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Study of Formaldehyde Content in Different Types of Tofu Using Micro Scale Laboratory Based Visible Beam Spectrophotometry

Studi Kandungan Formalin pada Berbagai Jenis Tahu Menggunakan Spektrofotometri Sinar Tampak Berbasis *Micro Scale Laboratory*

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ABSTRACT

Microscale laboratory is an analytical technique that requires a little reagent and produces a little waste. One application of microscale laboratory is the analysis of formaldehyde content in tofu. Formaldehyde is one of the chemicals that is harmful to the body but is often misused as a food preservative in tofu. This study aims at determining the content of formaldehyde in tofu using laboratory microscale-based Schiff reagents. The use of microscale laboratories is expected to reduce waste and support the implementation of green chemistry. The calibration curve is used to find the relationship between concentration and absorbance using a standard solution series of 10 ppm, 15 ppm, 20 ppm, 25 ppm, and 30 ppm measured at a wavelength of 561 nm. In the qualitative test, all samples were reactive and showed a purplish red color. In the quantitative test, the highest formaldehyde content in the tofu sample was obtained in the white tofu 3 with a content of 99.7 ppm.

Keywords: *Formaldehyde, microscale, Schiff reagent.*

ABSTRAK

Microscale laboratory merupakan sebuah teknik analisis yang membutuhkan sedikit reagen dan menghasilkan sedikit limbah. Salah satu penerapan microscale laboratory adalah analisa kandungan formalin dalam tahu. Formalin merupakan salah satu bahan kimia yang berbahaya untuk tubuh namun seringkali disalahgunakan sebagai pengawet makanan pada tahu. Penelitian ini bertujuan untuk mengetahui kandungan formalin dalam tahu dengan menggunakan reagen Schiff berbasis microscale laboratory. Kurva kalibrasi digunakan untuk mencari hubungan antara konsentrasi dengan absorbansi dengan menggunakan deret larutan standar 10 ppm, 15 ppm, 20 ppm, 25 ppm, dan 30 ppm yang diukur pada panjang gelombang 561 nm. Pada uji kualitatif semua sampel tahu reaktif dan menunjukan warna merah keunguan. Pada uji kuantitatif didapatkan kadar formalin tertinggi dalam sampel tahu pada tahu putih 3 dengan kadar sebesar 99,7 ppm.

Keywords: Formalin, *microscale*, pereaksi *Schiff*.

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1. INTRODUCTION

Tofu is a food ingredient processed from soybeans that is very popular in the society. Various processed tofu have been known by the public, including white tofu, silk tofu, fried tofu (pong), bandung tofu, and milk tofu. The nutritional content contained in 100 grams of tofu includes 7.8 g of protein; 4.6 g of fat; 1.6 g of carbohydrates; 124 mg of calcium; 63 mg of phosphorus; and 68 kcal of energy(Sikanna, 2016). People often choose tofu as a substitute for animal protein because it has the best quality of vegetable protein and the most complete amino acid composition and has a high digestibility of 85 – 98%.

Tofu is a high water content foodstuff with a 70 – 90% percentage, so it cannot be stored for too long because it is easily damaged(Seftiono, 2017). The high water content leads to tofu as a suitable medium for microbial propagation. A tofu without preservatives only lasts for three days if stored in refrigerator with less than 15% temperature. Whereas boiled tofu can be stored in the refrigerator for seven days, if it is more than that, pink spots will appear on its surface.

As a perishable foodstuff, a good process of making tofu is absolutely necessary to keep the nutritional content of tofu intact when consumed. However, some manufacturers use harmful Food Additives (BTPs) to maintain the quality of the tofu until it reaches the consumer. Some preservatives in the form of additives or chemical substances commonly used by food manufacturers are formaldehyde, borax, and rhodamine (Nasution & Supriatna, 2019)B. Based on reports submitted by the Food and Drug Administration, 141 of the 401 food samples tested in 2020 in East Java were positive for formaldehyde. Formaldehyde is often chosen because it is very easy to get on the market and the price is more economical than BTP which is not prohibited so that it can generate as much profit as possible(Sikanna, 2016). However, producers ignore the negative impact will have on the consumers health who consume these foods.

Formalin is a formaldehyde compound in water with anaverage concentration percentage of 37%, methanol 15%, and the rest is water(Kholifah & Utomo, 2018). Formalin is strictly prohibited for its use as BTP. This is because formaldehyde is used as a germ killer, so it is commonly used for floor cleaners, warehouses, clothing, fly and other insect repellents, coloring agents, as well as explosives (Kholifah & Utomo, 2018). Formaldehyde is strongly discouraged from being added as BTP because this chemical will be a toxic in the body(Berlian, Pane, & Hartati, 2017). Long-term ingestion of formaldehyde will trigger the development of cancer cells, respiratory tract irritation, burns, and allergic reactions (Sikanna, 2016).

