COLOR STABILITY OF NATURAL COLORANT IN TURMERIC

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A thesis submitted in fulfill of the requirements for the award of the degree of Bachelor Chemical Engineering

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APRIL 2010

ABSTRACT

Nowadays, synthetic food colorants are steadily replaced by the natural ones because of consumer preferences due to the health. Natural colorant additives are usually considered as color additives derived from plant or animal sources by extraction. Turmeric is used in this research because of their advantages especially as a source of coloring matter for food industries and textile. Plus, the application of turmeric as food colorant is limited in other research. Turmeric consists of three main components which are curcumin, demethoxy curcumin and bisdemethoxy curcumin that are responsible for its bright yellow in color. The purpose of this study is to determine the color stability of turmeric, by manipulated on storage days, by using difference concentration solvent and variety type of solvents. The method used in this research is the simple extraction process of the turmeric. The turmeric was soaked in 10%v/v, 20%v/v, 30%v/v and 40%v/v of ethanol and methanol with stabilizer (maltodextrin) in six days of storage days. The solutions were heated to their boiling point and their colors were analyzed. The stability of the turmeric was analyzed by hach DR4000 spectrophotometer by using CIE lab method based on Hunter Lab. The results shown that the values of L*, a* and b* of turmeric are different due to the storage days either in methanol or ethanol. Based on the results, turmeric color stability starts on day 5 for solvent with 10% ethanol.

ABSTRAK

Pada masa sekarang, pewarna tiruan telah mula digantikan dengan pewarna asli atas permintaan pelanggan disebabkan oleh masalah kesihatan yang semakin bertambah. Pewarna asli tambahan biasanya adalah warna tambahan yang diekstrak daripada tumbuh-tumbuhan ataupun haiwan. Kunyit digunakan dalam peyelidikan ini kerana kunyit mempunyai banyak kelebihan terutamanya sebagai sumber pewarna dalam industri makanan dan juga tekstil. Tambahan pula, peyelidikan mengenai kegunaan kunyit sebagai pewarna makanan adalah terhad. Kunyit mengandungi tiga komponen yang utama iaitu curcumin, demethoxy curcumin dan bisdemethoxy curcumin yang memberikan warna kuning dalam kunyit. Tujuan penyelidikan ini adalah untuk menentukan kestabilan warna dalam kunyit dengan menggunakan kepekatan cecair yg berbeza, pelbagai jenis cecair dan juga bilangan hari untuk penyimpanan. Method yang digunakan dalam penyelidikan ini adalah proses pengekstrakan kunyit yang mudah. Kunyit direndam di dalam kepekatan ethanol dan methanol yang berbeza iaitu 10%, 20%, 30% dan 40% , serta ditambahkan dengan pemantap (maltodextrin) dan di simpankan dalam masa enam hari. Semua larutan dipanaskan pada takat didih masing-masing dan warna mereka di analisiskan. Kestabilan kunyit dianalisis menggunakan spektrofotometer Hach DR4000 dan berdasarkan cara CIE lab daripada Hunter Lab. Hasil penyelidikan menunjukkan nilai-nilai untuk L*, a* dan b* adalah berbeza mengikut hari masing-masing sama ada di dalam ethanol atau methanol. Berdasarkan keputusan, warna kunyit mula stabil pada hari ke 5 dalam 10% ethanol.

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LIST OF ABBREVIATION/TERMINOLOGY/SYMBOLS

FD&C	-	Food, drugs and cosmetic
EU	-	European Union
CIE	-	Commision Internationale d'Eclairage
I	-	Intensity passing through the sample
Io	-	Intensity before pass through the sample
A	-	Absorbance
T	-	Transmittance
CCD	-	Charge Couple Device
L*	-	Lightness
a*	-	Color ranging from red through green
b*	-	Color ranging from yellow to blue
pH	-	Potentiometric hydrogen ion concentration
µg	-	microgram
mL	-	mililitre
°C	-	Degree Celcius
g	-	gram
v/v	-	Volume per volume
%	-	Percentage
nm	-	nanometer

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, the attractive colors of food products like strawberry jams, blood orange juice, or raspberry jellies is an important quality parameter, which influences consumer behavior. However, there are some problems to remain and to obtain a stable color of fruit products especially while processing and storage them in a long period. In order to improve and maintain the stability of color, scientific research on the chemistry of colors is needed.

Natural colorant additives are usually considered as color additives derived from plant or animal sources by extraction or other physical processing. Some examples of natural colorants are include carmine, annatto extract, grape skin extract, turmeric, saffron, and beta-carotene, which are the major natural color additives used in foods product. Synthetic colorant additives are including chemically synthesized substances and for example are tartrazine, erythrosine and indigo carmine.

