Faculty of Mechanical and Manufacturing Engineering Technology

CHARACTERIZATION ON THE NATURAL SOURCE PROPERTIES FOR DIGITAL PRINTING INK FROM WASTE COOKING OIL BASED

Nur Liana Anira Binti Muhamad Raus

Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

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This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor of Manufacturing Engineering Technology (Process & Technology) With Honours

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DECLARATION

I declare that this thesis entitled "Characterization on The Natural Source Properties For Digital Printing Ink From Waste Cooking Oil Based" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ….....

Name : NUR LIANA ANIRA BINTI MUHAMAD RAUS

Date :

APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours. The member of the supervisory is as follow:

Signature : …….....

Supervisor Name : ASSC. PROFESSOR MADYA TS. DR. ZULKIFLI BIN MOHD ROSLI

Date :

ABSTRAK

Kajian ini mengenai penggantian elemen dalam pembuatan dakwat bagi percetakan digital. Memandangkan pencemaran persekitaran yang semakin merisaukan, langkah kecil seperti penghasilan formula hijau telah menjadi suatu idea bagi penghasilan kajian ini. Pengeluaran dan perlepasan gas VOC daripada produk dakwat berasaskan petroluem menjadi salah satu alasan kukuh bagi penciptaan formula dakwat percetakan digital hijau yang kurang ataupun tidak menyumbang kepada pencemaran alam. Minyak masak terpakai digunakan sebagai asas menggantikan petroleum dan buah naga dikaji bagi menggantikan elemen pewarna dan seterusnya kajian dijalankan untuk mengkaji karakter sifat sifat serta kesesuaiannya. Minyak masak terpakai dipilih kerana ia akan membantu menggurangkan jumlah pembuangan secara menyeluruh. Methodologi yang digunakan adalah penapisan dan penyulingan semula minyak melalui proses "transesterification". Skala dan nisbah ditentukan untuk memastikan kualiti "methyl ester"yang terhasil. Pati ekstrak buah naga dijadikan elemen pewarna bagi formula kajian ini. Pengawet BHT diguna pakai dengan nisbah bersesuaian. Di akhir kajian ini, dakwat hijau akan dihasilkan. Beberapa ujian dijalankan ke atas dakwat hijau yang dihasilkan iaitu ujian kelikatan, ujian karakter sifat menggunakan FTIR, dan ujian pemerhatian melalui percetakan.

ABSTRACT

This research is about the replacement of the digital printing ink elements. Due to current pollution of environment, small steps like green printing ink development become an idea of this research. The release of VOCs from petroleum-based ink are one of the solid reason to formulates new green printing ink that is less or not contributes to environment pollution. Waste cooking oil (WCO) was used as binder to eliminates the VOCs contain and natural source such as dragon fruit, acted as pigment colorant were investigated to characterised the properties and suitability. WCO was chosen since this is also leads to reduction of WCO disposal. Methodolgy used in this research started with the WCO filtration and purification by transesterification process. The ratio was set to ensure the quality of the methyl ester produced. The natural source chose to be investigated in this research was scale down to one which is dragon fruit. The dargon fruit extracted by extraction process and becomes the colorant element for this ink formulation. Additive in this ink formulation was BHT with new ratio of usage. At the end of all processes, the formulation of ink was made and produced as GPi. Several testing have been done to justify the formulation result. Testing are Viscotester, FTIR and Visual Observation. Viscotester used Viscometer DV-II+ Pro to prove the viscosity in cP, FTIR used a drop of ink sanple for IR Spectrum and Digital Inkjet Printer was used to print some design by using the GPI of dragon fruit.

DEDICATION

Dedicated to

My beloved father, Muhamad Raus Bin Haji Mohd Said,

My appreciated mother, Suhani Binti Abu Bakar,

My lovely siblings, Nur Lisa Anira, Muhamad Helmi Hakim, Muhamad Hezri Hakim and Nur Lidya Izana Anira,

My respected supervisor, Assc. Prof. Madya Ts. Dr. Zulkifli Bin Mohd Rosli.