According to the Food and Drug Administration, tofu containing formaldehyde has very good shape characteristics, chewy, not easily crushed, lasts several days, and not easily rotten. Several studies have been conducted to test the formaldehyde content in tofu with various indicators. Research conducted by Sikanna (2016) used KMnO4 indicator showed that 6 out of 9 tofu samples in Palu City contained formaldehyde. Research conducted by Nasution&Supriatna (2019) used the dragon fruit peel indicator showed that there was a formaldehyde content in tofu sold at the Gede Bage market.

The research will be conducted using Schiff reagent based on microscale laboratory. Microscale laboratory is used because it is environmentally friendly and supports the green chemistry implementation. This is because during the research process, only very few chemicals are used, so it can reduce the waste of hazardous chemicals that are discharged into the environment. Over the past few years, microscale laboratory has become an

important part of developing chemical experiences, as they require little reagents and produce little waste (Botella & Ibanez., 2020). Microscale also increases interest and motivation in positive learning, fosters environmental awareness, and stimulates innovative thinking. Micro lab is not a simplification or miniaturization of normal experiments, but an innovation of chemical experiments that support green chemistry and quality education (Zhou, 2019). One application of microscale laboratory is to detect the presence of formaldehyde in tofu.

Considering the danger of formaldehyde if consumed for a long time, this study aims at testing qualitatively and quantitatively the formaldehyde content in tofu using Schiff reagent with Visible Spectrophotometry method. Through the test results, it is expected that people will be more careful in choosing the tofu which they will consume.

2. MATERIALS AND METHODS

2.1. Materials

The tools used in this study were reaction tubes, drop pipettes, mortar and pestle, as well as a visible spectrophotometer (Genesys-20). The material used in this study was Schiff reagent, H_2SO_4 96%, Formaldehyde 37%. The samples tested were ten tofu with three different types, namely white tofu, silk tofu, and fried tofu. Samples were obtained from four different markets in Malang.

2.2. Methods

2.2.1. The creation of calibration curves

The calibration curve is a method that can be used to determine the concentration of formaldehyde in a tofu sample using a series of standard solutions whose concentration has been known. Calibration curves production used formaldehyde standard solutions at concentrations of 10 ppm, 15 ppm, 20 ppm, 25 ppm, 30 ppm. The creation of the formaldehyde standard series was carried out by diluting 100 ppm with the help of a 5 mL volumetric flask, then adding Schiff's reaction amounting to 0.14 ml. Then the series of standard solutions were scanned using Visible Spectronics instrumentation at a wavelength of 561 nm.

2.2.2. Determination of formaldehyde levels in tofu samples

10 gr of tofu, each tofu sample is pounded until crushed. Add 10 mL of water then filter with filter paper until smooth. The filtrate was taken and then acidified with H_2SO_4 to pH 3, the purpose was to degrade the sample. After that, add 0.14 mL of Schiff reagent. Then it was scanned using a Visible Spectronics instrument at a wavelength of 561 nm.

3. RESULTS AND DISCUSSION

3.1. The Making of The Calibration Curve

In the calibration curve scanning, the absorbance result was acquired as shown in the **Table 1**. The absorbance result would form a curve with a straight line (linear), which stated the relationship between substance's concentration in a standard solution and absorbance detected by the instrument.

Table 1 Calibration Curve's Absorbance Data

Concentration	Absorbance
0 ppm	0
10 ppm	0,221
15 ppm	0,276
20 ppm	0,326
25 ppm	0,415
30 ppm	0,541

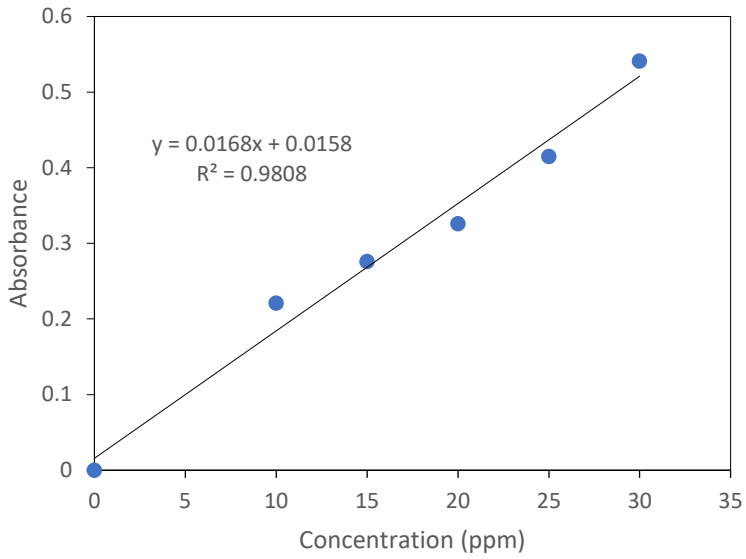

Figure 1. A straight line curve between concentration and absorbance

The linear relationship formed a straight line equation, as shown below:

$$Y = ax + b$$

Y = Absorbance
x = Analytic concentration
a = Slope

The relationship between the concentration and the absorbance is shown in **Figure 1.** From the curve, a straight line equation was acquired Y = 0,0168x + 0,0158 with the regression R = 0,9808.

