

# Potential of Virgin Coconut Oil in the Production of Lacquer Enamel Paint

Lina Depra dela Cruz

**Abstract** – Virgin coconut oil, which can only be achieved by using fresh coconut meat or what is called non-copra, is widely produced in the Philippines.

Paint, the group of emulsions generally consisting of pigments suspended in a liquid medium is used as decorative or protective coatings. Paint is usually formulated with a binder using linseed, soya, safflower oil or refined coconut oil.

Virgin coconut oil has not yet been explored as a binder but its usage in the paint industry can contribute to the upliftment of the economic status of small scale-entrepreneurs.

Virgin coconut oil, abundant in the Philippines, is investigated as potential binder in the production of white lacquer and clear gloss lacquer enamel paint. After a formulation was identified using virgin coconut oil, the paint was mixed and evaluated in terms of manufacturing control tests, evaluation tests and evaluation of acceptability by end users.

The properties of white lacquer enamel paint mixed with virgin coconut oil in terms of density, 4.57 kg/ gal; flexibility; gloss, 79.1<sup>0</sup>; drying time, 12 hrs; and resistance to chemicals showed comparable results with paint mix with refined coconut oil.

The properties of clear gloss lacquer enamel mixed with virgin coconut oil in terms of density 3.62 kg/ gal; gloss, 71.5<sup>0</sup>; flexibility and drying time in 6 sec. showed comparable results with paints prepared with refined coconut oil

The evaluation of acceptability by end users from different industries showed favorable results.

In conclusion, virgin coconut oil can be used as a potential binder in the production of lacquer enamel paint.

**Key Words:** binder, lacquer enamel, paint, refined coconut oil, virgin coconut oil

## I. INTRODUCTION

Coconut oil, also known as coconut butter, is tropical oil extracted from copra (dried inner flesh of coconuts) with many applications. Coconut oil constitutes seven percent of the total export income of the Philippines, the world's largest exporter of the product.

Unrefined coconut oil, also known as Virgin Coconut Oil (VCO), is coconut oil that is derived from fresh coconuts, not copra, and has not undergone the refined, bleached, deodorized (RBD) process that refined coconut oil derived from copra has gone through. Commercial grade coconut oils are made from copra. Copra is basically the dried kernel (meat) of coconut. (How is Coconut Oil Produced: Refined Coconut Oil, the Coconut Diet)

Lina D. dela Cruz is with the Chemical Engineering Department of the Technological Institute of the Philippines, Aurora Boulevard, Quezon City Philippines, Phone +6329110965 / +6329110970; Fax +6329130131. (email: [linadelaacruz22@yahoo.com](mailto:linadelaacruz22@yahoo.com))

Paint is the group of emulsions generally consisting of pigments suspended in a liquid medium for use as decorative or protective coatings. The word *paint* covers a whole variety of decorative and protective coatings used to impart a high degree of protection to engineering, building, and other materials.

## Background of the Study

The paints and coating industry is divided into two distinct subsectors—architectural and industrial.

Architectural coatings include interior and house paints, primers, sealers, varnishes, and stains. (U.S. Paint and Coatings Industry Market Analysis, 2006-2011).

Paint consists of four main components: pigments, binders, solvents, and additives. Pigment gives color to paint and, in its raw form it is fine powder. Binder is what holds the pigment, and what adheres it to the surface are principally natural polyunsaturated drying oils, such as tung, fish, linseed soya oil and coconut oil. There are numerous types of binders currently available to the paint industry for various applications, such as alkyds, polyesters, acrylics, vinyl, natural resins, and oils. Paint formulated for industrial coatings uses alkyd binders with drying oils such as tung, fish, linseed, soya oil, or coconut oil. (Turner, G.P.A, Weismantel, Guy, E, 1981)

In the recent data of Food and Agricultural Organization (FAO) of the United Nations:: Economic and Social Department: The Statistics Division, Philippines with a yearly production of 19,500,000 tonnes ranks first, followed closely by Indonesia in the world production of coconuts.

