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| | | |
|---|---|---|
| PPT-040 | Mrs. Ririn Puspadewi | The Activity Test Of Antimicrobial Water Extract, Ethanol Extract And Their Fractions From Pacing tawar (Costus speciosus Smith) Leaf To The Skin Of Microflora And The Intestinal |
| PPT-041 | Ms. Norsharina Ismail | Germinated brown rice extract protects neuronal cells from apoptosis through Akt activation and p53 inhibition |
| PPT-042 | Dr. Rina Herowati | Molecular Docking Studies of Chemical Constituents of Tinospora cordifolia on Glycogen Phosphorylase as a Cure for Diabetes Mellitus |
| PPT-043 | Dr. Andria Agusta | Biotransformation of Protoberberine Alkaloids by the Endophytic Fungus Coelomycetes AFKR-3 Isolated from Yellow Moonsheed Plant [Archangelisia flava (L.) Merr.] |
| PPT-044 | Prof. I Made Sudarma | Design and Synthesis New Candidate Antibiotics from leaf clove oil |
| PPT-045 | Mrs. PUTRANTI ADIRESTUTI | Biosinthetics of surfactant agents using Bacillus subtilis |
| PPT-046 | Mr. Jeffry Julianus | Synthesis 2-(4'-Hydroxybenzylidene) Cyclohexane-1,3-Dione A Curcumin Analogue |
| PPT-047 | Mr. Muhammad Khairuman | Java Pro : New Product Innovation To Make Tradisional Medicinal Plants Become Instant Herbal Medicine |
| PPT-048 | Mr. Dewa Ken Budiputra | Development of Curcumin-encapsulated Nanoemulsion and Characterization |
| PPT-049 | Ms. Nelly Setiawaty | Formulation and Characterization of Vitamin A Nanoemulsion |
| PPT-050 | Mrs. Hestiary Ratih | Formulation And Antioxidant Activity Of Water Extract Of The Mangosteen Rind (Garcinia Mangostana L) For The Preparation Of Liquid Soap |
| PPT-051 | Mrs. Irda Fidrianny | Antioxidant Compound From Ethyl Acetate Extract Of Breadfruit (Artocarpus Communis Forst) Leaves Grown In Cilacap - Indonesia |
| PPT-052 | Dr. Gunawan Pamudji Widodo | Hypoglycemic Effect of Basil (Ocimum basilicum) Herbs Infusion in Combination with Oral Antidiabetic Drugs on Alloxan Induced-Diabetic Mice and Glucose Tolerance Test |
| PPT-053 | Mrs. Bernadeta Wuri Harini | Development of Curcuminoid Content Measurement Equipment Device in Turmeric (Curcuma domestica) Rhizomes |
| PPT-054 | Mrs. Irda Fidrianny | Non Alkaloid Compound From Methanol Extract Of Quinine (Cinchona Officinalis L) Leaves Grown In Gambung, Bandung - Indonesia |
| PPT-055 | Mrs. Irda Fidrianny | Flavonoid Form Methanol Extract Of Kersen (Muntingia calabura L.) Leaves Grown In Coblong, Bandung- Indonesia |

# Development of Curcuminoid Content Measurement Equipment Device in Turmeric (*Curcuma domestica*) Rhizomes

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**Abstract**

*Turmeric (Curcuma domestica*/kunyit, Indo) is containing curcumin a medical compound for some diseases. The most important part of this plant is it's rhizomes.

It has developed the measurement equipment device with an aim to empower Turmeric *(Curcuma domestica)* farmers in the turmeric production centre area, Wonosobo, Wonogiri, Imogiri, Magelang, and Kulonprogo. This research showed that 33.3% farmers in that area do the sorting according to size and 23.8% according to water content. There is not any practice to sort according to curcumin content. It is caused by the lack of knowledge and practical equipment among the farmers. This is the reason why this research is carried out.

The measurement equipment device is using the principal of spectrophotometer. From the scanning test of standard curcumin using visible spectrophotometer, we get 405 nm for the maximum wavelength of absorbance. The wavelength is in violet range. Therefore, the device will be developed using light source of vilet LED (Light Emiting Diode) and violet Laser. The result of this research showed that both of the light source can be used to measure the absorbance of curcuminoid content of turmeric.