Thank you for all the moral support and encouragement that you have gave me throughout this research journey

Thank You So Much

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LIST OF ABBREVIATIONS

VOCs	Volatile organic compounds
WCO	Waste cooking oil
ASTM	American Society for Testing and Materials
FTIR	Fourier transform infrared
BHT	Butylated hydroxytoluene
GPi	Green Printing ink
BHT	Butylated hydroxytoluene
LDFE	Liquid Dragon Fruit Extraction

INTRODUCTION

1.1 Background Study

In this globalization era, air pollutant has been widely acknowledge as the most critical pollution in this world and contribute to the thinning of ozone layer which will then contribute to global warming. The highest hazard pollution are belongs to Volatile Organic Compound (VOC) categories. There are variety of chemical contains high amount of VOCs widely used in manufacturing industries. One of it is the manufacturing of petroleum-based printing ink. The used of toluene, benzene and xylene are harmful to the environment as it is hazardous towards living things.

Printing ink is a type of ink that is still widely being used ever since before. Printing ink is a liquid that made up by combinations of mixture of pigments, plasticizers, dispersants, deionized water, antifoaming agents and binder resins. This ink is produce for variety purpose, such as documentation, packaging, and as well functioning to improve a product appearance. Hence, it plays a significant role which influences our everyday lives.

Hence, due to the increasing awareness of volatile organic compound emissions, there have been studies on finding alternatives to substitute petrochemicals to renewable resources, which is the reused of waste cooking oil. Oil-based ink was proven to reduce the emission of VOC released during printing process. The most successfully used oil-based ink is the soybean. In fact, it also gives better improvement compared to the original ink. Several reuse of Waste Cooking Oil that had been analyzed by variation based on the properties can be used as value-added products including printing ink. Mello, Oliveira, &

Suarez (2013) proved that WCO as raw material to produce oil based resins suitable to be used as a binder in printing inks and it was using the typographic printer.

1.2 Problem Statement

Globally, the emission of more volatile organic compounds (VOCs) to the environment has lead to various pollutions. Ink is one of the releaser as ink is made up of petroleum based. The huge production of ink contributes to large scale of VOC releaser to the atmosphere. Furthermore, it becomes a threat to the world and becoming one of thinning ozone layer factors.

As time going, many researchers have done many alternative ways in making new formula to overcome the same issues that have occurred regarding current ink production and it side effects. In this study, the problem highlights are on the VOC content in ink production, eco-friendly disposal ink which are 100% green, and as well as the reused of waste cooking oil.

The ink based has been studied and tested hence replace with waste cooking oil with some chemical reaction, called transesterification. In previous studies and research, the replacement is successful (Najwa, 2017). However, the ink is still not 100% green. This is said to happen due to the ink colorant that are still made up of some chemical. Hence, this study will focus on the perfection of the ink by replacing the ink colorant with natural source colorant extraction.

1.3 Objectives

The objectives of this study are:

1. To investigate the effect of waste cooking oil with green printing ink formulation.
2. To investigate the suitability of natural sources as green printing ink.

1.4 Scope

The main objective of this study is to determine the characteristic of Green Printing ink (GPi) with natural source colorant via digital printing on paper. The Green Printing ink was based on waste cooking oil (WCO).

WCO is first undergoes filtration and oil purify treatment. The contaminants from waste cooking oil are filter by visual inspection and transesterification process. New experimented process is added in this study to see if the process could contribute to oil behavior in viscosity. Meanwhile, colorant extraction will be done to extract the desired pigment colorant for the ink making. After the extraction process, the extracted colorant is going to be mix with the treated waste cooking oil. This phase is the formulating process. At the end of this, the physical properties of the final product then will be physically observe, properties test and undergoes inkjet printing test.

1.5 Summary

In this chapter, it discussed on the overall determination in making this study. It started with background study, problem statement clarifications, objective and also scope. This chapter will guides the whole study to ensure it achieve the actual purpose. The purpose of

this study is to formulate a new recipe of printing in according to the Standards and market, as well being eco-friendly ink in time.

LITERATURE REVIEW

2.1 Introduction

This chapter review on the manufacturing of ink, green printing ink from organic substances based on waste cooking oil (WCO) and printing on paper substrates. This review consists of the component, character and composition of printing ink and the formulation of green printing ink extracted from organic substances based on WCO for the research were included. Ink colorant extraction process, ink making and printing techniques for paper substrates was added in this chapter follow by the scope of study.