In a report, of the Virgin Coconut Oil Producers and Traders Association of the Philippines, Inc. (Partnership for Supporting VCO Industry's Long-Term Viability, March 15, 2007), the number of virgin coconut oil producers increase yearly from 20 in 2003 to 200-300 producers in 2005. Due to the abundant supply of virgin coconut oil, it is perceived as a potential raw material in the alkyd resin component of the paint binder, which can be used in the production of industrial paints, particularly lacquer paints. .

It is in the light of the above-mentioned scenarios that this study has been conceived.

## Objectives of the Study

The purpose of the study is to formulate a lacquer enamel paint using coconut oil as one of the materials in the formulation.

Specifically, the study aims to:

1. conduct an experiment of a paint formulation using virgin coconut oil in the alkyd resin binder of lacquer enamel paints;
2. determine the properties of paint formulated;
3. determine the potential use of virgin coconut oil in lacquer enamel paint; and
4. evaluate its acceptability in terms of paint properties.

## II. REVIEW OF RELATED LITERATURE

### Lacquer Enamel Paint

Lacquer enamel paint contains high concentration of film formers which are binders combined with enough opaque pigment to give both color and opacity. Alkyds are employed in wide variety of industrial and consumer finishes.

### Fundamental Constituents of Lacquer Enamel Paint

Enamels are made in two forms: air drying and baking. Lacquer enamel paint dry essentially by evaporation of solvent, and dry as soon as solvent is gone. The basic film formers of lacquers are the cellulose. In addition, lacquers contain resin for improved adhesion, build, and gloss; and plasticizers for improved flexibility. (Singer and Weismantel, 1981).

In this study, virgin coconut oil was used both in clear gloss and white lacquer enamel. With the booming virgin coconut oil industry in the Philippines, using virgin coconut oil in the lacquer enamel paint production will increase virgin coconut oil demand. This demand will further increase the number of virgin coconut oil producers in our country. Data from VCOP shows that the number of virgin coconut oil producers increase yearly from 20 in 2003 to approximately 200-300 producers in 2005 with monthly production of 250-300 metric tones. To prove that virgin coconut oil is produced widely throughout the country, VCOP listed National Capital Region (NCR) and almost all regions in the country as producers of virgin coconut oil, with Region VIII having the most number of producers totaling to 60. (Partnership for Supporting VCO, Industry's Long Term Viability, March 2007, VCOP Accomplishment Report, VCOP & DOST).

However, in the latest report of the Virgin Coconut Oil Producers and Traders Association of the Philippines, it has listed over 70 members in it's website and the VCO business in the country is already an industry by itself. (AGRI Business Week. Virgin Coconut Oil: How our Local VCO Industry is Faring).

**Binder.** The binder is one of the main components of paint formulation. It holds the pigment and adhere it to surface. Binders are alkyd resins with drying oils, such as tung, fish, linseed, soya or coconut oil. These resins are made by reacting a polybasic acid with polyhydric alcohol and are modified with drying or non drying oil. (Singer, Weismantel. Resins Raw Materials, 1981)

Refined coconut oil is used in the binder in the lacquer enamel formulation.

The research paradigm as shown in Fig.1 is the graphical representation of the conceptual framework.

**Coconut oil.** Most commercial grade refined coconut oils are made from copra. Copra is basically dried kernel (meat) of the coconut. If standard copra is used as a starting material,

the unrefined coconut oil extracted from copra is not suitable for consumption and must be purified, that is, refined. The standard end product made from copra is RBD coconut oil. RBD stands, for refined, bleached, and deodorized. High heat is used to deodorize the oil, filtered through (bleaching) clays to remove impurities. Sodium hydroxide is used to remove free fatty acids and prolong shelf life. This is the most common way to mass-produce coconut oil. (How Is Coconut Oil Produced: Refined Oil the Coconut Diet))

Most paint make use of refined coconut oil in the alkyd formulation.

**Virgin coconut oil.** Virgin coconut oil can only be achieved by using fresh coconut meat or what is called non-copra. Chemicals and high heating are not used in further refining, since the natural, pure coconut oil is very stable with shelf life of several years. (Virgin Coconut Oil: Essential Facts).

