



Analysis of Formalin Content and Storage Sanitation of Tofu at Inpres Manonda Market, Palu

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ABSTRACT

In 2023, food poisoning cases in Central Sulawesi were recorded at 205 cases, including 30 cases in Palu City, making food safety supervision crucial. One commonly consumed food in Palu City is tofu, with an average consumption of 0.1917 kg per capita per week. However, tofu is easily spoiled and has the potential to contain hazardous food additives such as formaldehyde. Additionally, the sanitation of storage places English: serves to maintain marketed quality safety. The research aims to examine sanitation and formalin levels in tofu storage areas at Manonda Inpres Market, Palu City. Using descriptive methods, the population is permanent tofu sellers at Manonda Inpres Market, with a total of 8 samples. The samples were placed in coded plastic bags and tested at the Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Tadulako University, for formalin levels relevant to BPOM policy Number 22 of 2023. Sanitation was analyzed through questions and answers and direct observation based on Minister of Health Regulation 2 of 2023. 4 out of 8 samples (50%) tested positive for formalin, which is dangerous if consumed, and 81.25% of sellers have good sanitation. It is hoped that this study can be used as a reference for BPOM, the Health Office, and market managers in organizing vendor locations, conducting routine inspections, and implementing food storage using food-grade and covered containers, thereby continuously improving food safety standards.

Keywords : Tofu; Formaldehyde; Sanitation; Market

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INTRODUCTION

Improving quality of life, health status, and human productivity is strongly influenced by the consumption of nutritionally balanced foods (1). One type of food widely consumed by Indonesians due to its balanced nutrient content is tofu. According to data from the National Socio-Economic Survey (Susenas) and the Central Bureau of Statistics (BPS) the average Indonesian consumes approximately 0.152 kg of tofu per week (2).

Tofu is a soybean-based food product processed through protein coagulation, resulting in a soft texture that is easy to consume. Tofu is widely available in the market due to its affordability. However, because tofu is highly perishable and has a limited shelf life, some tofu products circulating in the market are still found to contain hazardous Food Additives (BTP), namely formalin, which is used to extend its shelf life (3).

According to BPOM Regulation No. 22 of 2023, formalin is a chemical substance prohibited for use in food, as it may cause poisoning and even death (4). Tofu soaked in water containing formalin tends to have a firmer and denser texture, making it resistant to microorganisms and longer-lasting (5). In addition, sanitation of tofu storage facilities is an important component that must be considered to maintain tofu quality and prevent contamination by bacteria or foreign matter (6). Food storage facilities that do not comply with Ministry of Health Regulation No. 2 of 2023 may increase the risk of food poisoning cases in the community (7).

World Health Organization (WHO) data show that foodborne illnesses affected 600 million people and caused 420,000 deaths worldwide in 2022. Children under five years old accounted for 40% of foodborne disease cases, resulting in 125,000 deaths annually (8). Food poisoning occurs most frequently in Africa, with 175 million cases annually, while Southeast Asia recorded 150,000 cases (9).

In 2022, the Ministry of Health of the Republic of Indonesia (Kemenkes RI) recorded 3,514 cases of food poisoning. In 2023, the number increased by more than 1,000 cases, reaching 4,792, and by 2024 the number rose further to 11,213 cases (10). Furthermore, from 290 tofu samples tested by BPOM, 33.45% were found to contain formalin, misused as a preservative. These samples originated from various regions in Indonesia, including Jakarta, Bandar Lampung, Semarang, Bandung, Surabaya, Yogyakarta, Makassar, and Mataram (11). In Central Sulawesi, two outbreaks (Kejadian Luar Biasa/KLB) of food poisoning were reported in 2024, occurring in Palu City and Parigi Moutong Regency, affecting a total of 44 individuals 32 in Palu City and 12 in Parigi Moutong due to the consumption of contaminated processed foods (12).

According to data from the Central Sulawesi Provincial Food Service, the per capita consumption of tofu in Palu City is 0.1917 kg per week, or 27.4 grams per day. However, this has not been balanced by sufficient public awareness regarding the potential presence of formalin in tofu and the sanitation conditions of tofu storage at Inpres Manonda Market (13).

Food safety supervision at Inpres Manonda Market remains relatively limited, particularly for high-risk food products such as tofu, which may increase the likelihood of hazardous food additives being used. This limitation is influenced by the absence of routine inspections for formalin content over the past few years, as monitoring priorities have shifted to other aspects. Preliminary observations also indicate that the sanitation conditions of tofu storage areas do not fully comply with good hygiene and sanitation practices. Several vendors were observed storing tofu in open containers without covers, which may lead to cross-contamination and a decline in food quality.

This study is based on BPOM Regulation No. 22 of 2023, which strictly prohibits the use of formalin in food products, with an allowable concentration limit of zero or negative. In addition, the assessment of storage sanitation refers to Minister of Health Regulation No.

