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Qualitative Analysis of Formaldehyde Presence in Tofu and Its Potential Health Effects

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ABSTRACT

Formaldehyde is a toxic chemical widely used in industrial applications but is sometimes illegally added to food products such as tofu to extend shelf life. This study aims to conduct a qualitative analysis of formaldehyde presence in tofu and to examine its potential health effects through a supporting literature review. Five tofu samples were collected from various local markets in Mataram City and tested using a formaldehyde detection test kit based on a colorimetric method. The presence of formaldehyde was indicated by a color change from cream to soft purple. All five samples tested positive, suggesting the unauthorized use of formaldehyde in tofu production.

To understand the health risks associated with formaldehyde exposure, a literature review was conducted using scientific journals, health reports, and regulatory guidelines. The findings reveal that formaldehyde can cause a range of adverse health effects, including respiratory irritation, gastrointestinal disturbances, and skin allergies. Long-term exposure is associated with more serious outcomes such as organ damage and increased risk of cancer, or death effect.

This study highlights the potential public health dangers of formaldehyde contamination in food and underscores the importance of regular monitoring and strict regulation. The use of simple qualitative test kits is also shown to be effective for preliminary screening. Greater public awareness and stronger food safety enforcement are essential to protect consumers from chemical adulteration.

KEYWORDS

Formaldehyde; tofu; qualitative, test kit, health

INTRODUCTION

Food plays an important role in human survival. Food safety is an important aspect that needs to be considered so that food can provide optimal benefits for the body. This food safety issue is one of the problems for people in developing countries, especially when viewed from the frequency of diseases that occur (Webb & Morancie, 2015). The development of food technology encourages people to try to produce food in a form that is more durable and practical than its fresh form, such as tofu, dim sum, yellow noodles, meatballs, and pempek. In addition, the trend of people's consumption who prefer easy and practical food often ignores food quality and security (Andriani & Utami, 2023).

Tofu is one of the processed products that is popular among Indonesian people. Tofu is made from finely ground white soybeans, boiled, then separated between dregs and filtrate, and finally given acetic acid. As a source of protein, tofu contains high vegetable protein, which is considered to be able to replace animal protein (Mayasari et al., 2024). However, despite its benefits, tofu is not always safe for continuous consumption if stored for a long period of time (Iftriani et al., 2016). Tofu is a food product that is easily damaged so preservatives are often added to extend the shelf life of the product (Wuisan et al., 2020).

Quality food should be produced without the addition of dangerous Food Additives (BTP) such as preservatives and food coloring. One of the dangerous BTPs whose use is prohibited is formaldehyde. The use of formaldehyde as BTP has been strictly prohibited based on the Minister of Health Regulation Number 1168/Menkes/PER/X/1999. Ironically, this formaldehyde is easily available at an affordable price, so it is often used by producers and traders as a preservative (Abdurraafi' Maududi Dermawan et al., 2024). This situation causes unrest and anxiety in the community because the side effects of formaldehyde consumption can be harmful to health (Wuisan et al., 2020). Several research results that found formaldehyde content in tofu include research from (Khumaeni, 2021; Sari et al., 2021; Rosita, 2022; Hayat & Darusmini, 2021; Widyan & Ratulangi, 2024).

Formaldehyde is the trade name for formaldehyde, a colorless, pungent-smelling solution (Sari et al., 2021). It contains 37% formaldehyde in water, generally with 15% methanol added. Formaldehyde is widely used as a preservative in various commercial and industrial sectors, including textiles, agriculture, the fertilizer industry, and for preserving specimens in hospital laboratories (Laly et al., 2018). Its carcinogenic nature means that the use of formaldehyde in food can have negative impacts on health (Bokthier Rahman et al., 2023). However, formaldehyde

is often misused as a preservative for food, such as tofu, wet noodles, fresh fish, and chicken (Fatimah et al., 2017).