Refined coconut oil used in the standard formulation is differentiated to virgin coconut oil, which was used in the trial formulation in this research.

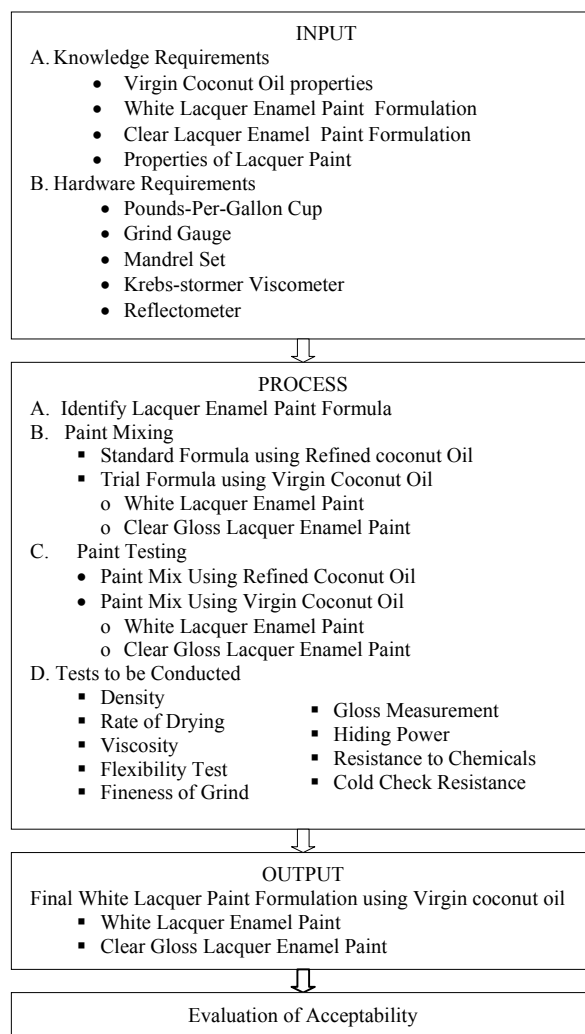


Figure 1. Research Paradigm

**Paint Testing**

Paint testing is conducted to generate definite information related to function, essential properties, specifications, and application procedures.

**Paint Specifications**

Paint specifications are of two principal types, performance and composition. Performance specifies the test methods that the paint must pass.

**III. METHODOLOGY**

**Method and Formulation**

*Identifying the formula.* The standard formula of lacquer enamel paint using alkyd resin as part of the base or vehicle was prepared. This was compared to the properties of the lacquer paint prepared using virgin coconut oil.

Paint samples were prepared using identified formula from Table 1 and were done by first pre-mixing the binder to the pigments. Binder consists of alkyd resin with coconut oil, wetting agents, solvents, and additives to form paste. This paste is routed to a sand mill, a large cylinder that agitates tiny particles of sand or silica to grind the pigment particles making them smaller. The mixture is filtered to remove sand particles and thinned with solvents to produce final product (Turner, G.P.A, Weismantel, Guy, E., How Paint is Made, 1981).

