

UV-Visible Spectrophotometric Determination of Formalin Contamination in Tofu Circulated in Maros City - Indonesia

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ABSTRACT: Tofu is one of the healthiest foods because of its high protein content and the quality is equivalent to the quality of animal protein. Formaldehyde has a function as an antibacterial agent that can slow down the activity of bacteria in foods that contain a lot of protein, so formaldehyde reacts with proteins in food and makes food durable, but when it enters the human body, formaldehyde itself is mutagenic and carcinogenic which can trigger the growth of cancer cells. and gene defects in the body. Thus, in this study, we aim to determine the formalin contamination in tofu circulated in Maros City – Indonesia. This research was conducted from December 2014 to June 2015. The analysis of formalin contamination in tofu was conducted in qualitative and quantitative analysis. The qualitative analysis was performed using the specific reagent, and the quantitative analysis was measured by UV-Vis spectrophotometric method. The result showed that sample codes RMD1 and RMD2 with formalin contaminants because the color of the solution produced after the test was red correspond to the positive result. As for the tofu sample with sample code RMD3, the results were negative because it gave a yellow color after adding potassium permanganate reagent. In the quantitative analysis, samples were measured using a UV-Vis spectrophotometer at a wavelength of 571.5 nm. From the measurement process, the result exhibited that the samples RMD1 and RMD2 contain formalin of 5.92 and 3.34 g/gram, respectively.

KEYWORDS: Formaldehyde; tofu; spectrophotometry; food.

1. INTRODUCTION

Tofu is one of the foods that contain nutrients, it is also a popular food in Indonesia even though it comes from China. The most popular tofu is not only limited because it tastes good, but it is also easy to make it can be processed into various forms of cuisine and the price is relatively cheap. Tofu is one of the healthiest foods because of its high protein content and the quality is equivalent to the quality of animal protein. This can be seen from the NPU (Ned Protein Utility) tofu which reflects a lot of protein that is utilized by the body, which is 65% (Suprapti, 2005).

Cases of contamination of hazardous compounds are often found in food products or pharmaceutical preparations. In Malang City – Indonesia, there are cases of the use of borax, formaldehyde, and chemical dyes in food products (Merta, 2006). Formaldehyde has a function as an antibacterial agent that can slow down the activity of bacteria in foods that contain a lot of protein, so formaldehyde reacts with proteins in food and makes food durable, but when it enters the human body, formaldehyde itself is mutagenic and carcinogenic which can trigger the growth of cancer cells. and gene defects in the body (Mahdi, 2008)

Formaldehyde is a colorless, pungent odor solution, and up to 15% methanol is usually added as a preservative. Formaldehyde is known as a pest killer (as a disinfectant) and is widely used in industry. In addition, formaldehyde is very well known as a preservative for corpses. For this reason, it is strictly prohibited to use it in food processing. Formaldehyde in the market traded is known by different names, including: formol, morbidic, methanol, formic aldehyde, methyl oxide, oxymethylene, methylene aldehyde, oxomethane, formoform, formaldehyde, karsan, methylene glycol, paraforin, polyoxymethylene glycols, superlysoform, tetraoxymethylene, and trioxane (Ditjen POM RI, 2006).

Formaldehyde can be dangerous if inhaled and swallowed, so that it can cause burns to the skin, irritation of the digestive tract, allergic reactions, and the danger of cancer in humans. Formaldehyde is a chemical that is prohibited from being used in accordance with the regulation of the Minister of Health Number 722/Menkes/Per/IX/1988. These additives are classified as hazardous materials in accordance with the Regulation of the Minister of Health No. 472/Menkes/Per/V/1996 concerning the safety of Materials Hazardous to Health (Ditjen POM RI, 2006).

The results of the study on tofu showed that the presence of formaldehyde in the case study of the use of formalin in tofu in the Municipality of Kediri was 62.50% containing formaldehyde by Ayudiah (2007), analysis of the formalin content of tofu circulating in the Makassar city market using UV-Vis spectrophotometry method amounted to 39.9322µg/gram. In addition, contamination of medicinal compounds in herbal products is also often found (Pratama, 2022). This is what underlies the need for research on qualitative and quantitative analysis of formaldehyde on tofu products circulating in Maros City using the UV-Vis Spectrophotometric Method.

2. EXPERIMENTAL SECTION

2.1. Sample collection

This research was conducted from December 2014 to June 2015 at the Chemistry Laboratory of the Faculty of Pharmacy, Muslim University of Indonesia, Makassar. The research population is processed soybean food, in the form of tofu circulating in Maros City. The research sample used is Tofu which is circulating in Maros City. The type of research used is an experimental laboratory by utilizing specific reagents for qualitative analysis and using the UV-Vis spectrophotometry method in quantitative analysis.