*Keywords: Curcuminoid, Curcuma Domestica, LED, Laser, violet*

## 1. Introduction

*Turmeric (Curcuma domestica*/kunyit, Indo) is containing curcumin a medical compound for some diseases. The most important part of this plant is it's rhizomes. Curcumin is a phenolic compound derived from the rhizome isolation of plant turmeric (Curcuma domestica Rhizome) containing desmetoksikurkumin, curcumin and bisdesmetoksikurkumin, which is often referred to as the curcuminoids. The main content of curcuminoids is curcumin, a yellow orange. Directed toward the development of medicinal plants to meet domestic industry, pharmaceuticals, cosmetics, household industry, carrying herbs and exports. There is a lot of data and literature that indicates that the compound curcumin in turmeric (Curcuma domestica) has great potential in the pharmacological activity of anti-inflammatory, anti immunodeficiency, anti-virus (bird flu virus), anti-bacterial, anti-fungal, anti-oxidant, anti-carcinogenic and anti-infective (Joe *et al*., 2004; Chattopadhyay *et al*., 2004).

It has developed the measurement equipment device with an aim to empower Turmeric *(Curcuma domestica)* farmers in the turmeric production centre area, Wonosobo, Wonogiri, Imogiri, Magelang, and Karanganyar. The measurement equipment device is using the principal of spectrophotometer. Some researchers have examined the absorption of curcumin by using spectrofphotometer. According to Harada, T., maximum wavelength of absorption of curcumin is 427-329 nm (Harada, T., 2011), while according to Jagannathan, R., maximum wavelength for absorption of curcumin in methanol is about 420nm (Jagannathan, R., 2011). From the scanning test of standard curcumin using visible spectrophotometer, we get 422 nm for the maximum wavelength of absorbance. From all this research can be seen that the

wavelength of absorption of curcumin present in purple light spectrum range, which is between 380-435 nm (Jones, A.Z., accessed in Oct 11, 2012). Therefore, the device will be developed using light source of violet LED (Light Emiting Diode) and violet Laser.

## 2. Research Method

The stages of this study are as follows:

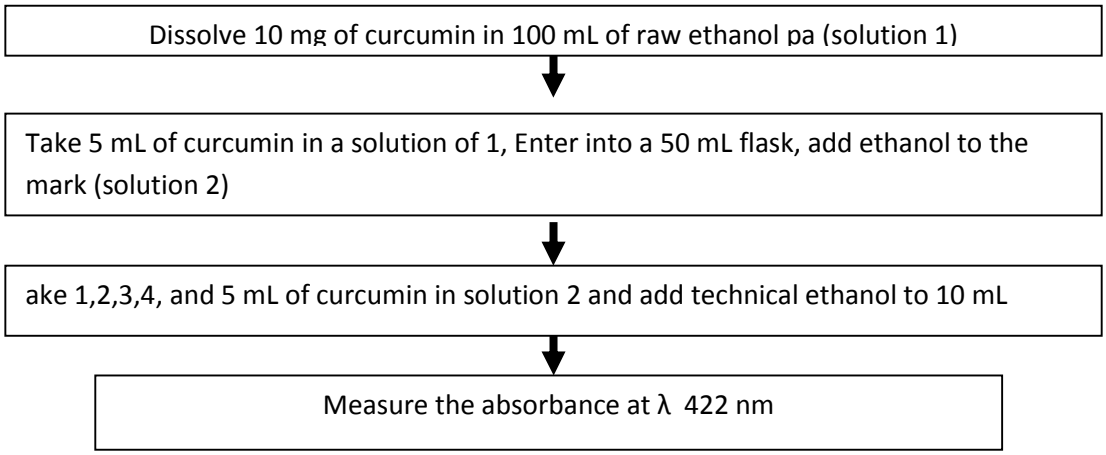
a. Survey of farmers capabilities in sorting turmeric and collect samples of 5 turmeric turmeric producing region is in Central Java and Yogyakarta, from the village of Jumantono Karanganyar, Wonogiri district, village Pandansari Magelang, Wonosobo, and village Kunden Imogiri

b. Preparation of standard curve of curcumin liquor to obtain a standard curve equation

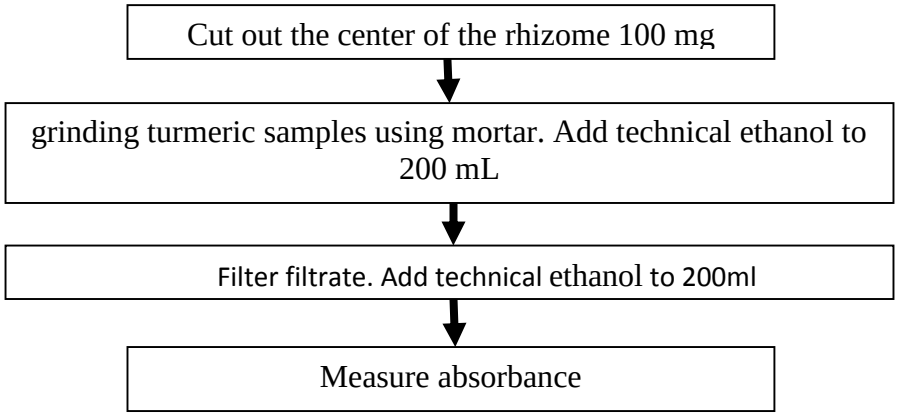
$$y=bx+a \quad (1)$$

where $y$ = absorbance
$x$ = levels of substances

How to create a solution for standard curve is as follows:




c. Preparation of samples from various places planting turmeric in the following ways




d. Prototyping curcuminoids measurement device using purple LED and laser light sources. The values of b and that is obtained on standard curve equation used to calculate the levels of curcumin in turmeric samples. At first photodetector receives the voltage of the beam of purple light when no molecular absorber between the light source and a photodetector. Then a solution containing curcumin is placed between the light source

and a photodetector. The light through the absorbing molecule to be received by a photodetector. Voltage difference between the before and after it is placed a solution of curcumin is the absorbance value (y). With the obtained values of a, b and y from these measurements, you will get the levels of curcumin in solution (x) according to standard curve equation above by the formula

$$x = \frac{y - a}{b} \quad (2)$$

Figure 1 shows the block diagram of this system.

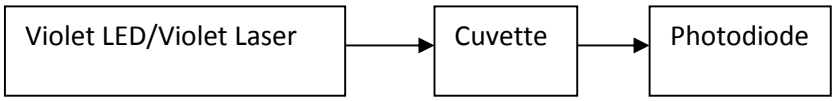



**Figure 1. Block diagram**

## 3. Results and Analysis

### A. Survey Result

Figure 2 shows the turmeric agricultural area in Karanganyar, Wonogiri, Wonosobo, Magelang and Imogiri.

(a) (b) (c) (d) (e)

**Figure 2. The turmeric agricultural area (a) Karanganyar (b)Wonogiri (c) Wonosobo (d)Magelang (e) Imogiri**

**Table 1. The results of the survey capability of farmers**

| Statement | %Yes | %No |
|---|---|---|
| Do sorting the harvest that is sold | 30.43 | 69.57 |
| Sorting criterion is based on the size of | 30.43 | 69.57 |
| Sorting criterion is based on the level of drought / water content | 21.74 | 78.26 |
| Sorting criterion is based on the amount of curcumin content | 4.54 | 95.46 |
| Farmers have to test the levels of curcumin in turmeric crop | 0 | 100 |

This research showed that 30.43% farmers in that area do the sorting according to size and 21.79% according to water content. Farmers who have been sorting turmeric by curcumin levels only 4.54%. It is caused by the lack of knowledge and practical equipment among the farmers. This is the reason why this research is carried out.

## B. Prototyping Curcuminoids Measurement Device

**Figure 3. Curcuminoids measurement device prototype**

## C. Preparation of Standard Curve and Samples of Turmeric

Figure 4 shows the cuvette, the solution for the standard curve and samples from different growing areas in Central Java and Yogyakarta. Table 2 shows the results of measurements of standard curves on tools that have been made and compared with results obtained with a standard spectrophotometer. These results are then illustrated in Figure 5.

**Figure 4. The sample**

**Table 2. The results of absorbance measurements for standard curve**

| NO | Curcumin solution | LED voltage (Volt) | Laser voltage (Volt) | Spectrophotometer |
|---|---|---|---|---|
| 1 | 1 ppm | 0.16 | 0.06 | 0.156 |
| 2 | 2 ppm | 0.35 | 0.08 | 0.306 |
| 3 | 3 ppm | 0.78 | 0.1 | 0.461 |
| 4 | 4 ppm | 1.73 | 0.11 | 0.612 |
| 5 | 5 ppm | 2.5 | 0.12 | 0.764 |