Natural food colorant additives should be used because there are so many advantages and benefits to consumer. There are no side affect that will give bad condition to consumers. Usage of natural colorant in food industry appears to have multidimensional potential (Dufosse, 2004) and it will help to increase the production of high quality product in food industries.

1.2 Background of Study

In this study, turmeric is used to determine the stability of color. Turmeric also known as *Curcuma longa* L. is used because it contains of curcumin, demothoxycurcumin and bisdemethoxycurcumin which will produce yellow color. Curcumin with polyphenolic structure is water insoluble and scarcely dissolved in the organic phase. However, it is unstable at neutral-basic pH values and in serum-free medium, and is degraded to vanillin, ferulic acid, feruloyl methane and trans-6-(40-hydroxy-30-methoxy-phenyl)-2,4-dioxo-5-hexenal (Chuan *et al.*,2009). Ishita *et al.* (2004) discovered that the turmeric compositions are containing 69.4% of carbohydrates and 13.1% of moisture, 6.3% of protein, 5.1% of fat and 3.5% of minerals.

There have several advantages of using turmeric in this study. Turmeric is used widely in food industries as a color spice, food preservative and coloring materials. In medical, turmeric is used because they contain of good properties such as antioxidant and contains of anti inflammaratory properties in clinical trials. (Sharma *et al.*, 2001)

Curcumin possesses not only chemo preventive but also anti-cancer activities (Sharma *et al.*, 2001). Curcumin has been considered by the National Cancer Institute (NCI) as the third generation of cancer chemo preventive agent in America and phase II clinical trials have been carried out in Germany. It had been proven a few years before. Besides that, the turmeric have traditionally been used as a source for cosmetics, textile and as well as medical agent as mentioned in Indian system of medicine for several common ailments. (Vikas *et al.*, 2007)

1.3 Problem Statement

Nowadays the usage of natural colorant is increasing especially for using in pharmaceutical and food industry due to the demand from consumers. However, there are some problems in order to maintain the stability of color in certain product. This is because color of product especially food product tend to fade and the quality is easily to damage. Usually food products are fading in a long period. So, this research is to determine the color stability of food product. The natural colorants are used to replace synthetic colorants. This is because synthetic colorants consists a lot of chemicals that will give bad side effect to consumer's health. So that, the consumer's health problems can be decrease by replacing synthetic colorant with natural colorants.

1.4 Objectives

The aim of this study is to determine the color stability of turmeric by using CIE lab based on storage days, by using difference concentrations solvent and variety of solvents.

1.5 Scope of Study

The scopes have been identified for this study in order to achieve the objective of this research:

i. Turmeric
ii. Characterization colors by using CIE lab
iii. Parameters of L*, a* and b* in different storage days
iv. Effect on stability in different solvent concentrations

1.6 Significant of Study

There are several significances in this research. Firstly is to remain the quality of colors so that the color can be the same even tough in a long period of storage days. Beside that, is to decrease the lost of color which means to maintain the color stability and to avoid from fading. In addition, the significance is to increase the usage of natural colorant because natural colorant has many advantages to humans. Lastly is to assure the safety of natural colorants where to make sure contain of natural colorant is safe to use in food products.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Color is an important attribute related to the visual appeal and the quality of food products (Bridle and Timberlake, 1997). In addition, color becomes the most sensitive part of any commodity not only for its appeal but also it will enhance consumer acceptability. Besides that, the color of a food substance is very important in order to indicate its freshness, safety and also indicate good aesthetic and sensorial values. For natural color and additives, adherence to the norms of bio safety protocol, are limited.

The demand for natural sources of such compounds is increasing day by day because of the awareness positive health benefits out of natural compounds. Therefore, it is necessary for looking into natural sources of food colorants and finds their potentials. Besides that, colors will give first impression and good attraction to consumers to get the food especially when they are in good conditions. Moreover, color also can show the condition of the food either they are in a good conditions or bad conditions.

2.2 Colorant

Color is usually considered as the most important attribute of any food's appearance, shape or looks especially if it is associated with other aspects of food quality, for example is the ripening of fruit or the visible deterioration which occurs when a food spoils. Nearly every food product has an acceptable colors range, which is it depends on a wide range of factors including variability among consumers, their age and ethnic origin, and the physical nature of the surroundings at time of judgment (Francis, 1989).