**Experimental Design**

Below is the experimental diagram of the study

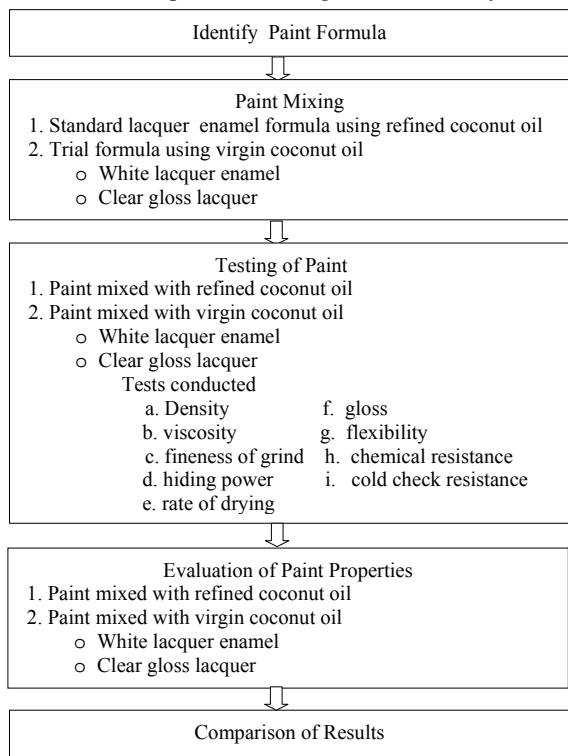


Figure 2. Schematic Flow Process of the Methodology

Table 1. Standard Lacquer Paint Formula Compared to Trial Formula

Raw Material Description	Standard Formula (parts by wt)	Trial Formula	
		White Lacquer (parts by wt)	Clear gloss lacquer (parts by wt)
Refined coconut oil alkyd	22	0	0
Virgin coconut oil alkyd	0	22	22
Nitrocellulose	24	24	24
Plasticiser	1.8	1.8	1.8
Dispersant	0.6	0.6	0.6
Titanium dioxide	22	22	
Isopropyl alcohol	7.3	7.3	9.3
Cellosolve Acetate	3	3	3
Toluene	11.5	11.5	21.5
Xylene	7.5	7.5	17.5
Leveling agent	0.3	0.3	3.0
Total	100.0	100.0	100.0

**Testing Procedure**

Parallel testings were conducted on paint using refined coconut oil and virgin coconut oil to determine results. The following tests were done:

1. Density - Paint sample is taken from the batch prepared, cooled to room temperature and density will be measured using the Pounds-per Gallon Cup.
2. Viscosity - the material's property that measures paint's resistance to flowing will be taken using the Krebs-Stormer Viscometer.
3. Hiding Power - this test method determines the hiding power of paint by visual evaluation of an applied paint.
4. Fineness of Grind - test will measure the pigment dispersion particularly pigment particle size range using a Fineness of Grind Gauge.
5. Rate of Drying - rate of drying is the time the film can be handled and this comes in stages film dried and cured.
6. Flexibility Test - measure the flexibility of how paint expand without rupture by bending the panel on which coated
7. Adhesion - this test determine the property of sticking to a surface. It is the most important property of paint. A series of closely spaced parallel scratches is made through the film and second series is made at right angle to the first series. The number of small squares remaining is a measure of adhesion. (Whittington, Weismantel, 1981)
8. Gloss - is the attribute of a sample that causes them to have shiny or lustrous, metallic or matt appearance.
9. Resistance to Chemicals - since lack of resistance to chemicals leads to rapid deterioration, the paint formulated with virgin coconut oil was subjected to resistance different types of chemicals where the items painted will be subjected to; like juice, alcohol, vinegar and water.
10. Cold check resistance - test will determine the ability of the coating to resist damage if subjected to different temperature changes. The paint film was subjected to the following temperature changes; 50°C, room temperature 27°C, and 0°C.

### Evaluation of Paint

The paint was evaluated by respondents in the manufacturing, handicraft and appliance repair industries. This was done by applying the paint sample by spray gun in a metal and wood panel sample. The test panel was evaluated in terms of gloss, adhesion, and ease of application.

### IV. RESULTS AND DISCUSSION

The following are the features of the project Table 4 gives the summary of the results of the testing done on the paint sample prepared with standard formulation and paint prepared with virgin coconut oil. The laboratory and testing results presented herein show the comparison of the paint properties from the paint prepared in the formulations identified.

#### Manufacturing Control Tests

**Density** – Using the Pounds Per Gallon apparatus, the density of 4.57 kg/gal. for white lacquer paint and prepared with virgin coconut oil showed comparable results with paints prepared with standard formulation. The result of the density data gives a significant indication that the virgin coconut oil blends well with the other ingredients in the formula and the pigment to binder ratios are in the proper and correct amounts. This is supported by the data on Table 2. (Whittington and Weismantel 1981).

