel which served as a dispersing agent was added followed by the addition of MEKO (Methyl ethyl glycol) which served as an anti-skinning agent, this was followed by continuous stirring for about 10 minutes, finally 2g of soya lecithin which served as an emulsifier was added with 5g of mixed drier which served as a drying agent, the mixture was stirred again vigorously for about 5 minutes. A semi-gloss paint of was formed which was ready for application and further characterization. Table 1 highlights the varying proportions of the semi-gloss paint in 250cm^3 formulation.

Components	Amount (g)
Alkyd resin (binder)	156.25
Pigment (TiO_2)	93.75
Xylene	37.5
Kerosene (Solvent)	25
Mixed drier (PbO)	5
MEKO (Anti-skinning agent)	2
Easy gel (Dispersing agent)	2
Soya lecithin (Emulsifying agent)	2

Table 1: Recipe for the formulation of Semi-Gloss Paint

III. RESULTS AND DISCUSSIONS

A. PHYSICOCHEMICAL PROPERTIES OF THE SEMI-GLOSS PAINTS FORMULATED FROM SESAMUM INDICUM SEED OIL-MODIFIED ALKYD RESIN (SISOMAR)

The physicochemical properties of the semi-gloss paints formulated were determined according to standards enumerated by (Osemeahon & Barminas, 2007), the results were summarized in tables 2 and 3 respectively.

It was observed that the 40%, 50% and 60% oil lengths semi-gloss paint formulation exhibited good resistance to both brine and distilled water but they were less resistant to the acidic and basic media to some appreciable extent having been immersed for 48 hours as shown in Table 2. This indicates that the formulated semi-gloss paint is therefore suitable for application and can withstand some environmental condition.

Some physical properties of the semi-gloss paint formulated from Sesamum indicum seed oil-modified alkyd resin (SISOMAR) has been highlighted in Table 3. As seen from the Table, properties such as tackiness, opacity, flexibility, adhesion, blistering, pH, glossiness, refractive index, density, stability and drying time schedules of the

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formulated semi-gloss paints fall within the acceptable ranges for paints (Standards Organization of Nigeria (SON), 2006)

It was recorded that the semi-gloss paint samples were all resistant to blistering and as a result can serve for both interior and exterior coating when undiluted paint samples were applied on a glass panel with a brush to give a wet film thickness of about 120mm and was allowed to dry for 24 hrs., which was followed by the introduction of 4 ml of distilled water in the form of circular drop was on the film formed. The presence of blistering, wrinkling, swelling or cracking within a period of 30 minutes indicated poor water resistance on observation (Osemeahon et al, 2013)

This result indicates that the semi-gloss paint thus formulated is stable and possess good external exposure resistance. This implies that the paint can perform well when exposed to environmental conditions such as rain and sun as reflected by the resistance to blistering property.

The autoxidation process, which causes an alkyd to dry hard and produce long-lasting coatings, is dependent on drying time. It has to do with the amount of double bonds in the oil as determined by the iodine value (Muizebelt et al., 2000). This implies that the higher the iodine value, decreases the drying time.

The drying time of the paint samples was evaluated according to (Osemeahon & Barminas, 2007) method. Sample of paint were applied on a glass panel with the aid of bar applicator and allowed to dry. Dry to touch were then taken when the paint film was no longer sticking to the finger while dry to hard were taken when the film resisted finger touch (Osemeahon et al., 2013). All the paint samples formulated exhibit hard-dry time within the standard.

The drying time of the paint depends on the environment, mainly temperature and humidity. It was observed that the formulated SISOMAR Semi-gloss paint met specifications for oil paints drying schedules, the set to touch of the 40%, 50% and 60% semi-gloss paints formulation were 15-20, 20-25 and 25-30 minutes whilst set to hard were 85-90, 90-95 and 95-100 minutes respectively, the set to touch times for the 50% and 60% semi-gloss paints were slightly higher than the standards set by (Standards Organization of Nigeria (SON), 2006). It can be deduced that the 40% oil length semi-gloss paint had a shorter drying time. It has been reported that higher oil content of 60% (long) and 50% (medium) oil alkyds gave slower initial drying due to more thermosetting of long oil alkyd as compared to 40% (short) oil alkyd (Singh, 2009).

This trend was similar to reports by Oladipo et al., (2013) for 40%, 50%, 60% and 70% oil lengths of the *Ximenia Americana* (Wild Olive) Seed Oil (XASO). The varying drying times exhibited by the various oil lengths of the SISOMAR could also be attributed to their iodine value of 122g I_2/100g which is a measure of their degrees of unsaturation and thus influencing their drying schedules as have been highlighted. The result can be related to the values obtained from literature reports of (Oladipo et al., 2013) whose Ximenia Americana oil gave 152.28g I_2/100g, (Ikhuoria et al., 2003) whose rubber seed oil yielded 136.2g I_2 /100g and to (Abdullahi et al., 2019) whose *Luffa aegyptica* seed oil yielded 123.28g I_2 /100g. It can be concluded that the SISO is a semi-drying oil whose iodine value fell in the range 120-150 g I_2 /100g (Majumder, 2006). Semi-drying oils have various applications such as in the synthesis of alkyd resins for the paint industry and manufacture of soap to mention but a few, whereas the non-drying oils are majorly employed as plasticizers (Aigbodion & Pillai, 2001).