The impact of consuming food containing formaldehyde on health is not immediately visible but will accumulate slowly in the body. The use of formaldehyde in food in the short term can trigger poisoning effects such as stomach ache accompanied by vomiting, seizures, and headaches, while long-term effects can trigger damage to the central nervous system and kidneys (Novita et al., 2021). In line with that, (Wariyah & Candra Dewi, 2013) also stated that if the body has been contaminated with formaldehyde, it can cause cancer. Accroding to study was done by paratmanitya *et al* (Paratmanitya & Veriani, 2016), formaldehyde should not be used as a preservative in food because it will cause several symptoms including: 1) If inhaled: burning sensation in the nose and throat, difficulty breathing, shortness of breath, headache, lung cancer; 2) If exposed to skin: redness, itching, burning skin; 3) If exposed to eyes: redness, itching, watery eyes, eye damage, blurred vision, blindness; and 4) If swallowed: nausea, vomiting, stomach upset, diarrhea, headache, dizziness, heart problems, liver damage, nerve damage, bluish skin, loss of vision, convulsions, coma and death.

Another explanation related to the effects of formaldehyde is also explained by (Habibi et al., 2016) that exposure to formaldehyde solution can cause irritation in the eyes, respiratory tract irritation, and dermatitis. Even inhaling large amounts of formaldehyde continuously can cause nasopharyngeal and nasal cavity cancer.

Most people do not know how to distinguish between foods that contain dangerous preservatives or not. They also do not understand the bad effects of formaldehyde if it has accumulated in the body in relatively large amounts. Therefore, it is necessary to conduct research related to formaldehyde (formaldehyde) screening in food and also its effects on body health so that people are aware of foods containing dangerous BTP and can carefully choose foods that are safe for consumption.

METHOD

The research method of formaldehyde testing on Tofu food samples In addition, organoleptic analysis has also been carried out as supporting data including color, odor, shape or texture.

Qualitative Formaldehyde Analysis by Using Test Kit

Qualitative formaldehyde analysis is carried out by taking number of samples then chopping them into small pieces or blending them, then taking one tablespoon and adding 20 ml of hot water then stirring and letting it cool. Take 5 ml of the mixed water and add each 4 drops of test reagents A and B. If a purple color is formed, the sample is positive for containing formaldehyde.

Preparation of Positive and Negative Controls

Making positive controls is done by adding 1 ml of 10% and 100% formaldehyde solution to the test sample weighing approximately 20 grams. Then the sample is treated as in the formaldehyde test steps. The sample added with 1 ml of formaldehyde solution shows a color change to purple. Meanwhile, making negative controls is done by adding distilled water and then dripping with the test kit reagent.

RESULT AND DISCUSSION

This study evaluated the presence of formaldehyde in tofu using a commercially available qualitative test kit. Five tofu samples from different sources were analyzed using a commercially available formaldehyde test kit. All five samples tested positive for formaldehyde, as indicated by a distinct color change typically from cream to soft purple after reagent application (Fig.1).

Fig 1. Qualitative Test Results of Formaldehyde on Tofu Samples

Table 1. Summary of Test Results

Sample ID	Source	Test Result	Color Change Observed
T1	TOFU 1	Positive	Cream→ Soft Purple
T2	TOFU 2	Positive	Cream→ Soft Purple
T3	TOFU 3	Positive	Cream→ Soft Purple
T4	TOFU 4	Positive	Cream→ Soft Purple
T5	TOFU 5	Positive	Cream→ Soft Purple

The presence of formaldehyde in all five tofu samples is a strong indication of either illegal adulteration or contamination during post-production handling. Tofu is a highly perishable, protein-rich product with a short shelf life. Unscrupulous vendors sometimes use formaldehyde to extend its marketability by delaying microbial spoilage and preserving firmness during transportation and display (Kurniawan et al., 2023).