**Viscosity** – results shows paints prepared with virgin coconut oil have a viscosity of 88 KU (kreb units) and comparable to the viscosity of paint using standard formula which is 86 KU (kreb units). Lacquer enamel paint, the subject of our study is usually applied to the surface using air-spray guns, and during the test it was found out that paints prepared using virgin coconut oil were non sticky when thinned to spraying viscosity. This was supported by data found in Table 2. (Whittington, Weismantel 1981).

**Fineness of Grind** – The paint formulated with virgin coconut oil has a Hegman grind gage reading of 7 ½ NS which means the pigment was properly dispersed in the virgin coconut oil binder (ASTM D 1316, Paint and Related coating Standards). This is supported by the data in Table 2.

**Hiding Power** – This determines by visual evaluation the ability of the paint prepared to hide the surface being applied. It was observed that the hiding power of the paint mixed with virgin coconut oil is comparable to paint mixed with refined coconut oil.

#### Evaluation Test

##### A. Laboratory Testing Method

In this testing method, a sample of paint is applied with a specified film thickness either a wood or metal panel depending on the test to be done. All laboratory Test Method Testing Results are shown in Table 2.

1. **Gloss Measurement** - The paint sample has comparable gloss measurements of 79.1<sup>0</sup> reading for white lacquer enamel paint, and 71.5<sup>0</sup> for clear gloss enamel paint. This gloss reading shows that virgin coconut oil, if used in lacquer paint formulation can produce glossy paint finish.
2. **Flexibility** - Metal panel coated with lacquer paint using virgin coconut oil showed comparable results with the

Table 2. Summary of Results of Paint Properties

Paint Properties	White Lacquer Enamel		Clear Gloss Lacquer	
	Standard	Trial	Standard	Trial
Density (kg/gal)	4.57	4.57	3.62	3.62
Viscosity (KU,s)	86 KU	88 KU	21 s	20 s
Fineness of Grind (NS)	7 ½	7 ½		
Drying Time	comparable/no visible line @12 hrs		6 s	6 s
Gloss	78.9°	79.1°	71.7°	71.5°
Adhesion	100	100	100	100
Flexibility	with hairline cracks			
Cold Check Resistance (50°C / 27°C / 0°C )	unaffected	unaffected	unaffected	unaffected
Chemical Resistance				
a) juice	unaffected	unaffected	unaffected	unaffected
b) alcohol	slightly stained	slightly stained	slightly stained	slightly stained
c) vinegar	slightly stained	slightly stained	slightly stained	slightly stained
d) water	unaffected	unaffected	unaffected	unaffected

sample coated with standard formulation. Each sample exhibited hairline cracks which are acceptable. This means that the paint film from the paint prepared with virgin coconut can be extended without rupturing by bending the panel on which it is coated.

**Cold Check Resistance** - This test determines the ability of the coating to resist damage to the substrate and to itself from the transmission of water through the film from the condensation of water vapor on the surface. This will also check resistance of the paint film when heated to a specified temperature. The data showed that the wood panel coated with paint prepared with virgin coconut oil was not affected when subjected to:

1. inside the oven with 50°C temperature
2. inside the refrigerator with temp of 0°C
3. room temperature
4. **Chemical Resistance** - The spot resistance determines the ability of the coating to resist staining by the chemical being tested when the chemical stands on the paint film. After the paint film from the paint using virgin coconut oil was subjected to the following chemicals, it was observed that it has comparable appearance results to those of paint standard formulation
  - a. juice - unaffected
  - b. alcohol - slightly stained
  - c. vinegar - slightly stained
  - d. water – unaffected
5. **Drying Time**-The time required for the drying film to reach different drying stages has been achieved by lacquer enamel paint using virgin coconut oil. The dried film was tested after 12 hours and it left no trace marks. Both formulations for white and clear gloss lacquer, therefore have acceptable drying time data.
6. **Adhesion** – the paint sample prepared with virgin coconut oil has comparable results of 100% adhesion with sample coated with the standard formula.

