

PERFORMANCE OF TURMERIC AS WCO GREEN PRINTING PRODUCT



BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this project entitled "Performance of Turmeric as WCO Green Printing Product" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.



DEDICATION

First and foremost, I want to thank God for the opportunity to complete this endeavour. Next, I'd like to thank my beloved parents and family. They have been incredibly compassionate and supportive of me since the day I started attending this university until today.



ABSTRACT

This study focuses on the substitution of digital printing ink components. Because of the current state of the environment, minor advancements such as green printer ink development have been a focus of this investigation. The release of VOCs from oil-based ink is one of the strongest motivators for developing a green printing ink that contributes little or nil to environmental contamination. Wasted cooking oil (WCO) was used as a cover to remove the VOCs, and natural sources, for example, went about as shade colourants, were investigated to demonstrate the qualities and reasonableness. WCO was chosen because it also promotes a decrease in WCO removal. The methodology used in this study began with WCO filtration and purification via transesterification. The proportion was chosen to ensure the quality of the methyl ester supplied. The normal source chosen for this study was reduced to one containing natural colourant. The turmeric extract is converted into the colourant component for this ink detailing during the extraction process. BHT with a new proportion of use was added as a new substance in this ink scheme. Everything being equal, the ink detailing was made and delivered as GPi near the end. A few tests have been conducted in order to validate the plan's outcome. Viscotester, FTIR, and Visual Observation are the testing methods. Waste Cooking Oil (WCO) is used to replace petroleum-based binders in the production of printing ink. Turmeric is used as a yellow colourant in the printing ink, which is derived from natural sources. Vehicles or binders, natural colourants, solvents, and additives are among the components required to create green printing ink. The materials' composition will be done to demonstrate the properties of both natural sources, and a few tests will be performed to observe and analyse the findings.

ABSTRAK

Kajian ini memberi tumpuan kepada penggantian komponen dakwat percetakan digital. Kerana keadaan persekitaran semasa, kemajuan kecil seperti pengembangan dakwat pencetak hijau menjadi tumpuan penyelidikan ini. Pelepasan VOC dari dakwat berasaskan minyak adalah salah satu pendorong kuat untuk mengembangkan dakwat percetakan hijau yang menyumbang sedikit atau nol kepada pencemaran alam sekitar. Minyak masak terbuang (WCO) digunakan sebagai penutup untuk menghilangkan VOC, dan sumber semula jadi, misalnya, digunakan sebagai warna pewarna, disiasat untuk menunjukkan kualiti dan kewajaran. WCO dipilih kerana ia juga mendorong penurunan penyingkiran WCO. Metodologi yang digunakan dalam kajian ini bermula dengan penyaringan dan pemurnian WCO melalui transesterifikasi. Bahagian tersebut dipilih untuk memastikan kualiti metil ester yang dibekalkan. Sumber normal yang dipilih untuk kajian ini dikurangkan menjadi sumber yang mengandungi pewarna semula jadi. Ekstrak kunyit ditukar menjadi komponen pewarna untuk dakwat ini secara terperinci semasa proses pengekstrakan. BHT dengan perkadaran penggunaan baru ditambahkan sebagai bahan baru dalam skema dakwat ini. Semuanya sama, perincian dakwat dibuat dan dihantar sebagai GPi hampir ke penghujungnya. Beberapa ujian telah dilakukan untuk mengesahkan hasil rancangan tersebut. Viscotester, FTIR, dan Visual Observation adalah kaedah pengujian. Waste Cooking Oil (WCO) digunakan untuk menggantikan pengikat berasaskan petroleum dalam penghasilan dakwat percetakan. Kunyit digunakan sebagai pewarna kuning dalam dakwat percetakan, yang berasal dari sumber semula jadi. Kenderaan atau pengikat, pewarna semula jadi, pelarut, dan bahan tambahan adalah antara komponen yang diperlukan untuk membuat dakwat percetakan hijau. Komposisi bahan akan dilakukan untuk menunjukkan sifat kedua sumber semula jadi, dan beberapa ujian akan dilakukan untuk memerhatikan dan menganalisis penemuan tersebut.

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TABLE OF CONTENTS

		PAGE
DEC	CLARATION	
APP	PROVAL	
DEL	DICATION	
AB	STRACT	i
AB	STRAK	ii
AC	KNOWLEDGEMENTS	iii
TA	BLE OF CONTENTS	iv
LIS	TOF TABLES	vi
T IG		
		VIII
LIS	T OF SYMBOLS AND ABBREVIATIONS	İXX
LIS	ST OF APPENDICES	Х
CHA 1.1 1.2 1.3 1.4 1.5	APTER 1 Background Study Problem Statement Objective VERSITI TEKNIKAL MALAYSIA MELAKA Scope Summary	1 1 2 3 3 4
CH4 2.1 2.2	APTER 2 LITERATURE REVIEW Introduction Digital Printing Ink 2.2.1 The Additives Nature of Printing Inks 2.2.2 Printing Ink Resistance Properties 2.2.3 Types of Printing 2.2.4 The Types of Printing Ink 2.2.5 Component of Printing Ink 2.2.6 Colourant of Printing Ink	5 5 7 7 10 11 14 20
2.3	Waste Cooking Oil 2.3.1 Treatment and Material for the Treatment of WCO	25 26
2.4	Inkjet Printer 2.4.1 Advantages of Inkjet Printer	27 28
2.5 2.6 2.7	Viscometer Fourier Transform Infrared Spectroscopy (FTIR) Ultrasonic Bath	30 31 33

2.8	Summary	33
CHA	APTER 3 METHODOLOGY	34
3.1	Introduction	34
3.2	Flow Chart of Project	35
3.3	Raw Material	36
3.4	Process of Ink Formulation	36
	3.4.1 Filtration of WCO	37
	3.4.2 Transesterification Process	38
	3.4.2.1 Methoxide Preparation Process	38
	3.4.2.2 Transesterification Process	39
	3.4.3 Washing Process	40
	3.4.4 Varnish Process	41
	3.4.5 Natural Colourant Extraction	42
	3.4.6 Ink Mixture	44
	3.4.7 Ultrasonic Bath	45
	3.4.8 Viscosity Test	45
	3.4.9 Fourier Transform Infrared Spectroscopy (FTIR) test	45
	3.4.10 Visual Observation	45
CHA	APTER 4 RESULTS AND DISCUSSION	46
4.1	Introduction	46
4.2	Viscosity Testing	46
4.3	Fourier Transform Infrared Spectroscopy (FTIR) Testing	47
4.4	Visual Printing Testing	48
	المنبقة ببيبة تتكنيكا ملسياملا	
CHA	APTER 5 CONCLUSION AND RECOMMEDATIONS	53
5.1	Conclusion	53
5.2	RecommendationSITI TEKNIKAL MALAYSIA MELAKA	54
REF	FERENCES	55
APF	PENDICES	57

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	The types of addivities used in printing ink	18
Table 4.1	Viscosity reading of samples	46
Table 4.2	Reading of FTIR testing	48



LIST OF FIGURES

FIGURE	TITLE	PAGE	
Figure 2.1	Chemical Structure	17	
Figure 2.2	The types of colourants and based in Ink-Jet	21	
Figure 2.3	Curcuma Aromatic	24	
Figure 2.4	Turmeric powder	24	
Figure 2.5	Ink-Jet Printer	28	
Figure 2.6	Brookfield Viscometer	31	
Figure 2.7	FTIR machine	33	
Figure 3.1	Flow chart of for the overall natural ink processing	35	
Figure 3.2		36	
Figure 3.3	Flow chart of Ink Formulation	37	
Figure 3.4	WCO Filtration and Heated up for 30 min	38	
Figure 3.5	Flow chart of Methoxide Preparation ALAYSIA MELAKA	39	
Figure 3.6	Sodium Hydroxide and Methanol	39	
Figure 3.7	7 Flow chart of Transesterification Process		
Figure 3.8 WCO mix with Methoxide			
Figure 3.9 Flow chart Washing process41			
Figure 3.10 Separate oil from distilled water41			
Figure 3.11Flow Chart Varnish preparation42			
Figure 3.12 Varnish process42			
Figure 3.13 Flow Chart of extraction preparation for Young Turmeric43			
Figure 3.14 Flow Chart of extraction preparation for Dry Turmeric 43			