The results of organoleptic observations of tofu samples that tested positive for formaldehyde showed that the color was brighter white while the aroma was not like the smell of soybeans in general that had undergone processing, the chewy texture remained intact and did not break easily when pressed. The use of the commercial colorimetric test kit proved effective as a field-based screening tool. Such kits typically rely on aldehyde-specific reactions, such as those involving chromotropic acid or Schiff's reagent, to produce a visible color change in the presence of formaldehyde (Zhou et al., 2021). This method offers a rapid, low-cost, and user-friendly approach to determine hazardous preservatives in food products. However, as a qualitative tool, it cannot measure concentration levels and may be affected by matrix interferences, highlighting the need for follow-up confirmation using laboratory-based methods such as high-performance liquid chromatography (HPLC) or Gas Chromatography-Mass Spectrometry (GC-MS) (Liu et al., 2020).

The detection of formaldehyde in tofu raises serious concerns. Formaldehyde is classified by the International Agency for Research on Cancer (IARC) as a Group 1 human carcinogen (IARC, 2022).

Chronic exposure through ingestion has been associated with gastrointestinal irritation, metabolic toxicity, liver and kidney damage, and increased cancer risk (Rahman et al., 2021; Zhang et al., 2019). Even at low levels, regular consumption of contaminated tofu poses significant risks, especially to vulnerable populations such as children, the elderly, and individuals with compromised health.

These findings are consistent with multiple reports of formaldehyde contamination in tofu and similar food products across parts of Southeast Asia, where regulatory enforcement and cold-chain infrastructure are often lacking (BPOM RI, 2023). Despite repeated crackdowns, the economic incentive for traders to use illegal preservatives remains a major obstacle to food safety.

Formaldehyde is not approved for use as a food preservative due to its well-documented toxicity. However, it is sometimes illegally added to tofu and other perishable food products to extend shelf life and maintain texture during transportation and display (Kurniawan et al., 2023). The detection of formaldehyde in all five tofu samples strongly suggests continued use of this chemical in food processing, especially in informal or unregulated markets.

The porous nature of tofu makes it particularly susceptible to absorbing and retaining chemical contaminants. Consumers ingesting such products are at risk of both acute and chronic exposure, depending on the concentration and frequency of consumption.

Health Implications of Dietary Formaldehyde Exposure

Formaldehyde is classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC, 2022). Chronic dietary exposure, even at low levels, is associated with gastrointestinal disturbances, nausea, vomiting, and long-term risks such as stomach ulcers and increased cancer susceptibility (Zhang et al., 2019). Acute ingestion can result in severe abdominal pain, liver and kidney dysfunction, and, in extreme cases, systemic toxicity or death (Rahman et al., 2021).

Tofu, as a staple protein source in many Asian diets, is frequently consumed in large quantities, thereby compounding the risk of cumulative exposure if contamination is persistent and widespread.

Although many countries have banned the use of formaldehyde in food, inadequate enforcement and lack of consumer awareness enable its continued misuse. In Indonesia, for example,

formaldehyde in tofu and noodles remains a recurrent issue despite periodic government crackdowns (BPOM RI, 2023).

To address these risks, several actions are recommended: Enhanced surveillance and testing of food products in markets and small-scale producers using portable kits or mobile labs. Stronger enforcement of existing food safety laws and harsher penalties for violators. Consumer education on identifying unsafe food practices and reporting suspicious products. Development and promotion of natural preservatives and cold-chain logistics to reduce incentives for chemical adulteration.

CONCLUSION

1. Based on the research results, all tofu samples obtained from one of the Traditional Markets in Mataram City were found to be positive for formaldehyde, which was indicated by a change in color to pink. This means that there are still many traders who do not comply with regulations regarding the use of dangerous preservatives such as formaldehyde which should not be added to food and ignore its adverse effects on health in order to gain profit.
2. Formaldehyde should not be used as a preservative in food because it has short-term effects, namely poisoning such as stomach ache accompanied by vomiting, convulsions, and headaches, as well as long-term effects that trigger damage to the central nervous system and kidneys or death effect.

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