The Identification and Measurement of The Concentration Red Dye in Sample Using Emission Spectrometer and Colorimeter Detector

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Abstract— The experiments have been performed to identify and to determine the concentration of red dye in samples. The absorption spectra were measured using the Emission Spectrometer and were used to identify the samples. The Colorimeter was used to measure the absorbance. The concentration of sample was determined using the calibration data. The result showed that one sample contained (9.9±1.2)ml/l Eritrozine CI 16035. The Carmoizine CI 14720 were detected on the other samples and their concentration were (12.4±0.7)ml/l, (12.7±0,8)ml/l, (15.9±2.1)ml/l, (11.9±0.7)ml/l, (15.3±0.9)ml/l, respectively.

Index Terms— Absorption spectra, Red dye, Spectrometer emisi, Colorimeter, and LoggerPro.

I. INTRODUCTION

RED drink obtained by using dye. People cannot know of molecules in dyes distributed in market. Certain dyes can harm health, such as allergies, asthma, urinary system damage, even trigger cancer. The government stipulates permissible red drink dyes made from Eritrozine CI 16035, Eritrozine CI 16035-Carmoizine CI 14720, Carmoizine CI 14720, and Ponceau 4R CI 16255 [1, 2].

To find out the molecular content in a beverage is needed a tool capable of distinguishing one molecule from another molecule. In addition, the tool must have high sensitivity and not change the condition of the sample being measured. Therefore, a selective and sensitive instrument is required in order to reduce interference during measurement [3].

Polarimeter can be used to determine the sugar content in solution. This measurement is based on rotating the field of vibrating light by molecules. By measuring the optical rotation of the specification of the solution, it can be determined the concentration of glucose, fructose, and lactose solution using a polarimeter [4]. Determination of such content can only be performed on optically active molecules.

The measurement of the dye concentration in the beverage can be done by using the UV-Vis Spectrophotometer. Carmoizine red dye can be known based on absorbance pattern on wavelength, while concentration is determined based on absorbance calibration data on standard carmoizine concentration [5]. In the study the measurement devices are relatively expensive.

At this time available a variety of computer based measurement devices are relatively inexpensive and easy to use. This device includes interfaces, appropriate sensors and software. One such device is made by Vernier and the software used is LoggerPro [6]. This software is equipped with data retrieval and data analysis.

Vernier also manufacture detector emission spectrometers is a detectors that designed to measure the intensity of light from various light sources. In addition Vernier also issued light sources. In addition Vernier also issued a Colourimeter detector which is used to determine the absorbance of the solution[6].

Therefore, this study will use emission spectrometers to identify the molecules contained in the solution. The colorimeter will be used to measure the absorbance and then to determine the concentration.

II. THEORY

The frequency of light with ν, wavelengths **λ** have energy of

$$E = h\nu = \frac{hc}{\lambda} \quad (1)$$

where h is the planck constant, c is the speed of light. The equation (1) it appears that the exertion of the light depends on the long wave. Molecule that given energy will suffer, if exertion excitation given equal to the diferrence in the level of energy transition. Molecule having the structure of the level of energy that certain. Molecul would absorb light come, at particular wavelengths anyway. A molecule can be determined from absortion spectra.

Light come to sample will be absorbed by moleculer contained in these sample. Absorption depens the absorbing molecules, concentration absorption, long the absorption, and wavelengths of light that used. Absorption is declared by absorbans. The solution with the concentration of c, long the absorption b, and absorptivity molar ε, having *absorbans A* follow the Beer and Lambert law [7,8]

$$A = \varepsilon c b \quad (2)$$

The molar absorptivity ε depending on the type of molecules and wavelengths of light that used. The determination of the concentration of solution done through the measurement of absorbans.

Sample placed on cuvette an appointed with thick. There-

fore for one kind of a molecule that measured on one wavelength, the value of absorbans only depending on the concentration follow an equation.

$$A = k\,c \tag{3}$$

With constan k is the calibration.

III. METHODS EXPERIMENT

This research in the broad sense covering two parats, such as identifying and measurement of concentration. An arrangement of equipment used to the identification process is presented in figure 1.