Figure 3.15	Dry Turmeric and Young Turmeric	44
Figure 3.16	Ink Mixture	44
Figure 3.17	Visual Printing	45
Figure 4.1	Yellow Ink Sample 1	49
Figure 4.2	Yellow Ink Sample 2	50
Figure 4.3	Yellow Ink Sample 3	51



LIST OF SYMBOLS AND ABBREVIATIONS

FTIR	-	Fourier transform infrared spectroscopy		
WCO	-	Waste cooking oil		
BHT	-	Butylated Hydroxytoluene		
ASTM	-	American Society for Testing and Material		
CH ₃ OH	-	Methanol		
VOC	-	Volatile organic compound		
EU	-	European Union		
ml	-	Millilitre		
°C	- 15	Degree Celcius		
%	TEKINGL	UTEN		
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	UNIVE	ERSITI TEKNIKAL MALAYSIA MELAKA		

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Cp Reading of Yellow Ink Sample 1	57
Appendix B	Cp Reading of Yellow Ink Sample 2	57
Appendix C	Cp Reading of Yellow Ink Sample 3	58
Appendix D	Graph Analysis for Yellow Ink 1	58
Appendix E	Graph Analysis for Yellow Ink 2	58
Appendix F	Graph Analysis for Yellow Ink 3	59
Appendix G	Gantt Chart UTGON اونيونه سيتي تيڪنيڪل مليسيا ملاك	60

CHAPTER 1

INTRODUCTION

1.1 Background Study

In this era of globalization, atmospheric pollution has been identified as the most important pollution in the world, as it contributes to the thinning of the ozone layer, which then contributes to global warming. Volatile Organic Compound (VOC) contamination is the most dangerous form of pollution. Solids and liquids release volatile organic compounds (VOC) as gases. Many production firms are currently using huge quantities of chemicalcontained VOC which can have both short- and long-term negative health effects.

The ink printing industry is one of the most famous producers of VOC-containing products. Linseed oil, soybean oil and a strong petroleum distillate as a solvent (called the vehicle) along with organic pigments are most common ingredients in printing inks. The heavy petroleum oil in printing ink has the potential to damage the environment.

When ink is disposed of volatile organic compounds (VOCs) and heavy metals in it can pollute the soil even water. The pigments are made up salts of multiring nitrogencontaining compounds (dyes) like a yellow lake, peacock blue, phthalocyanine green and diarylide orange according to Steve Ritter (1998). To a lesser degree inorganic pigments are still used in printing inks. Chrome green (Cr2O3), Prussian blue (Fe4[Fe (CN)6]3), cadmium yellow (CdS), and molybdate orange are few examples (a mix of lead chromate, molybdate, and sulfate). This ink is made for several purposes, including documentation, packaging, and improving the appearance of a product. Printing inks have now become an essential item for teachers, workplaces and schools in their everyday lives. As a result, it plays an important role in our daily lives. Many researchers have discovered alternative ways to protect the environment by making green printing. The issue focuses on the VOC content of ink processing, eco-friendly disposal ink that is100 % yellow and the reuse of waste cooking oil. Waste cooking oil can be used as an alternative to petroleum as a bender.

Oil-based ink has been shown to decrease VOC emissions during the printing process. As a result, the focus of this research will be on the characterization of the natural source properties for digital printing ink produced from waste cooking, oil-based yellow pigment in able to produce green printing. The yellowish colour comes from organic turmeric.

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1.2 Problem Statement

Printing ink can release fugitive volatile organic compounds (VOCs). Furthermore, many individual components of VOCs have been classified as hazardous air contaminants (HAPs) under the 1990 Clean Air Act Amendments and thus require regulation. Linseed oil, soybean oil and a strong petroleum distillate as solvent (called the vehicle) along by organic pigments are most common ingredients in printing inks. The heavy petroleum oil in printing ink can be harmful for the environment. When volatile organic compounds (VOCs) as well as heavy metals in ink are released it can pollute the soil even the water. Many researchers have discovered alternative ways to protect the environment by making green printing. The issue highlighted in this study is the VOC content in ink processing, eco-friendly disposal ink that is 100% yellow and the reuse of waste cooking oil. The ink-based has been researched and checked so it can be replaced with waste cooking oil through a chemical reaction known as transesterification. Thus, the research will aim to characterize the natural source properties for digital printing ink made from waste cooking oil-based yellow colourant to produce green printing.

1.3 Objective The objectives for this study are:

- i. To investigate the performance of turmeric properties as natural ink as a green printing product.
- ii. To analyze the ability of waste cooking oil as binders to substitute the petroleumbased.

1.4 Scope

The research aims are to characterize the natural source properties for digital printing ink made from waste cooking oil-based yellow colourant to produce green printing. Filtration and oil purification are conducted on used cooking oil. The natural colour extract would go through a phase with treated waste cooking oil. To achieve the perfect colour of digital printing ink, the colourant will be observed and characterize by various tests such as viscosity, concentration and so on.

1.5 Summary

In summary, this chapter discusses the overall processes and objectives of this report. It began with the study's scope which discussed the significance of green printing ink, followed by problem statements, objectives, and the scope of the study. The research will aim to characterize the natural source properties for digital printing ink made from waste cooking oil-based yellow colourant to produce green printing. This research would also reformulate the previous green printing ink without the addition of any chemicals, result in 100% green printing, digital ink that is also eco-friendly.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In new global economy, green printing product analysis will go into greater detail about research done in this chapter. The analysis will go into greater detail about the research done in this chapter. The review consists of studies on the principle as well as the requirements of the materials used in the manufacturing process of this green printing ink. Waste cooking oil (WCO) is the most generally used vehicle in manufacture of green printing ink. Since heavy vehicles such as petroleum-based ink are still used in this period waste cooking oil (WCO) is used in this research to reduce Volatile Organic Components (VOCs) which have negative environmental effects. To determine the composition of green printing ink, raw materials, substances, methods and manufacturing will be examined. To produce ink able to understand and analyses processes as well as describe the properties of the formulation. The extraction of yellow colour from natural sources was also reviewed with waste cooking oil (WCO) to produce ink.

2.2 Digital Printing Ink

Studies have found that digital printing ink play an important in any daily lifestyle, such as magazines, books, and newspaper. Printing ink is a liquid and paste that includes pigments as well as dyes used in the printing process. Ink is a type of pigment that dissolves in a solvent. Author researched that about 4500 years ago, the first man made ink appeared in Egypt and it be made from animal or vegetables charcoal (lampblack) combined with glue. Inks were made from fruit and vegetable juices, defensive secretions along with

cephalopods such as cuttlefish, octopus' blood from certain shellfish or tannin from tree galls, nuts and bark (Steve Ritter, 1998).

Many printing ink firms have switched their focus toward eco-friendly inks in recent years. Aside from resource scarcity or a higher legislative burden, drivers for this growth include increased environmental consciousness among population and as a result rising demand for inks with low environmental footmark. As a result, UV-curing and water-based processes have begun to replace the solvent-based inks resulting in a reduction for volatile organic compounds (VOC) produced during the printing process. Furthermore, products extracted from renewable resources is increasingly being polymeric binders, solvents, and other additives are used to replace petrochemical ink constituents such as polymeric binders, solvents, and other additives.