3.2. The Qualitative Analysis of Formaldehyde Content in The Tofu

The samples tested in this research were ten slices of tofu. All filtrated samples showed purplish red color when the Schiff reagent was dropped. It showed that the samples were positively proven to contain formaldehyde as shown in **Table 2**.

Table 2. The Qualitative Test Result of Tofu Samples

Sample	Sample Source	Test Result
White Tofu 1	Peddler	+
White Tofu 2	Market A	+
White Tofu 3	Market B	+++
White Tofu 4	Market C	++
White Tofu 5	Market D	++
Silk Tofu 1	Market A	++
Silk Tofu 2	Market B	+
Silk Tofu 3	Market D	++
Fried Tofu 1	Market A	+
Fried Tofu 2	Market B	+

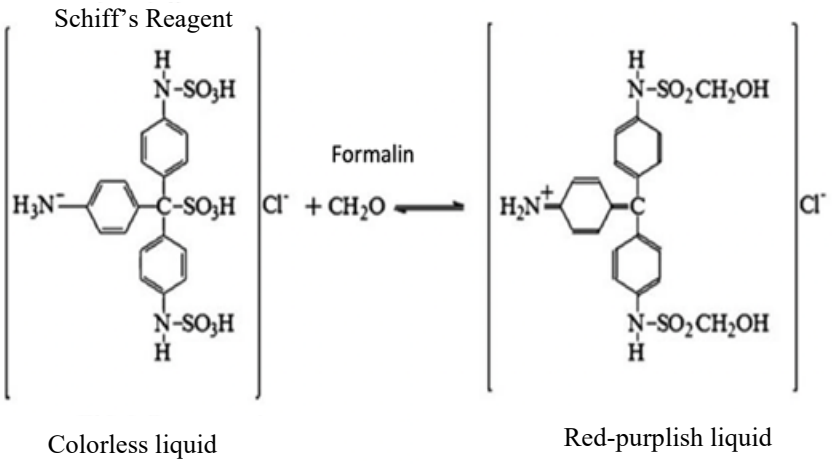

Figure 2. Reaction between Schiff reagent and Formaldehyde (Pielichowska K, 2012)

The more concentrated color showed a bigger formaldehyde concentration in a filtrate sample. The reaction between colorless Schiff reagent and colorless formaldehyde would result in a solution with pinkish color to purplish color as shown in the reaction in **Figure 2**.

3.3. The Quantitative Analysis of Formaldehyde concentration in the Tofu.

The level of formaldehyde in the samples which was proven qualitatively containing formaldehyde could be found out with regression analysis. The result of absorbance acquired from every sample was inserted in a straight line equation which had been gotten from the calibration curve. If the absorbance result was found out through the calibration curve, dilution was done and certain dilution factor score was gotten. The absorbance result of every sample with the dilution factor and the formaldehyde concentration is shown in **Table 3.** According to **Table 3**, it is known that the highest concentration of formaldehyde was found in the sample of white tofu 3 with 99,77 ppm concentration. Meanwhile, the lowest formaldehyde concentration was located in the sample of silk tofu 2 with 12,33 ppm concentration.

Table 3. The Result of Formaldehyde Concentration inside the tofu

Sample	Sample's weight (gram)	Extract Volume (mL)	Absorbance	Dilution Factor	Concentration (ppm)
White Tofu 1	15,00	10,00	0,256	1	14,30
White Tofu 2	15,00	10,00	0,253	1	14,12
White Tofu 3	15,00	10,00	0,282	6	99,77
White Tofu 4	15,00	10,00	0,234	2	26,92
White Tofu 5	15,00	10,00	0,242	2,5	35,07
Silk Tofu 1	15,00	10,00	0,281	1,5	24,15
Silk Tofu 2	15,00	10,00	0,223	1	12,33
Silk Tofu 3	15,00	10,00	0,261	1,5	22,36
Fried Tofu 1	15,00	10,00	0,309	1	17,45
Fried Tofu 2	15,00	10,00	0,234	1,5	19,95

International Programme on Chemical Safety (IPCS) mentioned that formaldehyde tolerance limit which could be received by the body in the form of liquid was 0,1 ppm. In one day; the allowed intake was 0,2 mg. Meanwhile, in the form of food, the limit of formaldehyde intake for an adult was 1,5 mg to 14 mg per day. According to the quantitative test result of formaldehyde, it showed that the concentration of formaldehyde in the samples had exceeded the limit which was set.

4. CONCLUSIONS

According to the result of the research, it can be concluded that the Schiff reagent can be used as *microscale laboratory,* because the Schiff reagent used in the research was only 0,14 ml. According to the test with the Schiff reagent, it was concluded that ten samples of tofu was proven positively containing formaldehyde. The highest formaldehyde concentration of the three kinds of tofu tested was found in the white tofu sold in one of the market in Malang, with 99,77 ppm concentration rate.

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