2.2. Qualitative analysis

The test tube A was filled with 2 mL of distilled water, and then added 1 drop of 1 N potassium permanganate dropper pipette and homogenized. The test tube B was filled with 10 mL of distilled water, then 5 g of sample was added and then homogenized. The mixture in the tube B was filtered with filter paper to collect the filtrate, then put the filtrate into tube A, wait for 30 minutes if the pink color fades, it indicates the sample contains formalin.

2.3. Standard solution

In the 500 mL volumetric flask, 37% formaldehyde was prepared to form a concentration of 2000 ppm. From the 2000 ppm solution, each 0.5 mL, 1 mL, 1.5 mL, 2 mL, and 2.5 mL were pipettes and then each was added to a 1000 mL volumetric flask. 1 mL of 5% chromotropic acid and 5 mL of concentrated sulfuric acid were added at each different concentration and the volume was made up to the mark with distilled water. Then the concentrations of 1, 2, 3, 4, and 5 ppm were formed. Then a standard solution is formed which is characterized by a color change from clear to purple (Ganjar and Rohman, 2007).

2.4. Quantitative analysis

2.4.1. Determination of maximum wavelength

The standard solution of formalin with a concentration of 2 ppm which has been added with concentrated sulfuric acid and 5% chromotropic acid is measured for its maximum wavelength in the wavelength range of 500-700 nm. Then the maximum wavelength obtained is a wavelength of 571.5 nm (Fawwaz, 2017).

2.4.2. Determination of formalin contamination

Weighed the sample of tofu as much as 10 g and put it into a beaker. Add 50 mL of distilled water and stir. The tofu sample was heated in a bath to boil, then filtered and cooled. 2 mL of the filtrate was taken and put into a test tube with 3 repetitions, then 1 mL of 5% chromotropic acid was added to each test tube and 5 mL of concentrated sulfuric acid was added. The absorbance was measured at a wavelength of 571.5 nm.

2.6. Data analysis

The absorbance value of the test substance using a spectrophotometer will be compared with the standard solution at each different concentration by linear regression method following equation: $Y = bx + a$, where: Y = Peak area; b = Slope; x = Concentration; a = Intercept. From the linear regression equation, the concentration of the sample is calculated by plotting the absorption results against the regression equation as can be seen in **Table 1** and **Figure 1**.

3. RESULTS AND DISCUSSION

Formaldehyde or better known as formalin is one of the chemicals whose use is prohibited in food products. Formaldehyde is commonly used in industry as a preservative or as a disinfectant. Although many people know, especially producers, that formaldehyde is dangerous if it is used as a preservative in foodstuffs, its use is not decreasing but increasing. This is because the price is relatively cheaper than food preservatives that are not prohibited. People who consume foods containing formaldehyde only a few times may not feel the consequences. But the effects of using formaldehyde can only be felt a few years later.

Table 1. Concentration series of formaldehyde

Concentration (ppm)	Absorbance (571.5 nm)
1	0.201
2	0.427
3	0.638
4	0.846
5	1.074

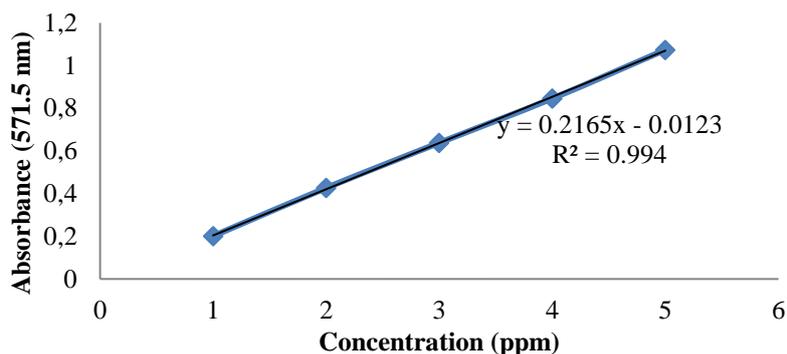


Figure 1. Calibration curve of formaldehyde series

In this study, an examination of the formaldehyde content in tofu was carried out with the aim of knowing and determining the level of formaldehyde contained in tofu circulating in the city of Maros using UV-Vis spectrophotometry method. The sample used in this study was tofu because this food ingredient is very popular among the public because the price is relatively cheap and usually affordable by all people, it tastes good and is easy to process into various types of dishes. In addition, tofu is also one of the healthiest foods because the protein content is very high, and the quality is equivalent to animal protein. Tofu contains nutrients such as fat, vitamins and minerals in high enough quantities. However, tofu has a weakness that is easily damaged or stale because of its high-water content, so some manufacturers add preservatives to increase consumer appeal. One of the preservatives that is often added to tofu is formalin.