The above advancements also coincide with an economic advantage as the inks allow reduced drying times or lower equipment costs the name a few. Despite this many inks are still primarily made from petrochemical feedstock. This analysis provides an overview recent development in the field of printing inks derived along as renewable materials, examines the benefits with disadvantages of the systems mentioned and addresses outstanding issues. Unlike paint films inks is very thin ranging from 2 to 30µm turn on the print process.

If an ink's primary functions are transmitting a message to decorate it is worthless if it would not move to substrate or stick satisfactorily after printing. In addition to its visual features, an ink is made to print in a certain way, dry under specific conditions, adhere to a given substrate, and have specific resistance properties dictated by intermediate processing and final end usage of the printed content.

2.2.1 The Adhesive Nature of Printing Inks

Among the most basic functions of an ink is to adhere and tie the colourant the substrate on which it is printed and hold it there over the lifetime of the printed product. Colourants have little to no effect on the adhesive quality of inks, however if are not adequately bonded by the vehicle, potentially due to inadequate dispersion, the ink will not adhere strongly. The type of resin used in ink can to a large extent decide its adhesive properties on absorbent substrates. The degree of ink penetration affects adhesion.

Pigments does not absorb well and it too much resin is drawn into the substrate the pigment can become under bound. On these conditions pigment will powder off. Adhesion on non-absorbent surfaces is largely governed by the resin's ability to form films as well as its molecular affinity for the substrate. The choice of resin for specific substrate is thus crucial, even though its output can be altered using other approaches. The right solvent mixture will improve adhesion by improving substrate wetting and flow-out.

Surface, active and chemical additives may also have an effect on adhesive properties. These materials alter the surface of the substrate as a result of a chemical reaction or physical interaction.

2.2.2 Printing Ink Resistance Properties

Throughout their 'lifespan,' every ink must withstand various types of chemical and physical attack. To begin with, the raw ingredients must be able to resist the manufacturing process use to make the ink. After being prepared, the ink must be able to withstand the rigours of the printing process. In lithographic printing, for example, it may have to work in the presence of corrosive solutions and under high shear conditions. In order to print, the ink may have to survive abrasion further processing such as cutting, creasing, gluing, shaping until the printed article is finished and ready for use. After that, the ink film can be exposed to new factors such as abrasive filling and heat sealing with heated jaws in direct contact with the ink film. The ink may also be required to withstand the chemical nature of packaged product as well as the environmental circumstances under which its placed. In order to survive in nature inks must have unique chemical and physical resistance properties.

i. Heat Resistance

Printed packages must often withstand high temperatures during processing and application, as well as the selection of resin pigment is vital to the ink's heat resistance properties. The heat resistance of pigments varies. Heat will make a colour dirty, strength loss and change the colour. Pigments should be examined and chosen to resist the temperatures encountered throughout the manufacturing process as well as the final use of the printed object.

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ii. Abrasion Resistance

During their life cycle, majority not all printed papers is subjected to various types of rub or abrasion. Both printing inks designed with this in idea. The degree to which a dried ink sheet can endure abrasive pressures is significantly controlled by the level of pigment attachment. More resin present, the greater ink's abrasion resistance, the hardness or flexibility of ink film can affect its ability to withstand abrasion or mechanical wear. To improve the scuff resistance of waxes, for example, are ink additives that facilitate surface slip are widely used. Wax is present in the majority of printing inks.

iii. Product Resistance

Ink must be able to survive touch with contents packaged in its many packaging uses. Colourants vary widely in their resistance to acids, alkalis, oils, fats, detergents, and other chemicals and must thus be selected with the eventual usage of the ink in mind. Resins has different resistance properties and should be tested in conjunction with colourants to determine their suitability for a particular application. Specific additives can be employed to modify a product's resistance qualities. When working on food packaging, ink components must be carefully selected to avoid odour and taint difficulties.

iv. Weathering

When exposed to weather and chemical elements an ink must be able to withstand physical and chemical assault. Pigments must be chosen for their environmental tolerance and in the case of particular chemical pollutants, it is critical to choose pigments that can withstand these. When exposed to damp or acidic conditions, certain pigments become more fugitive. Attempts are made on a regular basis to correlate rapid weathering experiments with real conditions. Should be used as a broad guideline Reliable ink formulation is achieved by careful pigment and binder selection, as well as substantial formulation experience.

v. Lightfastness

The level of light resistance will vary be determined by the ink's exposure use and life expectancy. Light action may cause a colour to weaken, get dirty, or change colour. Lightfastness of colourant used determines the light resistance of ink. Before using a colourant in any application, its lightfastness should be evaluated against a shaded scale such as the blue wool scale. Pigments such as carbon black, ultramarine and some iron oxides are considered lasting but the rest are all fugitive to some degree.

In general, lightfastness of pigment decreases as it is diluted by other colours, particularly white. Because of the pigments' self-masking effect highly concentrated coloured inks have greater light resistance. As a result, pastel inks are usually not as lightfast as more vibrant colours. A colourant's lightfastness varies depending on the form of the resin in which it is distributed amount of resin used can also have an impact on lightfastness. In general, greater the amount of binding material present, the greater light resistance. As a result, screen printing provides the more lightfast image of any printing process because it may produce a thick ink film with a high resin to colourant ratio.

2.2.3 Types of Printing

i. Offset Printing

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This method of printing on a flat surface with plates. The picture is transferred to an offset plate that has been chemically treated so that only image areas (such as form, colours, shapes and other elements) accept ink. The plate is splattered with water and ink. Ink only "sticks" to image regions that reject water due to the chemical treatment. Ink is rejected in areas where there are no photographs. The inked images are next transferred from the plate to the blanket's surface. Task of printing blankets made of special multi-layer rubber is to transfer the image or illustration to the paper which is repeated on each cardboard that passes through the printing machine.

The advantages of offset printing are image quality that is superior and consistent. Offset printing ensures smooth distinct form and pictures with no stains or spots. Better colour fidelity which applies to both colour accuracy and colour balance in

the design. Since offset printing may combine custom colour inks for each job, the colours will always be accurate. Get more value for money with high-volume work. Starting an offset job is expensive. Must spend money in order to create the plates which takes time. However, once invested in it all of the materials are ready to go and probably spend less on large offset jobs than will on digital print which costs around the same per piece regardless of size.

ii. Digital Printing

Digital printing do not use plates as offset printing does but instead uses toner (as in laser printers) or larger printers that do use liquid ink. Think of a run of 20 greeting cards or 100 flyers as an example of where digital printing shines. Another advantage of digital printing is its variable data capacity. When each item requires a unique code, name or address digital is the only option. This requirement cannot be met by offset printing. Find out more about the various digital printing options and capabilities.

Digital printing has some advantages such as Quick runs have lower setup costs. Print just what needed when need it. Reduced minimal amounts (as low as 1, 20 and 50 pieces) low-cost black white digital printing capability for variable data (name, addresses, codes or numbering can be done simply). Because of advancements in technology, digital quality is now suitable for a wider range of applications.