2.2 Printing Ink

Printing ink is liquid or paste that contains pigments or dyes that have been utilized for the printing process. There are 4 raw materials that involve in the ink engenderment which are the binders, solvents, colorants and additives. Each raw material plays a paramount role and has been culled due to its nature The ink must be functioning opportunely without causing damage to the print heads. The perpetual process in the ink industry is always being the concern of researcher and developer. Amending the product can be done by engendering incipient formulation.

2.2.1 Vehicle or Binder

The vehicle is the substance that holds the ink mixture in liquid form which

carries the particles of pigment and binds it to the printed surface. When the ink is deposited on the substrate, ink is coated with a binder to keep them dispersed while in the ink. Binders which are conventionally kenned as either resins or polymers, being used to dispersed the colorants and contained them. These binders are additionally responsible to carry these inks to the surface of any substrates and link or annex them on it. The vehicle can be formulated from petroleum or vegetable oils, solvents, or water. Sometimes resin or varnish of some kind. Most of the vehicle has a hydrophobic characteristic that helps with the printing process.

The vehicle must have the ability to modify the rheological and mechanical properties of the inks during the printing process to access dry rapidly behavior when it reaches the printing surface. The ink vehicle plays multiple roles to ensure the pigment wetting and transfer, film-formation after printing and during drying, pigment protection during the life cycle of the printed material (Blayo, Gandini, & Le Nest, 2001).The most typical binder rheological and mechanical properties derives from alkyd resin or synthesis resin.

2.2.2 Colorant

The colorant in ink could be from many sources and the substances may be in form of dyes, powder, liquid dispersions, concentrated pastes. Colorants are available either in dye forms (dyestuffs) or as pigments. They are commonly being used to integrate colors for the inks. The colorant is also known as pigment. Pigments are categorically described as insoluble powdered substances that are mixed with a liquid in

coating materials such as paint and ink. A fair amount of mystification subsisted in the early days by utilizing the terms dyes and pigments interchangeably. Pigments can be natural (plant or animal inception) or synthetic, and belong to both organic and inorganic classes. Synthetic analogues of natural pigments are withal kenned.

Natural pigments occurring in plants and animals are the sources of a variety of categorical functions. For example, the pigment chlorophyll that makes plants green participates in the central process of photosynthesis to engender the plant's victuals by absorbing light. Plus, plant leaves contain the pigments belonging to the class of carotenes, which are orange-yellow in color. The variation in these pigments gives elevate to the colorful foliage of aspens, poplars, maples and homogeneous deciduous trees, widely visually perceived in Incipient England and other places at the onset of the fall season. The familiar pH be speaker made from red cabbage juice functions with the avail of another class of pigments kenned as anthocyanins, which belong to the generic class of flavonoids.

2.2.2.1 Natural Colorant

Sustainable development is an important part of this research. Among other things, organic inks are based on plant-based binder systems. This makes them more easily bio-degradable than classic mineral inks, and therefore better for the environment and for the printing facility.

The choice for organic inks is not only based on our eco-friendly strategies, these inks also offer technical advantages. The highly concentrated organic inks are very fast-

setting, have good oxidative drying properties, and result in extremely sharp results. This is just one of the ways in new printing techniques and innovative technology.

2.2.2.1.1 Natural Colorant – Dragon Fruits

Dragon fruit or the scientific name is “Pitaya”, “pitahaya” originated from Southern Mexico and Central America. Today, it is grown all over the world. There are several types of dragon fruits, there are different in colors and taste. The colors of Red Dragon Fruit, are very high in dyes. Even the skins can left out color to bare hands that used to peel. The red and purple colors of *Hylocereus* fruits are due to betacyanins, a family of pigments that includes betanin, the same substance that gives beets, Swiss chard, and amaranth their red color. According to Enciso (2011) and Zee (2004), dragon fruit is classified as non-climacteric fruit as it is grown and available all year round.