The density of the paint can be attributed to the measure of the formulation in the paint. The densities of the 40%, 50% and 60% semi-gloss paint formulations were 1.23, 1.27 and 1.31g/cm^3 and it was observed that the 60% oil length semi-gloss paint had a slightly higher density when compared with the 40% and 50% oil lengths semi-gloss paints. Their densities were within the range stipulated by (Standards Organization of Nigeria (SON), 2006)1-12g/cm^3.

The refractive index results also indicated in table 3 show that the SISOMAR paint have refractive index value within the range specified for a semi-gloss paint which impart greatly on the glossy nature of the semi-gloss paint which was profound. The gloss of the formulated semi-gloss paints is the amount of smoothness of light a surface reflects. It was observed that the 40% oil length alkyd resin exhibited better semi-gloss property which could be attributed to its lower oil length ratio. The cream colour of the paint is attributed to the colour of the alkyd resin used for the formulation.

The flexibility of the formulated semi-gloss paints which is the ability of a coating to be bent or flexed without getting cracked or undergoing other failure. The paint samples exhibited good flexibility as they all withstood the bending force applied to them without getting deformed or cracked after bending of the aluminum panel with the film smoothly through 180^o for 1-2 seconds (Osemeahon et al., 2013), as enumerated in table 3.

Tackiness was done qualitatively on the dried film by hand feeling to find out if the paint film is sticky or not. Stickiness of a dried paint film is an indication that the film is tacky. Triplicate samples were used for each determination and the average assessment was noted (Osemeahon et al., 2013). It was observed that the semi-gloss paints exhibited good tackiness on the applied substrate.

It was also observed that the 40%, 50% and 60% oil lengths semi-gloss paint formulation exhibited good resistance to both brine and distilled water but they were less resistant to the acidic and basic media to some extent after been immersed for 48 hours as seen from Table 2.

Media	40% oil length SISOMAR	50% oil length SISOMAR	60% oil length SISOMAR
Distilled water	N	N	N
Acid (0.1M HCl)	S	S	S
Base (0.1M NaOH)	R	R	R
Brine (0.1M NaCl)	N	N	N

Key:
N = No effect
R = Removal
S= Shrinkage

Table 2: Chemical resistances of the paints formulated with SISOMAR

ISSN: 2394-4404

S/n	Physical property	40% Oil length SISOMAR paint	50% Oil length SISOMAR paint	60% Oil length SISOMAR Paint	SON standard
1	Tackiness	Pass	Pass	Pass	Pass
2	Opacity	Pass	Pass	Pass	Pass
3	Flexibility	Pass	Pass	Pass	Pass
4	Adhesion	Pass	Pass	Pass	Pass
5	Ph	7.82	7.80	7.83	7-8.5
6	Blistering	Pass	Pass	Pass	Pass
7	Glossiness	Pass	Pass	Pass	Pass
8	Refractive index	1.450	1.470	1.484	1.47-1.50
9	Density	1.31	1.27	1.23	1.01 (Min)
10	Drying Time (min) Set to touch	15-20	20-25	25-30	20
	Set to hard	85-90	90-95	95-100	120
11	Stability	Pass	Pass	Pass	Pass

Table 3: Analysis of some of the physical properties of semi - gloss paints formulated from 40%, 50% and 60% oil lengths SISOMAR

This stability of the formulated semi-gloss paints was carried out by completely sealing the paint sample in a container and leaving it there for two months at ambient temperature. The sample was again observed after this time of incubation to check for any coagulation or changes in viscosity. The semi-gloss paints passed the stability tests over the time period. A pass is considered to be the absence of coagulation or any change in viscosity as enumerated in table 3. it can be deduced that the semi-gloss paint thus formulated is comparable to those previously reported in literatures as shown in table 4.

S/n	Physical property	SISOMAR Paint	XASOMAR Paint *	LASOMAR Paint**
1	Opacity	Pass	Pass	Pass
2	Glossiness	Pass	Pass	Pass
3	Flexibility	Pass	Pass	Pass
4	Adhesion	Pass	Pass	Pass
5	Ph	7.82	NA	7.82
6	Resistance to blistering	Pass	Pass	Pass
7	Refractive index	1.450	NA	1.48
8	Drying Time (Hrs) Surface dry	<2	<2	2-3
9	Stability	Pass	Pass	Pass

Key:
XASOMAR: Ximenia Americana seed oil-modified alkyd resin.
LASOMAR: Luffa aegyptica seed oil-modified alkyd resin.
**(Oladipo et al., 2013)*
***(Abdullahi et al., 2019)*

Table 4: Comparison between some of the physical properties of semi - gloss paints formulated (SISOMAR) with other reported literatures

IV. CONCLUSION

An oil-modified alkyd resin was used as the binder in the formulation of a semi-gloss paint. According to the paint's physicochemical characteristics, which include blistering, adhesion, tackiness, opacity, flexibility, and stability, it is a promising paint that can survive environmental conditions. The paint is ideal for use in an area already challenged by pollution caused by VOCs because it emits comparatively little VOCs when compared to conventional oil-based paints. The paint also exhibited excellent resistance to chemical media, demonstrating its high stability and durability properties.

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