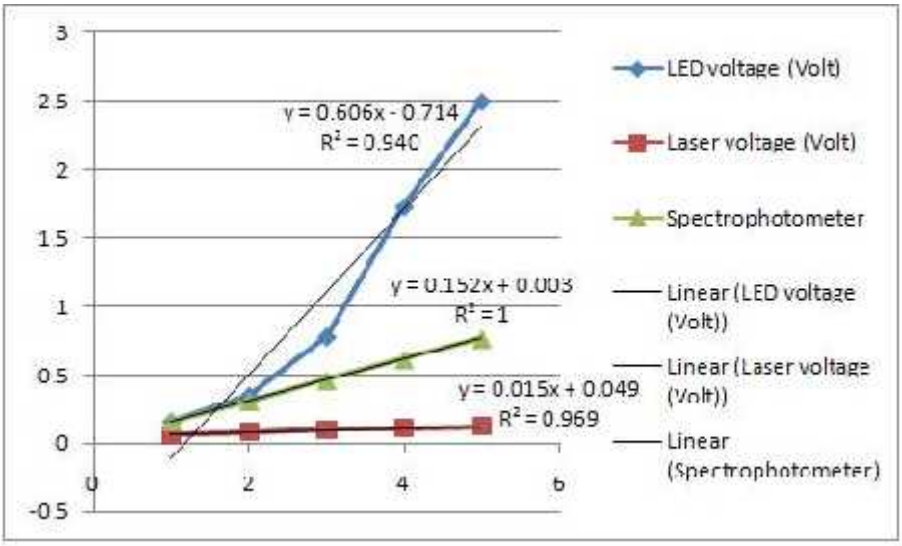



**Figure 5. Standart curve of curcumin solution**

From Figure 5 it appears that the results obtained from measurements using a standard spectrophotometer produced a linear graph with the level of linearity equal to 1, while for LED to laser at 0.940 and at 0.969. It appears that the results of measurements with a laser light source produced more linear than the LED. This is because the laser beam is more focused than LED beam. The linearity level could be improved by making the cover along the beam of light, so the measurement is not affected by the light from outside sources of light. From the chart above also obtained standard curve equation as follows:

f. Spectrophotometer

$$y = 0.152x + 0.003 \quad (3)$$

g. LED

$$y = 0.606x - 0.714 \quad (4)$$

h. Laser

$$y = 0.015x + 0{,}049 \quad (5)$$

In table 3 are shown the results of measurements of the sample absorbance planting from different regions by using three device. From these results is then used to measure the levels of curcumin in turmeric according to equation 2 with *a* and *b* as in equation 3-5, which are shown in Table 4.

**Table 3. The results of turmeric absorbance measurements**

| NO | Region | LED voltage (Volt) | Laser voltage (Volt) | Spectrophotometer |
|---|---|---|---|---|
| 1 | Karanganyar | 2.51 | 0.11 | 0.609 |
| 2 | Magelang | 2.38 | 0.13 | 0.848 |
| 3 | Imogiri | 2.32 | 0.13 | 0.812 |
| 4 | Wonosobo | 1.35 | 0.118 | 0.532 |
| 5 | Wonogiri | 2.15 | 0.12 | 0.784 |

**Table 4. The results of the curcuminoid levels calculation of turmeric sample (*x*)**

| **NO** | **Region** | **Curcuminoid Levels (*x*)** | | | ***Error (%)*** | |
|---|---|---|---|---|---|---|
| | | **LED** | **Laser** | **Spectrophotometer** | **LED** | **Laser** |
| 1 | Karanganyar | 5.32 | 4.07 | 3.99 | 33.44 | 2.00 |
| 2 | Magelang | 5.11 | 5.40 | 5.56 | 8.16 | 2.86 |
| 3 | Imogiri | 5.01 | 5.40 | 5.32 | 5.93 | 1.46 |
| 4 | Wonosobo | 3.41 | 4.60 | 3.48 | 2.14 | 32.17 |
| 5 | Wonogiri | 4.73 | 4.73 | 5.14 | 8.02 | 7.88 |

From Table 4 it appears that the level of curcuminoid (x) using LED and laser differ from those generated by a standard spectrophotometer with error between 1.46 to 33.44%. The smallest error resulting from the measurement of turmeric in Imogiri area using a laser light source. Greatest error resulting from the measurement of turmeric in Karanganyar area using LED light source. From the above calculations it appears that the measuring instrument with a laser light source produces measurements with an average error smaller (9.28%) than LED source (11.54%). It shows the performance of the laser light source is better than LED. The order from largest to smallest levels as follows::

a. LED: Karanganyar - Magelang – Imogiri – Wonogiri – Wonosobo
b. Laser: Magelang – Imogiri – Wonogiri – Wonosobo – Karanganyar
c. Spektrofotometer standar: Magelang – Imogiri – Wonogiri –Karanganyar –Wonosobo

The difference in results is due to the measurement is still in an open condition, so there is likely to be affected by external light. In addition, samples were measured after two hours the samples were extracted and in the outdoor environment without closed. This allows the change in turmeric samples. Hygiene factors cuvette and cuvette position when put in place will influence the measurement cuvette. Therefore prototype of curcuminoid levels device is still needed improvement, in good repair and measurement tools.

## 4. Conclusion.

The result of this research showed that both of the light source can be used to measure the absorbance of curcuminoid content of turmeric. Error that is generated by laser source (9.28%) is smaller than that is produced by LED source (11.54%).

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