Flourescent lamp I with 40 watts used as a source of light policromatis. Sample solution placed in cuvette k. The intensity of light from a lamp after cuvette detector will be measured using emission chamber for existence measurement D1. The light, cuvette detector and arranged in an enclosed space. A detector D1 connected to a computer PC. A detector work at wavelengths of 320 nm up to 900 nm at intervals of 1 nm. Measuremend sample, will immediately obtained a relationship velue intensity of wavelengths. The graph infiltration shows a pattern of molecules contained in solution.

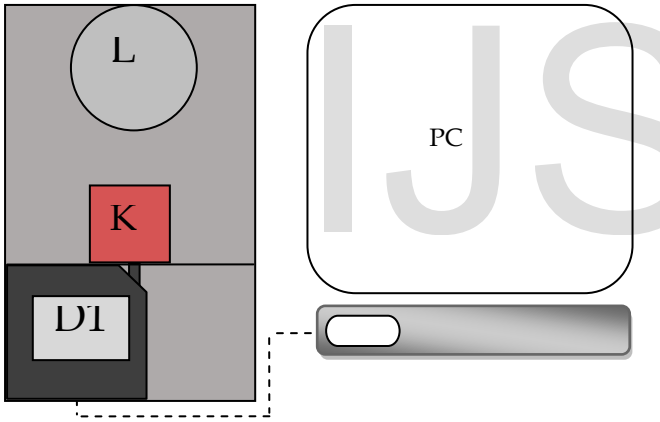

Figure 1. An arrangement of identification equipment in this experiments, L: Fluorescent lamp, K: cuvette, D1: Emission Spectrometer Detecteor, PC: Computer.

At the beginning of done the measurement of a absorption spectra of the various standards. Identification sample done by comparing absorption spectra sample with a absortion spectra from a standart of the molecule is kind of that wich is already known.

The arrangement of aquipment used for the measurement of concentration is presented in figure 2. Cuvette contains solution put in the D2 a colorimeter. Detector connected to computer PC through interface IF. Colorimeter detector having four a light source with wavelengths 430 nm, 470 nm, 565 nm, and 635 nm. Detector capable of measuring absorbans sample with range 0.05 until 1.0.

Calibration is performed by measuring from a standard woth various concentration. Calibration data used to fine graph absorbans of concentration. The determination of sample concentration is performed by measuring absorban. The concentration samples can be calculated by the equation (3) and charts calibration.

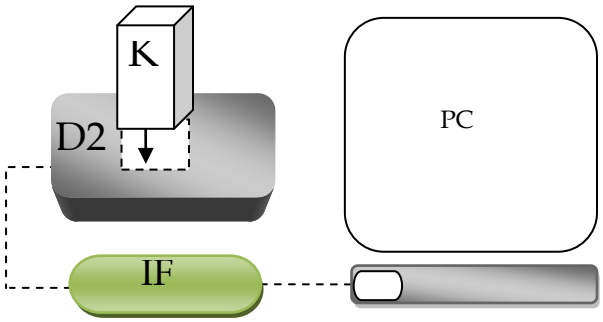

Figure 2. An arrangement of concentration in this experiment, K: cuvette, D2: Colorimeter Detector, IF: Interface, and PC: Computer.

IV. RESULTS AND DISCUSSION

Identification was done based on the absorption spectra. The absorption spectra obtained using spectrometer emission detector. The concentration of red dye obtained using Colorimeter detector.

Absorption spectra standard a carmoizine red dye, indicated from the measuring the intensity of light through cuvette contains carmoizine solution, of varied wavelength as in figure 3. Red dye standard were done in the measurement of absorption at some of the concentration of the 10 ml/l, 8ml/l, 6ml/l, 4ml/l, and 2 ml/l. The absorption shown decrease intensity at particular wavelengths.

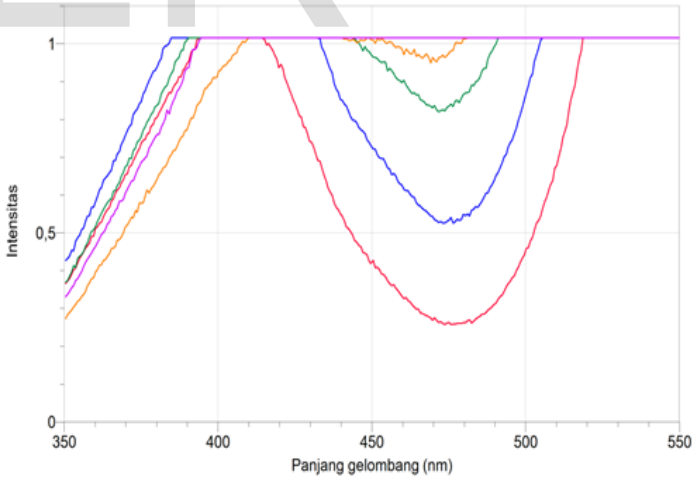

Figure 3. The intensity of wavelength on concentrations Carmoizine CI 14720 *10 ml/l ( ), 8 ml/l ( ), 6 ml/l ( ), 4 ml/l ( ), and 2 ml/l ( ).*