2.2.4 The Types of Printing Ink

i. Dye-Based Inks

Dye-based inks which were previously the only choice for inkjet printers, produce vivid rich colours that dry almost instantly reducing the risk that images will be smudged when treated. These characteristics are due to dyes' small molecular structure which allows for immediate paper absorption while reflecting and scattering very little light resulting in vivid colours. However, since these tiny molecules make dye-based inks water soluble they are easy to run or smear when exposed to water or humidity – regardless of how long it has been allowed to dry. Another disadvantage of the small molecular structure is that it makes dye-based inks particularly vulnerable to oxidation and fading. That is the superior colours they manufacture do not normally last very long. Finally, the fast absorption properties of dye inks can cause some unintentional overlapping of separate colours slightly altering the intended colour in a printed graphic.

ii. Pigment-Based Inks

Pigment-based inks though most costly than dye-based inks, pigment-based inks have grown in popularity in inkjet printing due to their ability to withstand the test of time. Whereas dye inks can begin to fade within days of being applied to paper, pigment inks can maintain most of their original vibrancy for up to 100 years depending on the type of paper used. The reason for this transcendent durability is that each colour is composed of a neutral base and tiny coloured particles. Because these particles are not organic and do not degrade to mix with the liquid, they are resistant to being degraded by potentially hazardous factors such as moisture and sunshine.

However, since this mixture of neutral base and pigmented colour creates a slightly diluted template the printed result is sometimes less vivid than would be the original dye-based version. Furthermore, since its colour is not in liquid form and cannot be absorbed by conventional paper, pigment ink is more prone to smudging if not thoroughly dried before handling.

iii. Solid Inks

Solid inks are relatively new to the printing world consisting of vegetable oilbased, wax-like blocks that are melted and transferred to paper. Strong inks, such as pigment inks, remain on the paper's surface rather than being absorbed by it, resulting in no fading or degradation over time. However, because the printed colours are not separated by a neutral foundation, the results are often more vivid than those of pigment inks. Solid inks are often more environmentally friendly than other inks because they are not stored in disposable cartridges that must ultimately be discarded. One of the most significant disadvantages of solid inks is their availability. Currently, only one company Xerox produces solid ink printers which come in a small price range. As a result, the possibility of purchasing less costly ink refills from a non-branded manufacturer is non-existent.

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iv. Other Types

Although there are a variety of other types of inks available the majority are designed specifically for particular tasks or industries and require particular equipment to use. Solvent inks which contain colour pigments and organic chemical compounds that become waterproof when heated are used to make decals, posters, billboards and artwork on plastic products. UV-curable inks are used to print on stainless steel, glass, wood, ceramic and other materials after their acrylic molecules are coated with direct UV rays. T-shirts, baseball caps, flags and other cloth materials are made with dye-sublimation inks which contain a form of dye that transfers to fabric when heated.

2.2.5 Component of Printing Ink

i. Vehicles and Binders

This is an additional essential ingredient for three reasons. First, it serves as a solvent for the dye to dissolve in, or as a liquid in which the pigment is evenly suspended in the case of pigments. Second, it aids the transfer of ink from pen to the paper. Finally, it improves to add ink to the paper so that does not quickly rub off. Many different vehicles and coatings are utilised in the production of ink for these purposes.

Vehicle process of moving the shading fixings from ink wellspring to sort structure may be either a vegetable base (linseed, rosin, or wood oils), which dries by entrance and oxidation while also ensuring obsession or a dissolvable base derived from lamp oil in which case drying occurs next to disappearing (Robert Lechene, 2020). Vehicles or folios were applied to colours to break down with dissolvable. Gums are used as coverings. Fasteners enable ink shade to adhere to substrate ink that is continuously dispersed.

The aim of fasteners is to wet the shade. Since tars are inconsistent in their natural intensification the sub-atomic load of gum is high. The tar determines how the sparkle scatters the paint which is important because the better a hue is scattered the better the shine is. Acrylic pitches with low mellowing focuses, vinyl saps with weak flow, shine and warmth obstruction and hydrocarbon-solvent gums with high strength yet low quality varnishes are examples of saps. A broad range of sap concoction types are utilised to change the desired characteristics of the varnish.

ii. Resin

Resin is a broad term that refers to a variety of naturally occurring, semisynthetic or synthetic materials used as binders for printing inks. It's are polymers chemically. It's either solids or viscous liquids. The majority of them have a noncrystalline structure.

Natural resins contain the following pine tree rosin that can be divided into turpentine oil and colophony. Colophony is a hard-brittle amber material. Its primary component is abietic acid. It not be used as is but should be chemically modified for example, by esterification with glycerol or reaction with maleic or fumaric acid anhydrides. Asphalt is the by-product of distilling crude oil or coal tar. Since they are so dark, they can only be used with black inks. There is naturally occurring materials with identical chemical compositions (e.g. gilsonite). Shellac is derived from an insect's secretion. It is unique in that it is soluble in after saponification, the methylated spirit is dissolved in water.

Semi-synthetic resins consist of esters of alkyd. There are polyesters composed of (for example) phthalic acid esters or glycerol that have been modified with a fatty acid. The alkyd may be "drying" or "non-drying" depending on the fatty acid used. Cellulose that has been chemically modified such as nitrated cellulose, ethyl cellulose, sodium carboxymethyl cellulose and so on. There are several synthetic resins available. Only a few examples are acrylic resins, polyvinyl acetate, polyvinyl alcohol, polyamide resins, polyurethane resins, and epoxy resin.

iii. Solvents

Solvents are chemicals that are used to dissolve the binders in printing inks. Both the producer and the printer will frequently utilise it to adjust the viscosity of the ink to the printer's specifications. Solvents used in printing inks include mineral oil, various aliphatic and aromatic hydrocarbons, ketones, esters, and alcohols. These compounds are not involved any chemical reaction Toluene, xylene, mineral oil 280/310 (boiling point range, °C), mineral spirits 80/110, 100/140, acetone, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), ethyl acetate, isopropyl acetate, n-propyl acetate, isobutyl acetate, and water are examples.

The dissoluble parameter and the potential hydrogen holding associated with a tar arrangement in the system can be used to predict solvent determination. Dissolvable selection can also affect the gleam of ink as previously stated since it affects shade scattering and printing quality.

The solvent used in this study is Butylated hydroxytoluene (BHT), with the compound name [2, 6 - Di - tert - butyl - 4 - methyl phenol] as show in figure 2.1 and an atomic load of 220.4 g/mol. BHT, also known as dibutyl hydroxytoluene is a lipophilic natural exacerbate that is synthetically imitative of phenol and is beneficial for its cell reinforcing properties (Rahman et al.,2015). BHT is also used as a cancer prevention agent in foods and as an ingredient in certain foods. Metalworking liquids, perfume, elastic, pharmaceuticals and transformer oils are examples of products that use BHT as a cancer prevention agent.



Chemical Formula: C₁₅H₂₄O Butylated hydroxy toluene (BHT)

Figure 2.1 Chemical Structure BHT

iv. Additives

The additives able to stabilize the mixture and give the ink more attractive properties (Robert Lechene, 2020). To make printing inks more suitable for the current mission additional substances and modifiers are used. Wax may be used to improve the rub obstruction of a kind of ink used in packaging. Letterpress inks come ready to print, with no additional ingredients needed. Added substances are commonly used to offer ink qualities that varnishes and colours not provide. Oils, for example can, give the ink specific stream and grease characteristic while waxes give ink durability or toughness and driers aid in the advancement of quick drying components. Table 2.1 drying agents, magnesium carbonate, and gel reducers are the three primary types of additives.