2 of 2023, which includes indicators such as the use of food-grade storage materials, separation from ready-to-eat foods, freedom from vectors and hazardous substances (B3), storage height of at least 15 cm above the floor, protection from direct sunlight, and the cleanliness of the soaking water used for tofu. Based on these references, this research aims to identify the presence of formalin and evaluate the sanitation level of tofu storage at Inpres Manonda Market. The findings are expected to provide a scientific basis for the National Agency of Drug and Food Control (BPOM) in formulating strategies to strengthen food safety control and improvement efforts in traditional markets.

METHODS

This study is a descriptive research aimed at illustrating the presence of formalin and the sanitation conditions of tofu storage at Inpres Manonda Market, Palu City, conducted in August 2025. The study population consisted of all permanent tofu vendors, totaling eight respondents selected using a total sampling technique. The inclusion criteria included vendors with permanent stalls, actively selling for at least the past six months, and willing to participate as respondents. Seasonal vendors and those who were absent during data collection were excluded from the study.

The analysis of formalin content was carried out at the Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Tadulako University, using a qualitative test with Potassium Permanganate (KMnO_4) reagent following the laboratory's standard procedures. The testing process began by weighing 5 grams of tofu, grinding it, and mixing it with 25 mL of distilled water until homogeneous. The mixture was then centrifuged for one hour to separate solid and liquid components, producing a clear supernatant. Subsequently, 5 mL of the supernatant was transferred into a new test tube, followed by the addition of 1 mL KMnO_4 solution and 1 mL Hydrochloric Acid (HCl). The mixture was allowed to stand for 10–15 minutes and observed for color change. The result was considered positive for

formalin if the purple color of KMnO_4 faded or turned yellowish-brown, and negative if the color remained unchanged.

The sanitation assessment of tofu storage was conducted using an observation checklist developed based on the Minister of Health Regulation of the Republic of Indonesia No. 2 of 2023, which implements Government Regulation No. 66 of 2014 on Environmental Health. The evaluated aspects included the use of food-grade storage materials, the presence of a lid, a minimum storage height of 15 cm above the floor, freedom from vectors and hazardous substances (B3), protection from direct sunlight, and the cleanliness of the soaking water. The results were categorized as “compliant” if $\geq 60\%$ of the indicators were met, and “non-compliant” if $< 60\%$. Data collection included primary data from field observation, laboratory testing, and documentation, as well as secondary data obtained from BPOM Palu, the Health Office, the Food Agency, the Central Bureau of Statistics (BPS) of Central Sulawesi, and relevant literature. Data were analyzed univariately to describe formalin content and sanitation conditions, with findings presented in tables and narrative descriptions.

RESULTS

Characteristics of Tofu Vendors

Table 1. Distribution of the Characteristics of Tofu Vendors at Inpres Manonda Market, Palu City, 2025 (n=8)

Type Sex	n	%
Male	3	37,5
Female	5	62,5
Age	n	%
26-35 years	1	12,5
36-45 years	3	37,5
>45 years	4	50
Education	n	%

Graduated from elementary School	1	12,5
Junior high school graduate	2	25
High school graduate	5	62,5
Duration of Trading		
5-10 years	5	62,5
11-20 years	2	25
21-25 years	1	12,5
Tofu Production Site		
Factory 1	2	25
Factory 2	1	12,5
Factory 3	1	12,5
Factory 4	1	12,5
Factory 5	3	37,5
Total	8	100

Source : Primary Data, 2025

The majority of respondents were female (62.5%), aged over 45 years (50%), with a high school education (62.5%), and had been trading for 5–10 years (62.5%). The smallest groups were male respondents (37.5%), those aged 26–35 years (12.5%), with elementary school education (12.5%), and those with 21–25 years of trading experience (12.5%). In addition, Factory 5 contributed the largest number of samples (37.5%), while Factories 2, 3, and 4 each contributed only 12.5%.

Formalin Content Analysis

Table 2. Results of Formalin Content Analysis in Tofu at Inpres Manonda Market, Palu City, 2025 (n=8)

No.	Sample Code	Formalin Content Test
1.	A	Negative (-)
2.	B	Positive (+)
3.	C	Negative (-)
4.	D	Positive (+)
5.	E	Positive (+)

No.	Sample Code	Formalin Content Test
6.	F	Negative (-)
7.	G	Negative (-)
8.	H	Positive (+)

Source : Primary Data, 2025

As presented in Table 2, qualitative laboratory analysis of eight tofu samples revealed that four samples tested positive for formalin, while the remaining four were formalin-negative. This finding indicates that 50% of the tofu samples sold at Inpres Manonda Market contained formalin, suggesting potential non-compliance with food safety regulations. The detection of formalin in half of the tested samples highlights the persistence of unsafe food additive practices among tofu vendors. Consequently, these results underscore the urgent need for strengthened food safety surveillance and regulatory enforcement to ensure that tofu products distributed at Inpres Manonda Market comply with national food safety standards.