The measurement result velue intensity standard solutions of red dye Eritrozine CI 16035, Eritrozine CI 16035-Camoizine CI 14720, Camoizine CI 14720, and Ponceau 4R CI 16255, by concentration of the 8 ml/l shown in figure 4. As a standard for comparison in figure 4 is also shown absorption a Tartrazine CI 19410 green dye.

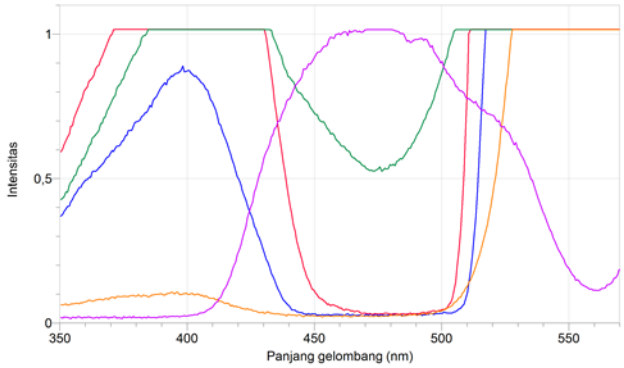

Figure 4. The intensity versus wavelength (nm) standard solution of Eritrozine CI 16035 ( ), Eritrozine CI 16035-Carmoizine CI 14720 ( ), Carmoizine CI 14720 ( ), and Ponceau 4R CI 16255 ( ) at concentration *8 ml/l* and Tartrazine CI 19410 ( )at concentration *8 ml/l*.

Figure 4 used to identified of the types of sample and determined of the selecting wavelength. Selective wavelengths optimal determined by means of choose wavelengths that have the maximum absorption to red dye and most minimum to Tarttrazine CI 19410. Selective wavelength standard solutions of red dye of the 450 nm until 500 nm.

The determination of concentration was performed with the colorimeter detector, at the available wavelength. The results of the standard solution absorbance of Carmoizine CI 17429 at 470 nm wavelength with various concentration are shown in Table 1 and Figure 5.

Table 1. The Absorbance *A* to concentration C (*ml/l*) of standard solution of Carmoizine CI 14720 at wavelength 470 nm.

No	Konsentrasi C (*ml/l*)	Absorbans
1	2	0,1345
2	4	0,3488
3	6	0,4578
4	8	0,6255
5	10	0,7703

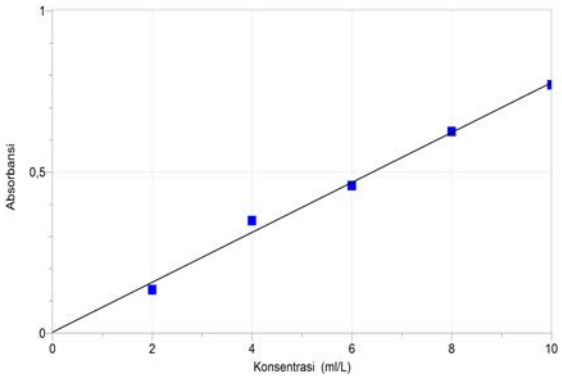

Figure 5. The absorbance versus concentration for standard Carmoizine solution CI 14720 at 470 nm wavelength.

Figure 5, there is a correlation between absorbance *A* to cocentration *C*.

$$A = 7{,}8 \times 10^{-2} C + 0{,}2 \times 10^{-2} \quad (4)$$

The gradient of the equation show the sensitivity device. The greater the gradient velue means the more sensitive the device. The Carmoizine standard solution absorbance calibration was also carried out at the wavelength of 430 nm, 470 nm, 565 nm, and 635 nm as shown in figure 6.