Table 3. Evaluation of Acceptability by End Users:  
% Acceptance

	Highly acceptable	Acceptable	Slightly acceptable
<b>1. White Lacquer Enamel Paint</b>			
Ease of application	52%	36%	12%
Film Integrity	76%	20%	4%
Consistent quality	60%	36%	4%
<b>2. Clear Gloss Lacquer Enamel Paint</b>			
Ease of application	70%	20%	4%
Film Integrity	68%	32%	0%
Consistent quality	54%	34%	12%

**B. Evaluation of Acceptability by End Users**

A sample of paint formulated with virgin coconut oil was taken for actual application by respondents who were paint users themselves, like furniture makers, spray painters in paint repair shops, and handicraft maker. This will determine the specific properties that should be taken into account when specifying the performance of paint for the particular end use. The results of this evaluation are shown in Table 3.

**Project Capability**

**White Lacquer Enamel.** The white lacquer enamel paint mixed with virgin coconut oil can be used in different industrial coating industries such as those in appliance, transportation vehicles, repair shops, furniture, handicraft, and home fixtures.

**Clear Gloss Lacquer Enamel.** The clear gloss lacquer mixed with virgin coconut oil has a wide range of usage and like white lacquer enamel, this includes furniture, handicraft, and home furnishings.

Virgin Coconut oil is a product that has tremendously grown in importance in the modern world. The guidance and support relating to its regulation, development, and funding, as well as the promotion of economic activities of the government that utilize virgin coconut oil, it will surely add fuel to boost its growth.

One of the critical implementing programs of VCOP assures not only the big players but also the small processors of full support by the association. This means increase of income for these small virgin coconut oil producers, which in turn will uplift their standard of living. (Virgin Coconut Oil: How our Local VCO Industry is Faring?)

**References**

- [1] Food and Agriculture Organization of United Nations: Economic and Social Department: The Statistical Division. retrieved from FAOSTAT, Data Base 200 <http://apps.fao.org>:
- [2] Grind Gauge, American Society of Testing Materials. Grind Gauge is a tool to determine the fineness of grinding particles. [www.ansi.org](http://www.ansi.org) retrieved from [www.pinetruth.hk](http://www.pinetruth.hk)
- [3] How is Coconut Oil Produced: Refined Coconut Oil the Coconut Diet. This is the most common way to mass produce coconut oil.. retrieved from [www.coconutdiet.com/what\\_is\\_virgin\\_coconut\\_oil.html](http://www.coconutdiet.com/what_is_virgin_coconut_oil.html)
- [4] Singer, Elias ; Weismantel, Guy, E. (1981)Lacquers, p 3.17 Paint Handbook New York: McGraw Hill
- [5] Turner, G.P.A. Introduction to Paint Chemistry & Principle of Paint Technology, 3<sup>rd</sup> ed., Chapman and Hall, 1988; Weismantel, Guy, E, Paint Handbook, How Paint is Made, Manufacture, Making, Used Components: Raw materials. Retrieved from [www.madehow.com/html](http://www.madehow.com/html)
- [6] U.S . Paint and Coating Industry Market Analysis (2006-2011) retrieved from [www.paint.org/resources/market\\_analysis.com](http://www.paint.org/resources/market_analysis.com).
- [7] Virgin Coconut Oil: Essential Facts. Virgin coconut oil can be achieved Retrieved from [www.thevirgincoconutoil.com](http://www.thevirgincoconutoil.com)
- [8] Weismantel, Guy, E (1981) Paint Handbook New York: McGraw Hill
- [9] Whittington, Trevellyan, V; Weismantel, Guy, E, Description of Typical Paint Tests. P.2.27-2.28 ) Paint Handbook New York: McGraw Hill
- [10] AGRI Business Week. Virgin Coconut Oil: How’s Our local VCO Industry is Faring? Posted on Sept 23, 2009 under Other Crops. Tags: Coconut, VCO, Virgin Coconut Oil. A product that has tremendously grown in the modern world is virgin coconut oil. Retrieved from [www.agribusinessweek.com.virgin\\_coconut\\_oil\\_hows\\_our\\_local\\_vco\\_industry\\_faring/](http://www.agribusinessweek.com.virgin_coconut_oil_hows_our_local_vco_industry_faring/)