While colorant is the activity of that molecule (Hari *et al.*, 1994). Colorant shows activity when applied to a substance. Since the early civilization, products are made to give an attractive presentation by addition of natural colorants. Colorants become the most sensitive part of any commodity not only for its appeal but also, it will enhance consumer acceptability (Clydesdale, 1993). The use of color by the food industry is necessary to

i. restore the original food appearance even after processing and during storage, this is because while processing, the quality of food can disappear slowly without we realize it
ii. ensure color uniformity for avoiding seasonal variations in color tone which is to make sure all the food will get the same appearance
iii. intensify colors normally found in food thus to maintain its quality so that the quality always remain in every situation
iv. protect other components such as flavor and vitamins to keep maintain the flavor and nutrients
v. obtain the best food appearance
vi. reserve characteristic associated with food
vii. help as visual characteristic of food quality

2.2.1 Natural Colorant

The natural colorants have been relatively free of criticism may be due to the belief that most are derived from food sources that have been consumed for many years (Francis, 1989). According to scientific investigations humans take up the largest part of their information visually. Also, food is asses first on the basis their outside appearance. A part from form and general presentation the color contributes substantially to the quality assessment by the consumer. For different product groups a different expectation attitude developed concerning the chroma. Generally products with a more intensive coloring are preferred. Processing or storage of a product can lead by oxidative or enzymatic influences to the impairment of the natural colors. In order to arrange the product optically responding, in the context of the legal regulations coloring materials can be added to food.

Natural colors are organic colorants that are derived from edible sources using recognized food preparation methods. One of the advantages of using natural colors is that they are generally more widely permitted in food-stuffs than synthetic colors. Contrary to many reports, natural sources can provide a comprehensive range of attractive colors for use in the modern food industry. However, although the color of fruits and vegetables can vary during the season and processing can cause color loss, food manufacturers need to ensure uniformity of product appearance (Henry, 1996).

Besides that, colors may be added to foods to give color to certain foods such as sugar confectionery, ice lollies and soft drinks, which would otherwise be virtually colorless (Food Advisry Committee, 1987). Color is a major of quality in the natural products to be commercialized. Alan (2006) discovered that natural colors are pigments that made by living organisms where usually the pigments that made by modification of materials from living organisms, such as caramel, vegetable carbon, and Cu-chlorophyllin (vide infra), are also considered natural though they are in fact (except for carbon) not found in nature.

The application type of natural food colorants are however so far limited, since they have some disadvantages in comparing with the artificial colorants (Toufel *et al.*, 1993). They are however relatively safe dealing with toxicological check and incompatibility reactions (Baltes, 1995). Use of natural colorant in food industry appears to have multidimensional potential (Dufosse, 2004). For example, in addition to coloring property, carotene may be used in food as an essential vitamin source or betalains as source of essential amino acid or anthocyanins as quality control marker of food stuffs. Flavonoids are colorants with high pharmacological promise. Sometimes, diets with carotenoid mixtures are recommended instead of having just one particular carotenoid. This is because great variability of radicals and microenvironments take place *in vivo* (Pritam *et al.*, 2008).

2.2.2 Synthetic Colorant

Synthetic organic and inorganic colorants are copies of vegetable, animal, and mineral-based colorants, and are made in a laboratory. Until the nineteenth century, all colorants were of natural origin. The first synthetically made commercial colorant, mauve, was developed from aniline, a coal tar derivative, by William Henry in year 1856 (Pritam *et al.*,2008). Today, chemists arrange and manipulate complex organic compounds to make dyes of all colors. Synthetic dyes, made in a controlled atmosphere, are without impurities and the colors are more consistent from batch to batch. Natural dyes still have some commercial value to craftspeople, but synthetic colorants dominate the manufacturing industry. Moreover, synthetic colorants are water-soluble and can be form as powders, pastes, granules, or solutions. However, the stability of synthetic colorants can be affected by light, heat, pH, and reducing agents.

A number of dyes have been chemically synthesized and approved for usage in various countries. These colorants are designated according to special numbering systems specific to individual countries. For example, the United States uses FD&C numbers (chemicals approved for use in foods, drugs, and cosmetics), and the

European Union (EU) uses E numbers. The example of name of synthesis that used in some product is shows in table 2.1.