Types	Function	Typical example
Waxes	Wax additives are widely used due to their versatility and substantial positive effects on a wide range of formulation forms.	COO(CH ₂) ₃ CH ₃ COO(CH ₂) ₃ CH ₃ dibutyl phthalate
Plasticiser	Plasticisers are added to inks to make the dry print more flexible and malleable.	inks which dry by evaporation tend to be quite brittle
Drier	catalyses the oxidation process of oxidation-dried ink	cobalt, manganese, or zirconium salts or soaps
Chelating agent	raises the viscosity of the ink (aluminium chelate) and improves adhesion (titanium chelate)	
Antioxidant	Interacts with free radicals generated during autoxidation and prevents them from reacting further, delaying the start of oxidation polymerization.	H ₁ C H ₃ C eugenol
Alkali UNIVER	Acrylic resin viscosity/solubility in water- based inks can be controlled.	HOCH2 CH2 NH2 mono-ethanolamine
Defoamer	Reduces surface tension in water-based inks, preventing stable bubbles from forming.	hydrocarbon emulsions

Table 2.1 The types of additives used in printing ink

v. Drying Agents

Drying operators usually react with visible oxygen all around to the pitches used in the ink and to form an intense layer of ink on the outside of the substrate. When ink is imprinted on a substrate it begins to penetrate the substrate. Mineral or vegetable diluents speed up the retention of pigment. Mineral diluents are often consumed faster than vegetable diluents because they are more liquid. The type of substrate on which the ink is printed often determines how quickly ink dries. The faster a material absorbs the more permeable it becomes. Reduces the surface tension of water-based inks, preventing stable bubbles from forming.

Uses of oxygen to solidify varnishes in the ink is known as air oxidation. With the use of additional chemicals, this process can be sped up. It usually does not take much of this added substance to get the desired effect. A large amount of this added substance will prevent chemical bond activity. Crosslinking refers to the joining of different atoms by increasing the sub-atomic weight of the ink film through a synthetic reaction between crosslinking added substance and tar fastener. Cobalt and manganese salts are commonly used driers.

vi. Magnesium Carbonate

Magnesium carbonate (chalk) is another important added material that alters the "duration" of ink. It is used to adjust the varnish in order to make it "shorter." To solidify and shorten the ink magnesium carbonate is used. When the ink film is isolated ink continues to "string out." Magnesium carbonate enables the application of ink efficiently to the outside of the image by rollers when printed, it permits the ink film to move crack until print is completed, and the plate is put to use. travel in opposite direction from the substrate. This gives the image an unmistakable edge. Magnesium carbonate will darken an ink. Shade white ink is often use.

vii. Gel Reducer

The third kind is gel reducers important form of added material and they reduce "tack" of ink. When printing on delicate paper stock that "picks" gel reducers are used. The paper strands are pushed away from the paper stock as the plate or type pulls away from the paper stock when a substance "picks." The ink is worn enough that it separates strands from the paper, and these filaments can either blend in with the ink or fill minor gaps in the image. This usually necessitates a cleaning visit throughout a run.

2.2.6 Colourant of Printing Ink

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There are three categories of colouring ingredients: pigments, which are small solid particles created from chemicals that are typically insoluble in water and just slightly soluble in solvents, agents, which are often derived from compounds that are soluble in both water and solvents, and dyes, water, solvents, and lacquers are produced by affixing a colouring agent on powdered aluminium (Robert Lechene, 2020).

Ink can be used in a variety of ways including liquid, paste, powder and liquids. Colourants are classified into two types: pigments and dyes. Pigments of ink are usually less colour stable and have a narrower colour spectrum than dyes but pigments are used more commonly than dyes. It can also provide polish, abrasiveness or resistance to light, solvents,
heat and other chemicals. Pigments are solid opaque particles that produce colour when suspended in ink. The consistency of the pigments is governed by the pigments' colour, saturations, and brightness, as well as their source and shape. Dyes are more powerful than pigments and can create much more colour. Since dyes are readily dissolved in liquid form it appears to soak into the paper causing the image or text to bleed around the edges.

Figure 2.2 natural dyes, pigments and polymeric dyes are three types of colourants use in printing. This project will make use of pigments. There are two other kinds of pigments: organic and carbon black (Hafeezullah, 2015).



Figure 2.2 The types of colourants and based in Ink-Jet

i. Natural Colourant

Natural colourants are derived from sustainable sources with limited potential for synthetic reaction. Plants, vegetables and animals are used as natural sources of pigments. There are a variety of natural pigments that can be used to create ink. This material is easily accessible and the price varies according to the source. As a result, there are not harmful to the body's health and also have a restoring effect. It is more easily bio-degradable than standard inks so it is increasingly suitable for printing offices to lessen pollution. Natural colourants are often derived from common sources such as foods grown from the earth. These sources are not difficult to obtain and are less expensive. Turmeric was used as a natural yellow colourant in this study. Natural colourant is very eco-friendly since it is derived from a natural source with no artificial additives.

• Turmeric

Experienced turmeric that is cultivated in various parts in India but the familiar with the five-type mentioned below which are primarily grown in Kerala, South India. The majority of them are yellow, but there are also white and black turmeric it are less frequent and farmed. The first is Curcuma aromatic, commonly known as Kasturi turmeric, and has a nice odour. It is frequently used as a natural cosmetic to enhance the look of the skin. Curcuma aromatic is typically avoided in cooking due to its harsh flavour.

The powder derived from this Turmeric's root is widely available from any herbal vendor in India, and its colour is remarkably similar to that of regular turmeric used in cooking. The second form is most often found in curry powder, which is commonly used in cooking. Turmeric, which is derived from the Curcumin longa plant and is produced by boiling the roots in water before drying them to form the powder, is the key component in the majority of curry powders. Third is similar in colour the turmeric but has a round elongated shape similar to a miniature version of an umbrella, it is used in ceremonies and rituals, and it is considered very sacred people hold it at home as part of their religious symbols and venerate it for its heavenly spirit.

Fourth turmeric type is known as curry, turmeric or black turmeric, and the roots have a dark brown colour. Turmeric variety is used to make many Ayurvedic medicines.

22

Mara turmeric, sometimes known as tree turmeric, is a kind of vine that is highly valuable in the creation of certain very unique remedies. This type of turmeric is quickly becoming extinct in the Western Ghats.

• Turmeric as natural medicine

Figure 2.3 curcuma aromatic powder has a pleasant aroma and a bright yellow colour and it is used almost as a medicine to promote beautiful and healthy skin. Kasturi is derived from medicine obtained from Deer Musk which has a very fine scent. Turmeric of this type is grown in many parts of South India mostly in the western Ghats. It are larger in size than other lean edibles. Though it smells wonderful Curcuma aromatic tastes bitter when cooked so it is usually avoided. The following is some of the most popular uses of curcuma aromatic as an antibiotic and cosmetic that people are familiar with. There are numerous others to be discovered.

Growing up, it was popular for me to see girls and women use pieces of curcuma aromatic to make a paste and apply to their faces for a bright shiny appearance. Curcuma aromatic powder is usually mixed with yoghurt or milk to create a smooth texture. For body massages a paste of curcuma aromatic and mustard oil is a good option. It was formerly common in Kerala to keep a bit of turmeric and a grinding stone in the bathroom to prepare turmeric paste to apply to body areas to prevent undesired hair growth during bath time. It has long been customary in most parts of India to bathe new born children in curcuma aromatic.



Figure 2.3 Curcuma Aromatica

• Turmeric as food

Curcuma longa Linn also known as Curry turmeric is the most widely used variety of turmeric in cooking. Turmeric powder is the main ingredient in the popular "curry powder," a very ordinary term use for a variety of Indian dish. Powder of turmeric is made from turmeric root after skinned roots have been boiled in hot water for a few days and then dried. Figure 2.4 turmeric powder is prepared by powdering the dry roots of turmeric. It is a hugely effective ingredient for making dish colourful, tasty and nutritious. Turmeric can be used in a number of ways, including cooking and producing beverages.



Figure 2.4 Turmeric powder

2.3 Waste Cooking Oil

WCO is a part of the tribe of used oils which are considered hazardous waste to the environment. WCOs are the primary representatives of this category as the majority of WCOs are gathered from kitchens and the catering industry. WCOs are widely used and processed all over the globe since frying is the most regularly utilized cooking method. The global yearly output of used vegetable oils exceeds 190 million metric tonnes, with the European Union (EU) contributing around 1 million tonnes per year. In some countries, WCOs must be treated with caution (and is currently the topic of political debate in others).