Sanitation Practices of Tofu Storage Facilities

Table 3. Distribution of Sanitation Practices in Tofu Storage among Vendors at Inpres Manonda Market, Palu City, 2025 (n=8)

No	Assessment Aspects	Yes		No		Total	
		n	%	n	%	n	%
1.	Storage must be made of food-grade materials	1	12,5	7	87,5	8	100
2.	Hazardous and toxic substances (B3) must not be present in the storage area	8	100	0	0	8	100
3.	Storage must be free from vector contamination (flies, cockroaches, or other animals)	8	100	0	0	8	100
4.	Storage must be separated from ready-to-eat foods	8	100	0	0	8	100
5.	Storage containers must not be placed directly on the floor and should be elevated at least 15 cm	7	87,5	1	12,5	8	100

No	Assessment Aspects	Yes		No		Total	
		n	%	n	%	n	%
6.	Tofu must be stored in covered containers	1	12,5	7	87,5	8	100
7.	The storage area must be clean	8	100	0	0	8	100
8.	Tofu in storage must not be exposed to direct sunlight	8	100	0	0	8	100
9.	Soaking water must be clean (not cloudy or dirty)	8	100	0	0	8	100
10.	If tofu is not sold out, the soaking water must be replaced regularly	8	100	0	0	8	100

Source : Primary Data, 2025

As shown in Table 3, all vendors (100%) used clean storage areas that were free from vectors such as flies and cockroaches, free from hazardous and toxic materials (B3), separated from ready-to-eat foods, protected from direct sunlight, and maintained the cleanliness of tofu soaking water by changing it regularly. However, several aspects of sanitation were not fully met. Specifically, seven vendors (87.5%) did not use food-grade containers and stored tofu in uncovered containers, while one vendor (12.5%) placed tofu directly on the floor or ground without a clean base or elevated rack at least 15 cm above the surface. Overall, the compliance rate of vendors with tofu storage sanitation standards at Inpres Manonda Market reached 81.25%, indicating that most vendors had implemented appropriate sanitation practices.

Nevertheless, certain aspects—particularly the use of food-grade and covered containers—were still lacking. These findings suggest that although the majority of vendors have adhered to proper sanitation standards, the presence of formalin in several tofu samples is likely not solely attributed to poor sanitation practices during storage. Instead, it may be associated with factors occurring prior to the distribution stage, such as contamination or the intentional use of formalin during the production or supply process.

DISCUSSION

The environmental conditions at Inpres Manonda Market in Palu City remain poorly organized, as vendors are not grouped according to their type of merchandise. In particular, tofu vendors are not placed in a designated area but are instead scattered across various locations. Some tofu vendors sell in front of shops, while others are situated near vegetable, corn, or spice vendors, and even in close proximity to fish vendors, which increases the risk of cross-contamination. Moreover, tofu vendors located near fish sellers face additional risks, such as wet and muddy walkways and the possible entry of foreign materials into uncovered tofu containers.

Samples were collected by placing them in clean plastic containers labeled with sample codes. The containers were then sealed and carefully arranged to prevent impact or damage during storage and transportation. Finally, the samples were taken to the Laboratory of the Chemistry Study Program, Faculty of Mathematics and Natural Sciences, Tadulako University, for formalin content analysis.

Formalin Content Test

Formalin testing in the laboratory was carried out qualitatively using potassium permanganate (KMnO_4) reagent. If the purple KMnO_4 solution faded, became colorless, or turned yellowish-brown, the result was considered positive for formalin. Conversely, if the purple color of KMnO_4 remained stable without change, the sample was considered negative for formalin.

The results of the study showed that out of eight tofu samples analyzed, four samples tested positive for formalin, originating from factories 2, 3, and 5. This was indicated by the discoloration of the KMnO_4 solution from purple to a faded or yellowish-brown hue. Since observations of texture, color, and odor could not distinguish between positive and negative samples, this color change indicated the presence of formalin at low concentrations.

This finding is consistent with research at a traditional market in Batang Regency, which reported that of eight white tofu samples examined, six tested positive for formalin. The results showed that the filtrate changed color from reddish purple to clear with a brown precipitate after reacting with KMnO_4 . The presence of formalin was confirmed by the reaction of the aldehyde group, which reduces potassium permanganate, thus decolorizing the solution (14).

The results of this study do not comply with the standards set forth in BPOM Regulation No. 22 of 2023 on Prohibited Raw Materials in Processed Food and Prohibited Substances as Food Additives (BTP), which strictly prohibits the addition of formalin to food due to its potential to cause food poisoning. Therefore, tofu sold at Inpres Manonda Market in Palu City cannot be considered entirely safe for consumption, as some samples were found to contain formalin. Nevertheless, these findings should be considered alongside the overall sanitation conditions of tofu storage areas, since the implementation of adequate storage sanitation is essential to preserving product quality, ensuring food safety, and minimizing the risk of contamination in tofu distributed at Inpres Manonda Market.