Table 2.1: The Most Commonly Used Synthetics Dyes

Common Name	United State	European Union	Products
Allura red AC	FD&C red no 40	-	Gelatin, puddings, dairy products, beverages
Brilliant blue FCF	FD&C blue no 1	E133	Beverages, icings, syrups, confections
Erythrosine	FD&C red no. 3	E127	maraschino cherries
Fast green FCF	FD&C green no. 3	-	beverages, puddings, ice cream, sherbet, confections
Indigo carmine	FD&C blue no. 2	E132	confections, ice cream, bakery products
Sunset yellow FCF	FD&C yellow no. 6	E110	bakery products, ice cream, sauces, cereals, beverages
Tartrazine	FD&C yellow no. 5	E102	beverages, cereals, bakery products, ice cream, sauces

2.2 Color Stability

Color stability is the ability of lamp or light sources to maintain its color rendering and color appearance properties over its life. The color properties of some discharge light sauces may tend to shift over the life of the lamp. There are several ways that can used to analyze color, with spectrometer and CIE lab.

2.2.1 Stabilizer

A stabilizer is a chemical which tends to inhibit the reaction between two or more other chemicals. It can be thought of as the antonym to a catalyst. It can be also a chemical that inhibits separation of suspensions, emulsions, and foams. Some kinds of stabilizers are antioxidants which is preventing unwanted oxidation of material, sequestrants that forming chelate complexes and inactivating traces of metal ions that would otherwise act as catalysts and emulsifiers and surfactants, for stabilization of emulsions.

Stabilizers are an indispensable substance in food items. When added to the food items, they smoother the texture of the food & give a definite body to the food. They are added in relatively small amount which gives aggravates the effect of emulsifiers. They give a uniform nature to the product and hold the flavoring compounds in dispersion. Perfect binders for the varied conflicting components, stabilizers are a must. The common stabilizers are gelatin and carrageenan. Sometimes, stabilizer is used to help in reducing the process degradation of material, in order to maintain its quality and stability.

2.2.1.1 Maltodextrin

Maltodextrin is a polysaccharide that is used as a food additive. It is produced from starch by partial hydrolysis and is usually found as a creamy-white hygroscopic spraydried powder. Maltodextrin is easily digestible, being absorbed as rapidly as glucose, and might be either moderately sweet or almost flavorless. It is commonly used for the production of natural sodas. Besides that, maltodextrin is water soluble materials and protect encapsulated ingredient from oxidation. (Shahidi and Han, 1993), they have low viscosity at high solids ratio and are available in different molecular weights which provides different wall densities around the sensitive materials (Cai and Lorke, 2000).

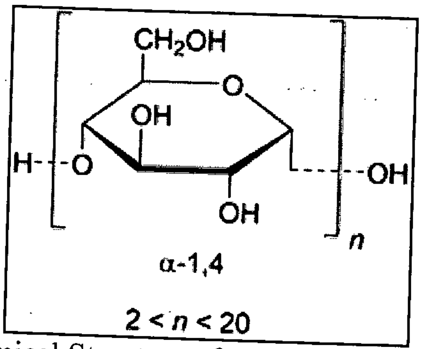

Figure 2.1: Chemical Structure of Maltodextrin (Wikipedia,2010)

2.2.2 Spectrophotometer

Spectrophotometer is an instrument that used in ultraviolet-visible spectroscopy and it used to measure the intensity of light passing through a sample (I), and compares it to the intensity of light before it passes through the sample (I_o). The ratio I / I_o is called the *transmittance*, and is usually expressed as a percentage (%T). The absorbance, A, is based on the transmittance:

$$\mathbf{A = -\log(\%T / 100\%)} \tag{2.1}$$

The basic parts of a spectrophotometer are a light source, a holder for the sample, a diffraction grating or monochromator to separate the different wavelengths of light, and a detector. The radiation source is often a Tungsten filament (300-2500 nm), a deuterium arc lamp which is continuous over the ultraviolet region (190-400 nm), and more recently light emitting diodes (LED) and Xenon Arc Lamps for the visible wavelengths. The detector is typically a photodiode or a CCD. Photodiodes are used with mono chromates, which filter the light so that only light of a single wavelength reaches the detector. Diffraction gratings are used with CCDs, which collects light of different wavelengths on different pixels.

A spectrophotometer can be either single beam or double beam. In a single beam instrument as in figure 2.1 all of the light passes through the sample cell. I_o

must be measured by removing the sample. This was the earliest design, but is still in common use in both teaching and industrial labs.