Issues concerning treatment of WCOs are primarily two: the collection-and-disposal approach and waste reconversion. Disposal and collection systems will not be discussed in this Because there is a plethora of material accessible elsewhere, reconversion. Review article is unnecessary. In terms of WCO reconversion, it may be utilized as main raw materials in a number of industrial processes, such as bio-lubricant or fuel processing, or as asphalt and animal feed additives. Other possible applications for WCOs are entirely dependent on their chemical makeup. WCO are primarily a combination of triglycerides and fatty acids contaminated by derivatives such as free fatty acids (FFA), heterocycles, transesterification reaction products, and metal residues from pads and food leaking during the frying process.

. The fundamental structure of WCOs can also be utilized to produce chemicals for the production of bio plasticizers, syngas, and sorbents for volatile organic compounds (VOCs). This review article will identify and analyse certain technical developments linked to the utilization of WCOs as raw materials. The time period from 2015 to early 2020 will be given significant consideration. Browning food waste cooking oil is often supplied by cooking oil containing prepared plant or creature fats. Cooking oil is a glycerol ester made up of several types of basic unsaturated fats that dissolves in water. Plant-based lipids such as coconut oil, palm oil, olive oil, and canola oil, as well as lipid-based creatures such as margarine and ghee, are the primary sources of cooking oil (Jacob et al. 2013). At room temperature, fat and oil are responsible for waste in fluid formations. Waste might occur as a result of food industry preparedness or a recession.

2.3.1 Treatment and Material for the Treatment of WCO

Chemical treatments of WCO are applicable in refine will be addressed in this section. WCOs are long chain fatty acid mixtures (primarily linoleic, linolenic and oleic) in the form of tridi- and mono-glycerides, with varying levels of free fatty acids (FFA). It serves as a raw material platform for a lot industry. WCOs have a chemical composition that is quite close to one of the parent edibles oils, but they differ from the former in terms of breakdown and leaching products. During the frying process, some of the triglycerides in the ester moiety degrade. The number of frying cycles, frying duration, temperature, and the kind of vegetable oil used all influence the degree of deterioration. Furthermore, many volatile compounds are produced during deep frying as result of the combination of high temperature or oxygen which promotes oxidation processes and other transformations. Furthermore, proximity to food and tools during frying promotes leaching, enriching the oil composition with metal traces, herbs and other organic molecules. WCO volatile fraction analysis reveals a complex mixture of chemicals, including aldehydes, alcohols, dienes and heterocycles.

Typically, collected WCOs are treated with a first gross filtration to extract solid materials dispersed in the oil. This is complemented by the use of crude material directly as

raw material in the production process, eliminating the need for extra purification / transformation stages. WCO raw material can then be subjected to various change depending on the particular application. Oil and fat will often change their chemical composition as the frying process progresses. The treatment increased the size of polymeric particles and included particulate matter. According to research, the majority of waste cooking oil is treated by transesterification, which reacts with a chemical to generate a safer, more sustainable oil base with the added advantage of glycerol (Program,2013). According to BilGin, Gülüm, Koyuncuoglu, Nac and Cakmak (2015), the transesterification method is when methanol and oil molar proportion of 6:1 and sodium hydroxide/oil weight proportion of 0.40 percent were used the highest ester yield obtained was 87wt percent.

2.4 Inkjet Printer

An inkjet printer is a PC component that prints copies by splattering ink into paper. Figure 3.5 a standard inkjet printer can replicate with a target of 300 specks per inch in any case (dpi). Some inkjet printers can print full-shading copies at 600 dpi or higher. Several models include several computers such as a scanner, printer and dedicated fax machine all housed in a single box alongside the printer.

The print head of an inkjet printing device has a few small spouts, also known as planes. When the paper moves through the written head the spouts spray ink on it, framing the characters and images. An inkjet printer can print from 100 to a few hundred pages before removing the ink cartridges depending on the idea of a printed copy. There is usually one dark ink cartridge and one alleged shading cartridge with colour ink (cyan, red and yellow). Some inkjet printers use a single cartridge that contains cyan, magenta, yellow and black ink. Some models in addition to a dark ink cartridge require separate cartridges for each essential colour.





An inkjet printer has a very low initial cost. Surprisingly, even the most inexpensive inkjet printers may generate high-quality images. Even multi-functional inkjet printers are less expensive than laser printers as well comparable size. If users are concerned about cost inkjet printers are the best choice. Companies can save money by purchasing several inkjet printers for office use. Employees will also improve their overall efficiency by saving time.

ii. Quality

Ink cartridges are well-known for their high pigmentation. Since ink technology is used in inkjet printers, they can produce high-quality output for both images and text. Inkjet printers are recommended for high resolution picture printing due to their finer and smoother detailing.

iii. Start-up Time

Inkjet printers unlike laser printers do not need a warm-up period. That is, it does not need the printer to be heated before printing. The printer will begin printing as soon as it is switched on.

iv. Physical Size

Apart from laser printers which need a significant amount of space an inkjet printer is much smaller in size. Even the most sophisticated inkjet printers seem to need only a small amount of space. If your workplace is running out of space inkjet printers are the best choice.

v. Portability

Most inkjet printers are lightweight and plug-and-play devices. As a result, they are highly compact for use at home or in the workplace. It can be conveniently shifted to the user's desired location.

2.5 Viscometer

The viscosity of ink defines how far it travels from the anilox to the plate and from the plate to the printing substratum. It influences how much the ink dries on the substrate. In addition, the viscosity of the ink has a strong relationship with the processing speed of your press and the accuracy of your printing. Figure 2.6 Brookfield Viscotester DV-II+ Pro creates all variants by having an appropriate ink viscosity.

Surface tension and viscosity two physical ink elements are used to determine print accuracy. These two factors affect ink drop shape which affects the accuracy of the resulting printout. For high-quality printing ink viscosity must be regulated. The ink's viscosity, which includes pigments, resins, and binding agents, is governed by the ink's components.

The viscosity test is critical because ink processing provides manufacturers with a forecast of the material's characteristics in practice. Thickness is proportional to a substance's resistance to movement under an imposed force. The thickness unit is communicated in centipoises (cP). To achieve this investigative objective the ink that was produced must be within the range of normal quality for advanced ink printing. The Brookfield Viscotester DV-II+ Pro will be used after the ink has been shipped to be tested. Low thickness is needed to use axle number 62.



Figure 2.6 Brookfield Viscometer

2.6 Fourier Transform Infrared Spectroscopy (FTIR)

Fourier Transform Infrared Spectroscopy known as FTIR Analysis or FTIR Spectroscopy a technique for identifying natural, polymeric and in some instance inorganic materials. Infrared light is used in FTIR investigation technique to filter specimen samples and track compound properties. FTIR analysis determines the atomic composition and structure of a compound by measuring the infrared light absorption at various wavelengths The Fourier shift spectrometer works by transforming raw data from a broad-band light source into absorbance levels at each wavelength. FTIR can be used for solid, fluid, and vaporous testing.

In one case, the FTIR instrument absorbs infrared radiation from 10,000 to 100 cm-1, with part of it absorbed and some going through. The example atoms convert the stored radiation into rotational and extra vibrational life. The following sign at the locator appears as a range, usually ranging from 4000 cm-1 to 400cm-1 referring to a sub-atomic special mark of the example. Any atom or compound structure can leave a one-of-a-kind ghostly special finger imprint making FTIR analysis a fantastic tool for synthetic recognizable evidence.