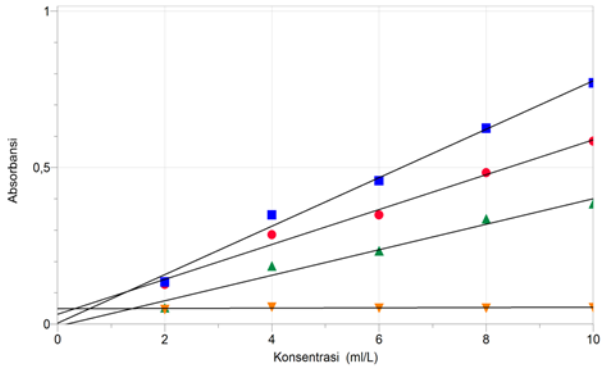

Figure 6. The absorbance versus concentration (ml/l) at 430 nm ( ), 470 nm ( ), 565 nm ( ), and 635 nm ( ) wavelength for standard Carmoizine CI 14720 solution.

Figure 6 it appears that the measurements at the 470 nm wavelength have the greatest gradient value. The question 4 is used to measure the concentration of Carmoizine CI 14720 in the beverage sample. Such calibration for other red color molecules.

Drink sample obtained from beverage packaging, syrup, and drinks sold by street vendors. Sample is done the identification of molecules by comparing its uptake with the absorption of standard solution. Then after the type is identified, absorbance measurements are taken to obtain concentration.

The result of the identification of the "X" beverage sample shown in figure 7. The absorption spectra of the sample follows the Carmoizine CI 14720 absorption spectra. Therefore it can be determined that the red dye in the "X" drinks sample is Carmoizine CI 14720.

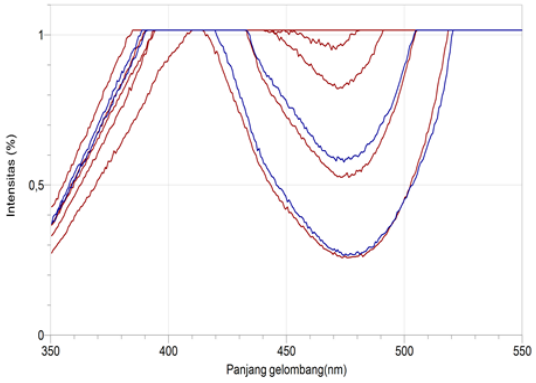

Figure 7. The relation of intensity to wavelength of standard solution of Carmoizine CI 14720 ( ) with concentration *10ml/l, 8 ml/l, 6 ml/l, 4 ml/l, and 2 ml/l* and "X"( ) beverage sample with C_1 and *0,8* C_1 concentration.

Futher measurement with the colorimeter resulted in the absorbance of the "X" beverage sample of 0,9059. The absorbance value of this Carmoizine CI 14720 concentration value in the beverage sample "X" can be calculated by equqtion 4 of

(11,9 ± 0,7) *ml/l*. The measurement result of various samples shown in table 2.

Uncertaintly this measure from 6% to 12%. A source of uncertainly derived from an uncertaintly about constant calibration. This related to the creation of solution standards done by means of diluting solution parent use a measuring glass.

According to BPOMRI limits the use of carmoizine in alcoholic beverages, syrup, and of sugar solutions having the limit 70 *ml/l* [9]. The merasurement result suggest that red dye used in the sample is a compound allowed. Besides concentration used also within the safe.

Table 2. A red dye concentration in various samples.

No	Nama sampel	Pewarna sampel	Konsentrasi (*ml/l*)
1	Pamela1	Eritrozine CI 16035	9,9±1,2
2	Pamela 2	Carmoizine CI 14720	12,4±0,7
3	USD 1	Carmoizine CI 14720	12,7±0,8
4	USD2	Eritrozine CI 16035	15,9±2,1
5	"X"	Carmoizine CI 14720	11,9±0,7
6	"Y"	Carmoizine CI 14720	15,3±0,9

The measurement of the concentration of red dye in a sample of drink can be performed with a tool that is relatively easy. This experiment it can enhance understanding of atomic theory and molecules. In addition, this result is true for provide us with information for the public regarding a dye that allowed for use drinks and food.

V. Conclusion

Identification of dye in sample done by means of compare the absoption spectra. A red dye in sample beverage researched meet the security for consumed.

Acknowledgment

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