Sanitation of Tofu Storage Facilities

The results of the study indicate that tofu vendors at Inpres Manonda Market have generally applied proper sanitation principles in storage practices, particularly in maintaining clean storage areas, separating storage from ready-to-eat foods, and ensuring that hazardous substances (B3) and vector contamination are absent. These practices comply with the requirements outlined in Ministry of Health Regulation No. 2 of 2023, which stipulates that storage areas must be clean, free from pesticides or hazardous materials, separated from ready-to-eat foods, and protected from vector contamination. This finding is consistent with Lamatenggo's research which emphasized that food storage

must be kept clean, free from dust, chemicals, and disease vectors, and must be separated from ready-to-eat foods to prevent cross-contamination (15).

Another sanitation principle applied by tofu vendors at Inpres Manonda Market is avoiding direct exposure of tofu to sunlight. According to Timotiwu, exposure to high temperatures can reduce the physical quality of fresh food products, particularly by altering texture and color, which accelerates spoilage. In addition, tofu vendors routinely replace the soaking water daily and add ice to extend shelf life and preserve tofu quality (16). This aligns with Jamiah, who reported that soaking water should be replaced regularly to prevent quality deterioration, such as sliminess, unpleasant odor, and sour taste in tofu (17).

However, some vendors still place tofu storage containers directly on the floor without using mats or racks elevated at least 15 cm above the ground. This practice does not comply with the criteria in Ministry of Health Regulation No. 2 of 2023 and is inconsistent with Wulandari, who emphasized that food storage containers should not be placed directly on the floor and must be elevated at least 15 cm to reduce the risk of cross-contamination (18).

Furthermore, most vendors do not use food-grade storage containers and leave the tofu uncovered or in open containers. This also does not meet the requirements of Ministry of Health Regulation No. 2 of 2023. Willma stated that food storage containers must be food-grade and kept covered. Open storage may lead to cross-contamination and accelerate spoilage, particularly in perishable food products (19).

Overall, the findings demonstrate that the majority of tofu vendors at Inpres Manonda Market in Palu City have complied with storage sanitation requirements and applied proper practices. Nevertheless, improvements are still needed, particularly in the use of food-grade and covered storage containers, as well as ensuring that storage units are not placed directly on the floor, to minimize the risk of contamination.

The findings of this study revealed that 50% of the tofu samples sold at Inpres Manonda Market tested positive for formalin, while the majority of vendors had already complied with proper storage sanitation standards. This indicates that food safety is not solely determined by vendors' storage practices, but also reflects weak regulatory control over the use of hazardous food additives beyond the storage stage—particularly during the production and distribution processes. Therefore, stricter monitoring and enforcement of regulations concerning the use of harmful additives such as formalin are necessary. These measures should be accompanied by continuous education and capacity-building programs for vendors to maintain and improve good storage sanitation practices, thereby ensuring comprehensive food safety at Inpres Manonda Market.

Despite its contributions, this study has several limitations. The number of samples analyzed was relatively small, and the use of a qualitative formalin test limits the generalizability of the results to all tofu vendors in Palu City. Moreover, the research was conducted in only one traditional market, and conditions in other markets may differ. The assessment of storage sanitation was observational and did not cover all behavioral or environmental factors that may influence tofu safety. In addition, the observation instrument was qualitative, preventing quantitative measurement of cross-contamination risks or variations in daily sanitation practices. Hence, further research with a broader scope, larger sample size, and quantitative methods is recommended to provide a more comprehensive understanding of the quality and safety of tofu distributed in local markets.

CONCLUSIONS AND RECOMMENDATIONS

This study revealed that four tofu samples from Inpres Manonda Market tested positive for formalin, thereby failing to meet the requirements stipulated in BPOM Regulation No. 22 of 2023. In contrast, the sanitation aspects of tofu storage among all vendors at the market were found to comply with the standards set forth in Minister of

Health Regulation No. 2 of 2023. Strengthened routine monitoring and inspection by the National Agency of Drug and Food Control (BPOM) and the local Health Office are essential to prevent the use of hazardous food additives. In addition, educational initiatives should be provided to vendors regarding the use of food-grade storage containers and covered storage practices to ensure food safety.

It is further recommended that market management organize trading areas based on product types to minimize the risk of cross-contamination. Meanwhile, both vendors and producers are encouraged to comply with existing food safety regulations and refrain from using formalin or other prohibited substances in food products. These collaborative efforts are expected to enhance the overall safety and quality of tofu products distributed at Inpres Manonda Market.

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