Figure 2.7 FTIR spectroscopy is a built-up technique for quality control when assessing modern fabricated material which can frequently fill in as the initial step in the material inspection process. A change in the hallmark example of ingestion classes clearly indicates a change in the arrangement of the content or the proximity of emissions. If a visual assessment identifies a problem with the item, the root reason is generally found via FTIR microanalysis. Method is functional for breaking down the compound arrangement of smaller particles typically 10 - 50 microns with larger regions on a surface level.

FTIR investigation utilized to:

• Distinguish and describe obscure material (e.g. films, powders, solids or fluids).

• Identify defilement on or in a material (e.g. particles, filaments, powders or fluids).

• Distinguish compounds added after polymer extraction framework.



Figure 2.7 FTIR machine

2.7 Ultrasonic Bath

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The use of an ultrasonic bath can help to minimal agitation at high pressure frequencies. To lift the liquid deformation bubbles moved by high frequency pressure waves were used in ultrasonic cleaning. Agitation's high forces will work on the substrate and perforate recesses. Due to the general isolation of the mixture as a result of the ink mixture phase, this process will be performed after the ink mixture process.

2.8 Summary

Observations are largely focused on the identification of natural colourants for the production of green printing ink based on waste cooking oil (WCO). Treatment or methods of waste cooking oil purification were also investigated. Turmeric were used as natural colourants in this study to create green printing ink. In this study, the equipment to be used was also thoroughly examined as were the methodologies.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will review and cover the materials that are needed the processes that are stated in the scope of the project and the flow charts of this procedure to ensure that this investigation is conducted on schedule in order to complete this undertaking. All of the evaluations and research that will be conducted in this role will be based on the senior's previous investigation. The content selections and decisions are made after a review and a couple of study projects completed by other researchers, as well as journal readings.

This investigation has been completed by senior, and the reason for the continuation of this research is to compare the properties of natural turmeric sources. The senior's inquiries have only focused on pitaya fruit and pandan leaves. Other goals include improving the ink composition so that the shading looks better on the paper surface.

The standard boiling extraction, grinding and drying with a stove will be used to remove the shade of the natural products. Another important advancement is the treatment of waste cooking oils with a transesterification process and various materials in the appropriate amounts to achieve the goals. Figure 3.1 flow chart of entire process of performance of turmeric as wco green printing product.

3.2 Flow Chart of Project



Figure 3.1 Flow chart for the overall natural ink processing

3.3 Raw Material

The natural assets are used as the primary materials in the formulation of a green printing ink. Figure 3.2 turmeric as a yellow colourant was chosen as the natural source for the content. After methanol (CH3OH) reacts with the presence of a catalyst at a controlled temperature filtered waste cooking oil (WCOs) is generated to act as a binder. The solvent used in the turmeric extraction and BHT will be cultivated as a colourant.



3.4 Process of Ink Formulation

The ink formulation process includes several steps as figure 3.3 involving waste cooking oil and several steps involving natural colourants such as turmeric. The first step is to filter the waste cooking oil to eliminate any dirt or contaminants. Following that is the transesterification process with methanol accompanied by ink checking to ensure that the ink meets ASTM standards.





3.4.1 Filtration of WCO

Waste cooking oil was obtained from Kampung Kedah of snack stall. First, the obtained WCO was manually filtered with a white cloth. To remove the water content from UNIVERSITIEE AND ADD STATE AND AD

- i. Figure 3.4 WCO was filtered manually by using white cloth.
- Figure 3.4 Filtered WCO was heated at high temperature and let it cool for 30 min.
- iii. WCO was filtered once again by white cloth and stored in container.



Figure 3.4 WCO Filtration and Heated up for 30 min

3.4.2 Transesterification Process

The transesterification process begins with a phase in which waste cooking oil is mixed with methanol and sodium hydroxide as a catalyst to remove impurities. A 1000ml beaker was used to observe the reaction and it was filled with filtered waste cooking oil. The process reaction was carried out in a 1000 ml glass beaker with filtered WCO added to it. The waste cooking oil was heated and continuously stirred until the temperature reached 60°C. Figure 3.5 show the methanol and sodium hydroxide were applied to the waste cooking oil the mixture was constantly stirred. For the next 30 minutes, the mixture was stirred and heated. Figure 3.9 show after 24 hours, two layers of glycerol and methyl ester began to emerge.

3.4.2.1 Methoxide Preparation Process

- i. List of Material
 - Methanol, CH₃OH
 - Sodium Hydroxide pellet, NaOH

- Distilled water
- Filtered WCO
- Glass jar
- Measuring cylinder
- Weight scale Mortar and pestle

ii. Procedure of Methoxide Preparation



Figure 3.6 Sodium Hydroxide and Methanol

3.4.2.2 Transesterification Process

- i. List of Material
 - Distilled water
 - Methoxide
 - Filtered WCO

- Glass jar
- Measuring cylinder
- Beakers
- Heating plate
- Magnetic stirrer

ii. Procedure of Transesterification Process



Figure 3.8 WCO mix with Methoxide

3.4.3 Washing Process

- i. List of Material
 - Distilled water
 - Methyl ester from transesterification

- Glass jar
- Heating plate
- Magnetic stirrer
- ii. Procedure of Washing Process



Figure 3.9 Flow chart of Washing Process



3.4.4 Varnish Preparation

Instead of its high boiling point of 265°C, Butylated Hydroxytoluene (BHT) was chosen as the solvent. Figure 3.11 flow chart of process varnish preparation the varnish is made up of two components: a binder and a solvent. Varnish is made because it prevents the evaporation of ink used in digital printing.

- i. List of Material
 - Methyl ester from transesterification

- Glass jar
- Heating plate
- Magnetic stirrer
- Butylated Hydroxytoluene (BHT)
- ii. Procedure of Varnish Preparation



Figure 3.12 Varnish process

3.4.5 Natural Colourant Extraction

Turmeric has been chosen as the natural colourant for this study. Turmeric is used as a yellow colour to create ink for green printing. Natural sources have a high concentration of colour. There are many techniques for extracting colour from natural sources including mixing, powder form and heat up. Figure 3.14 and 3.15, the blending process is the most common method of colour extraction.

- i. List of Material
 - Kasturi turmeric
 - Young turmeric
 - Heating pan
 - Blender

ii. Procedure of Natural Colourant Extraction



Figure 3.13 flow chart of extraction preparation for dry turmeric



Figure 3.15 Dry turmeric and young turmeric

3.4.6 Ink Mixture

i. Procedure of Yellow Colourant Ink Mixture





25ml of young turmeric mixture were mixed with 50ml of WCO mixture

Figure 3.16 all samples will shake well and the changes in colour will observed in 7

days. UNIVERSITI TEKNIKAL MALAYSIA MELAKA



Figure 3.16 Ink mixture

3.4.7 Ultrasonic Bath

• The yellow colour extracts will analyses to an ultrasonic bath for two hours and the results of the samples were examined for before and after effects of the process.

3.4.8 Viscosity Test

• The viscos tester was turned on, and the samples were tested at spindle speeds of 62 and 100rpm.

3.4.9 Fourier Transform Infrared Spectroscopy (FTIR) Test

• The FTIR tester was turned on and the samples were placed on top of the nozzle screen to obtain chemical composition data.

3.4.10 Visual Observation TEKNIKAL MALAYSIA MELAKA

• Once the black ink cartridge ran out, figure 3.17 is the yellow ink cartridge was inserted and A4 paper was printed on.



Figure 3.17 Visual Printing

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Three tests will be carried out in order to improve the outcome of this project, which is the production of green printing ink utilizing turmeric as the yellow colour. This project will be put through its paces in terms of viscosity, ink structure testing (FTIR), and visual printing.