Figure 2.1 Red Dragon Fruit

The exotic aesthetic characteristics of dragon fruit with its attractive deep purple coloured pulp make it highly appealing in the European and United States market (Rebecca et al., 2008a) and widely cultivated in Vietnam, Malaysia, Taiwan, China, Okinawa, Israel and Southern China. The deep purple colour of the pulp is contributed by a set of pigments known as the betalains which are nitrogen-containing pigments (Wyler and Dreiding, 1957; Harivaindaran et al., 2008), made up of the red-violet betacyanins and yellow betaxanthins with maximum absorptivity at 535 and 480 nm, respectively (Herbach et al., 2006).

A pigment group of water-soluble phytochemical components, Betacyanin is the most found in the red-flash dragon fruits as the abundant pigments. Dragon fruit is found rich in betacyanin and been studied world widely in terms of their properties. There are 32 to 47mg/100g total Betacyanin content in the dragon fruit. (Herbach et al., 2004a; Vaillant et al., 2005). The formulation and decomposition of betcyanin is most affected by thermal processing. The result color may changes affected by the thermal treatment. Betaxanthin produces orange/yellow pigment and betacyanin produces red/purple pigment. It is said to be the most important pigments in this fruit (Gibson and Nobel, 1986).

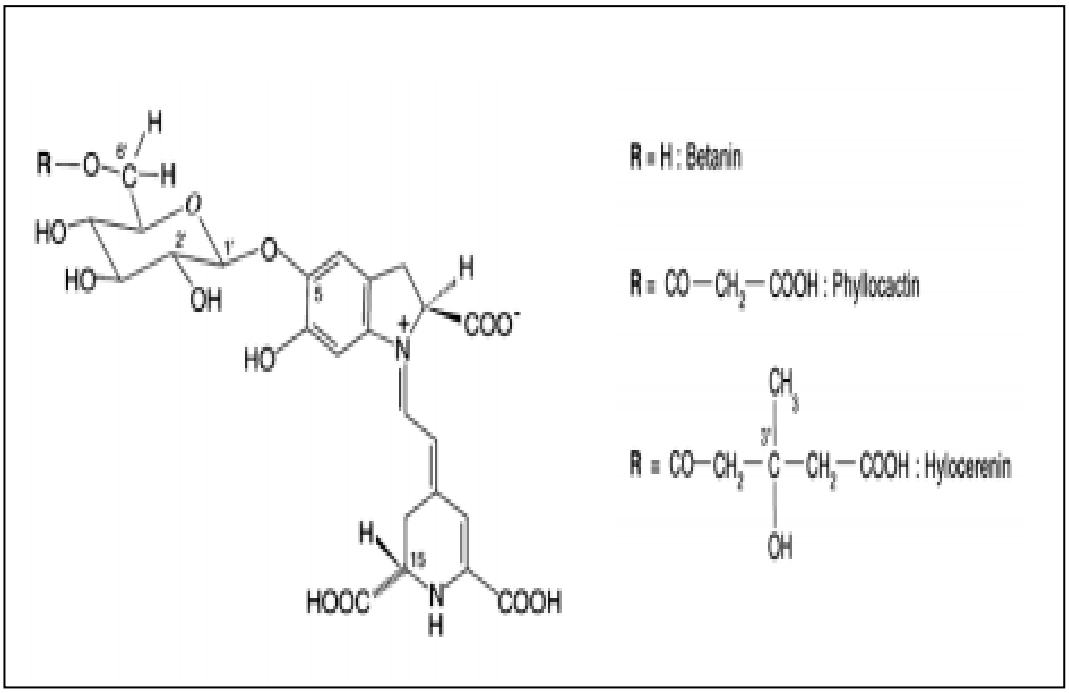

Figure 2.2 Chemical structure of betacyanin (Stintzing et al., 2003)

2.2.3 Solvent

A solvent is a substance that is capable of dissolving another substance (called a solute) into a uniform coalescence kenned as a solution. In order for a solvent to be able to accomplish this task it must overcome the forces that bind the solute (the substance being dissolved) together. According to Ahmed (2007), the solvent shall responsible for keeping the ink in liquid form when it is applied to the printing plate until it is peregrinate to the surface of the substrate.

The solvent utilized in solvent ink accommodates a dual purport in that it's both a carrier to distribute the coloured pigment to the media, and it avails to melt the surface of the media. The ink colourants can perforate beneath the intenerated surface to bite into the media itself. When the solvent evaporates, the colourants are left etched into the media