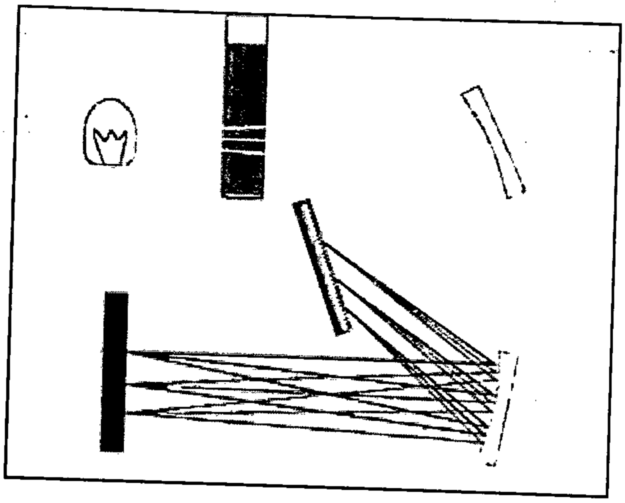

Figure 2.2: Single Beam Instruments (Google, 2010)

In a double-beam instrument, the light is split into two beams before it reaches the sample. One beam is used as the reference; the other beam passes through the sample. Some double-beam instruments have two detectors (photodiodes), and the sample and reference beam are measured at the same time. In other instruments, the two beams pass through a beam chopper, which blocks one beam at a time.

In this respect the human eye is functioning as a spectrometer analyzing the light reflected from the surface of a solid or passing through a liquid. Although, we see sunlight like uniform or homogeneous in color it is actually composed of a broad range of radiation wavelengths in the ultraviolet, visible and infrared portions of the spectrum. As show in figure 2.3, the component colors of the visible portion can be separated by passing sunlight through a prism, which acts to bend the light in differing degrees according to wavelength.

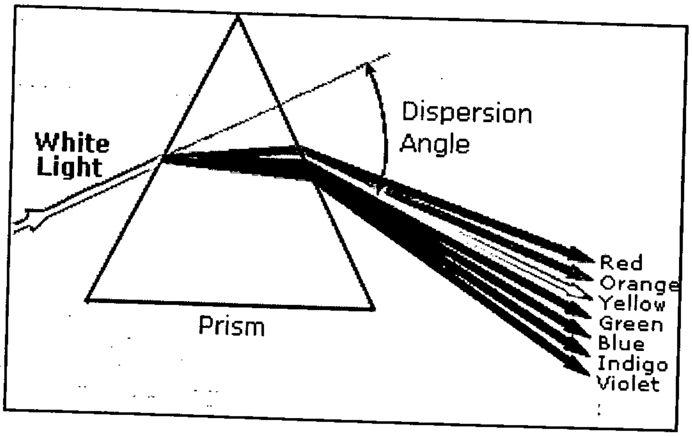

Figure 2.3: Prism of Color (Google, 2010)

Electromagnetic radiation such as visible light is commonly treated as a wave phenomenon, characterized by a wavelength or frequency. Wavelength is the distance between adjacent peaks, and may be designated in meters, centimeters or nanometers (10^{-9} meters). Frequency is the number of wave cycles that travel past a fixed point per unit of time, and is usually given in cycles per second, or hertz. Visible wavelengths cover a range from approximately 400 to 800 nm. The longest visible wavelength is red and the shortest is violet. The wavelengths of what we perceive as particular colors in the visible portion of the spectrum are displayed in figure 2.4, 2.5 and 2.6.

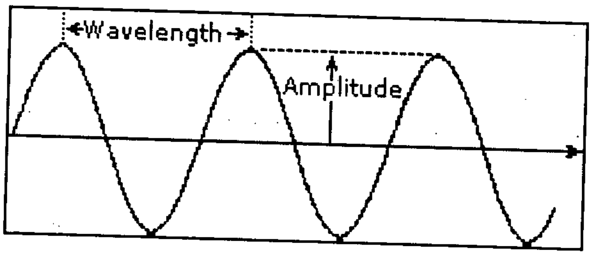

Figure 2.4: Wavelength (Google, 2010)

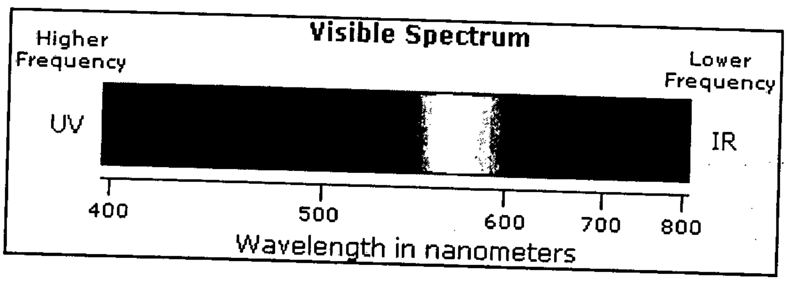

Figure 2.5: Visible Spectrum (Google, 2010)