4.2 Viscosity Testing

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The capacity to obtain information on the performance of a substance's viscosity provides "a significant product factor" for manufacturers. Understanding an ink's viscosity qualities is significant when evaluating its pourability, efficiency in an action, or the ease with which it may be stored, processed, or used. The viscosity test will be performed to determine the ink viscosity that is comparable to commercial inks on the market. The typical viscosity of commercial printing inks on the market ranges from 1cP to 20cP.

	Yellow Colour Sample				
Viscosity	1	2	3		
	(25ml young	(8g dry	(10g dry		
	turmeric)	turmeric)	turmeric)		
cP	2.40	8.10	8.70		
RPM	100	100	100		

Table 4.1	Viscosity	Reading	of Samples
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The table 4.1 above indicates that the viscosity reading is acceptable because it is still within the range of 1cP to 20cP. Because the project is based on oil and inks, the RPM utilised in this test is the same for all samples, which is 100, as suggested by machine standard. The viscosity was measured using spindle number 62. Sample 1 of the yellow colour ink shows 2.40cp, which is low viscosity, and sample 3 shows 8.70cp, which is high viscosity. If the ink is overly viscous, it may impair the printing outcome by fading and spreading from the printed ink. As a result, we may infer that sample 2 is appropriate for both colour inks.

4.3 Fourier Transform Infrared Spectroscopy (FTIR) Testing

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Fourier transform infrared spectroscopy (FTIR) is a tremendously versatile materials examination approach that can differentiate natural and a few inorganic materials that may be the source of item defilement or produce a glitch.

For this test expected for good wavenumber peaks and transmittance as range given. The contrast between different ink tests will be noticed by looking at the escalated of primary top, the design of each spectrum, and the absence or closeness to a few distinguishing elements.

Sample	Transmittance, %	Wavenumber Peaks, cm ⁻¹	Range	Functional Group
Yellow 1 (25 ml young turmeric)	73.95	2923	2900-2800	CH Stretch
Yellow 2 (8g dry turmeric)	81.75	2923	2900-2800	CH Stretch
Yellow 3 (10 g dry turmeric)	91.75	2925	880-830	CH Deformation
THIS				

Table 4.2Reading of FTIR Testing

According to the table 4.2 above, yellow samples 1 and 2 have the same wavenumber peaks of 2923 cm-1. Both samples are classified as aldehydes. Sample 1 of yellow is a categorization of alcohol that belongs to the tertiary alcohol group. The contrast between different ink tests may be seen by checking at the escalated of major top, the design of each spectrum, and the absence or closeness to a few distinguishing elements.

4.4 Visual Printing Testing

The visual printing test will be performed after the printing ink samples have been seen for 7 days. To print the samples, they were injected into cartridges one at a time. There will be some yellow ink samples. The photograph to be printed for this project's cover page will be chosen. Figure 4.1, 4.2 and 4.3 the printed samples will be monitored for 24 hours to check if the colour remains the same as when it was first printed or if it fades.

I. Printing test of sample





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Figure 4.1 Yellow Ink Sample 1 49



SAMPLE 2

Figure 4.2 Yellow Ink Sample 2

SAMPLE !

PEFORMANCE OF TURMERIC AS WCO GREEN PRINTING PRODUCT

Figure 4.3 Yellow Ink Sample 3

As shown in the sample images above, sample 3 is most likely the lightest in colour when compared to the other samples. When compared to other samples, it seems to have a peach golden colour. The colour of sample 2 was similar to mustard, although it seems dull on paper. Because the turmeric utilized was in powder form, the colour of samples 2 and 3 seems light. Even though the turmeric powder had been sieved carefully, some lumps were found. As a result, the powder did not dissolve properly in the WCO combination, resulting in poor pigmentation. Sample 1 is more pigmented than samples 2 and 3. In sample 1, blended young turmeric was utilized, which helps to make the ink colour appear brighter. The pigmentation of ink samples is affected by the WCO with colorant ratio. The colour in Sample 1 printing test is brilliant and pigmented. The printed samples were studied for 24 hours to check if the colour remained the same as when it was first printed or faded. Fortunately, the samples are good, and sample 1 was chosen as the final result, and the ink colour is comparable to commercial inks.

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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Finally, the goal of this study was accomplished by experimenting with waste cooking oil to generate green printing ink in one colour yellow. As fugitive emissions, commercial printing ink has the ability to emit volatile organic compounds (VOC). Because heavy petroleum oil was the major element in ink manufacture, printing ink can have a negative impact on the environment. As a result, the goal of this research was to create green printing ink as an alternate method.

The project focuses on the VOC content in ink manufacturing, eco-friendly disposal ink that is 100% yellow from turmeric, and the reuse of waste cooking oil from snack stall. As an alternative to petroleum as a binder, leftover cooking oil was employed. Turmeric has a golden colour and was therefore ideal for our project. The ink pigment from the samples performed admirably. Oil-based ink has been shown to minimise VOC emissions during the printing process. As a result, the study focused on characterisation of natural source qualities for digital printing ink using waste cooking oil based yellow colourants to make green printing was successful.

A few tests were performed to ensure that the sample turned out successfully, including a viscosity test using a viscometer, Fourier Transform Infrared Spectroscopy (FTIR), and a visual printing test. All of the samples that were examined yielded the expected results. The samples were not overly viscous for the viscosity test, since they were in the range of 1cp to 20cp. Because the colour appeared brilliant and saturated on paper, sample number 1 from yellows was chosen as the final outcome.

In a nutshell, the project's objectives were met with success. The ink formulation was improved by switching volatile compounds to natural sources such as turmeric. A proper ink mixture ratio will aid in achieving proper ink pigmentation. The second goal was likewise met by characterising the natural source features for green printing ink. We utilise turmeric for colour extraction, and because it is a raw food source, it may develop an odour if stored for more than three weeks. If they are stored at room temperature, the stench can be avoided. If it begins to smell, it will get lumpy and stinky over time. There was no odour detected in this project. The fading time was another characterisation. All samples were kept under observation for a week to check if there was any difference in colour change. However, the printed samples were adequate, and no change was seen.

5.2 Recommendations

There are a few options that may be suggested and offered to move this product inquiry further. The colour consistency of the pigments in this green printing ink can be improved. The temperature of the ink was not addressed in this study; therefore, it may be a component to be improvised. Aside from that, the additional material may be swapped for a greater improvement, as well as the observation on other standard sources to offer another coloured ink hue. The pH value, surface tension, viscosity, and temperature of are all crucial factors in attaining the optimum ink-water balance during printing. In the future, paper type should be taken into account in order to achieve a smooth finish of printing on the paper surface.

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APPENDICES



APPENDIX B Cp Reading of Yellow Ink Sample 2



APPENDIX C Cp Reading of Yellow Ink Sample 3



APPENDIX D Graph Analysis for Yellow Ink 1



APPENDIX E Graph Analysis for Yellow Ink 2



APPENDIX F Graph Analysis for Yellow Ink 3



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PROJECT TITLE: PERFORMANCE OF TURMERIC AS WCO GREEN PRINTING PRODUCT														
Activities	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14
TASK 1:														
PSM Briefing														
TASK 2:														
BDP Claim														
TASK 3:														
Implementation of Project														
TASK 4:	Sec.													
Discussion with supervisor & Report	182													
TASK 5:	100													
Implementation of Project	1 19													
TASK 6:														
Implementation & Testing of Project														
TASK 7:	-									1				
Prepare Video and Slide														
TASK 8:		-					-							
Implementation of Project														
TASK 9:								1						
Update Report and logbook				1			-							
TASK 10:														
Submit Final Report / Video / Slide Presentation														
TASK 11:														
Progressing Report		1		1.1										
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