Tofu samples were taken from three markets, namely Maros Central Market, Diccekan Market and Leko Market with three different producers. For the analysis of formaldehyde, a qualitative test was carried out using a specific reagent of potassium permanganate. Potassium permanganate is used to bind formaldehyde to release from the sample. Formaldehyde reacts with potassium permanganate to produce a red complex. From the test, there were tofu samples with sample codes RMD1 and RMD2 with positive results, because the color of the solution produced after the test was red. As for the tofu sample with sample code RMD3 the results were negative because it gave a yellow color after adding potassium permanganate reagent.

For quantitative analysis, samples were measured using a UV-Vis spectrophotometer at a wavelength of 571.5 nm. From the measurement process, the result is that the sample RMD1 and RMD2 contain formaldehyde of 5.92 and 3.34 g/gram, respectively (**Table 2**)

Table 3. Formalin contamination in tofu circulated in Maros City – Indonesia.

Sample code	Weight of sample (g)	Absorbance (571.5 nm)	Formalin contamination ($\mu\text{g}/\text{gram}$)
RMD1	10.32	0.2511	5.92
		0.2530	
		0.2513	
RMD2	10.24	0.1382	3.34
		0.1364	
		0.1333	

In the body, if accumulated in large quantities, formaldehyde is a toxic substance and is harmful to human health. If the content in the body is high, it will react chemically with almost all substances in the cell, thereby suppressing cell function and causing cell death that causes poisoning in the body. High accumulation of formaldehyde in the body will cause various complaints, such as stomach and skin irritation, vomiting, diarrhea and allergies. Even common to cause cancer, because formaldehyde is carcinogenic. So, the use of formalin is strictly prohibited by the government because it is carcinogenic (Hastuti, 2010).

The characteristics of tofu containing formalin are tofu being durable and not damaged for up to three days at room temperature (25°C) and can last more than 15 days at a refrigerator temperature (10°C). Tofu becomes shiny and feels chewy when pressed and does not crumble easily. The slightly pungent smell of formaldehyde. Meanwhile, tofu without preservatives can only last one to two days and the texture is easily destroyed.

4. CONCLUSION

Based on the results of the research that has been done, it can be concluded that all tofu samples tested positive for formaldehyde with each level of formalin contained in the samples RMD1 and RMD2 were 5.92 and 3.34 g/gram, respectively.

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REFERENCES

- Ayudiah, A., Amar, MR., Zaqiah, NF., Dian P. Studi Kasus Penggunaan Formaldehid pada Tahu Takwa Di Kotamadya Kediri. PKM Universitas Muhammadiyah: Malang. 2007.
- Ditjen POM RI. Formaldehid. Departemen Kesehatan RI: Jakarta. 2006.
- Fawwaz, M, Siti N A and Muzakkir B. Potensi Daun Pala (*Myristica fragrans* Houtt) Sebagai Sumber Fenolik. *Jurnal Fitofarmaka Indonesia*, 2017; 4(1): 212-214.
- Gandjar, IG and Rohman, A. Kimia Farmasi Analisis, Pustaka pelajar, Yogyakarta, 2007.
- Hastuti, S. Analisis Kualitatif dan Kuantitatif Formaldehid Pada Ikan Asin di Madura. Universitas Trunojoyo: Madura. 2010.
- Mahdi, C. Mengenal Berbagai Produk Reagen Kit Tester Untuk Uji Formaldehid, Borak, Zat Pewarna Berbahaya Dan Kandungan Yodium pada Garam Beryodium. Universitas Brawijaya: Malang. 2008.
- Merta. Penanganan Penggunaan Formaldehid dan Bahan-bahan Berbahaya Lainnya. Fakultas Teknologi Pertanian: Universitas Udayana. 2006.
- Pratama, M., Harisman, D., Labasy, L., Seniwati, S. and Fawwaz, M. Determination of Acetaminophen in Jamu Pegal Linu by High Performance Liquid Chromatography. *Pharmaceutical Reports*, 2022; 1(1).
- Suprpti, I.M., Lies. Pembuatan Tahu. Kanisius: Yogyakarta. 2005.

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