IDENTIFICATION OF FORMALDEHYDE CONTENT IN FISH SOLD IN SEVERAL TRADITIONAL MARKETS IN BANDUNG CITY

Identifikasi Kandungan Formalin Pada Ikan Laut yang Dijual di Beberapa Pasar Tradisional Kota Bandung

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ABSTRACT

Fish are one of the types of food that quickly spoil. The use of ice blocks as a preservation medium for fish is relatively expensive due to the large amount of ice required. Therefore, some traders use formalin as a fish preservative because it is considered more economical. The purpose of this research is to analyze the presence of formalin in fish sold in some traditional markets in Bandung City. The identification of formalin content was carried out qualitatively using the Nash reagent and quantitatively using the UV-Vis spectrophotometer. The analysis of four traditional markets and three types of fish found formalin in Kosambi Market and Gedebage Market. The identified fish species containing formalin were mackerel (Rastrelliger) and tuna mackerel (*Euthynnus affinis*). The highest formalin concentration was found in tuna mackerel (*Euthynnus affinis*), with a concentration of 1.79 mg/L.

Keywords: Bandung City, Fish, Formaldehyde, Traditional Market

ABSTRAK

Ikan laut merupakan salah satu jenis pangan yang cepat mengalami pembusukan. Penggunaan es balok sebagai media untuk memperpanjang masa simpan ikan relatif mahal dikarenakan jumlah es yang dibutuhkan cukup banyak. Oleh karena itu, ada beberapa pedagang yang menggunakan formalin sebagai pengawet ikan karena dinilai lebih ekonomis. Tujuan dari penelitian ini untuk menganalisis ada tidaknya kandungan formalin pada ikan laut yang dijual di beberapa pasar tradisional Kota Bandung. Metode identifikasi kandungan formalin dilakukan secara kualitatif menggunakan pereaksi nash dan kuantitatif menggunakan spektrofotometer UV-Vis. Hasil analisis dari empat pasar tradisional dan tiga jenis ikan ditemukan adanya formalin di Pasar Kosambi dan Pasar Gedebage. Jenis ikan yang teridentifikasi mengandung formalin yaitu ikan kembung dan ikan tongkol. Kadar formalin paling tinggi ditemukan pada ikan tongkol dengan kadar sebesar 1,79 mg/L.

Kata Kunci: Formalin, Ikan Laut, Kota Bandung, Pasar Tradisional

INTRODUCTION

Marine fish is an animal protein that is very good for humans. Compared to freshwater fish, marine fish have a higher amino acid content. This is due to the abundance of natural food with high levels of amino acids in seawater habitats (Andhikawati *et al*., 2021). In general, the nutritional content of marine fish consists of 11.13% - 18.21% protein, 1.03% - 7.72% fat, 0.43% - 3.93% ash content and water content 70.28% - 86.30% (Suseno *et al*., 2006).

The high water content in fish causes the fish to rot quickly. The decay process in fish is caused by the activity of bacteria and enzymes in the fish's body, as well as external factors such as contamination and oxidation (Deni, 2015). Fish that have just been caught and landed will experience damage and decline in quality within a few hours (Adawyah, 2007). Deni (2015) stated that fish quality deterioration can occur within 8 hours after the fish is caught and landed.

Traditional markets are one of the places selling marine fish. However, most of the handling of marine fish in traditional markets does not comply with good fish handling standards. Good fish handling is needed to maintain fish freshness, one of which is by maintaining the cold chain during storage (Mailoa *et al*., 2020). Lokollo & Mailoa (2020) in their examination of the handling of marine fish in the traditional markets of Ambon City found that the storage and presentation conditions of fish at sales places did not pay attention to the ratio of the volume of fish and the number of ice cubes used. Buton *et al*. (2017) stated that fish storage at fish sales tables in traditional markets is mostly still littered with spilled fish blood.

Marine fish are generally sold fresh. This can affect the distribution and shelf life of fish. The short shelf life of fish makes it difficult for marine fish to be distributed to areas far from the coast, one of which is the city of Bandung. To maintain the freshness of the fish until it reaches consumers, good handling is required during the process of transporting the fish, one of which is using ice cubes. However, this method is relatively expensive because the ice blocks required are very large (Suryadi *et al*., 2010). Therefore, there are some traders who use formalin as a fish preservative to extend the shelf life because it is considered more economical (Noorrela & Munggaran, 2021).

Formalin is a dangerous preservative if it enters the body. Consuming high doses of formalin can cause the growth of cancer cells and changes in the body's tissue systems (Berliana *et al*., 2021). The use of formalin in food has been prohibited based on the Republic of Indonesia Minister of Health Regulation No. 033 of 2012, but there are still many violators who do it. Yuliantini *et al*. (2019) in their research on the formaldehyde content in chicken and fish in one of the traditional markets in Bandung City, found that the formaldehyde content in mackerel (Rastrelliger) was 7.48 µg/g. Cengristitama & Sari (2019) conducted research on the formaldehyde content in tuna mackerel (*Euthynnus affinis*), pomfret and mackerel (Rastrelliger). The test results obtained positive results for all samples. Simanjuntak & Silalahi (2022) also conducted research on pomfret fish, grouper fish, snapper fish, tuna fish and tuna mackerel (*Euthynnus affinis*). The test results obtained positive results for formalin in all samples with levels ranging from 0.528 mg/L - 3.42 mg/L. Based on the above, this research needs to be carried out to determine whether there is formaldehyde content in marine fish sold in several traditional markets in Bandung City.

METHODS

Time and Place

Research activities were carried out in January-February 2024. The samples used as research material were obtained from several traditional markets in Bandung City, namely Caringin Market, Kosambi Market, Simpang Dago Market, and Gedebage Market. Sample

testing was carried out at the Biotechnology Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

Tools and Materials

The tools used in the research were analytical scales, test tubes, mortar and pestle, measuring pipettes, measuring cups, UV-Vis spectrophotometer, cuvettes, Hot Plate Stirer, Waterbath, micropipettes (10-100 µl and 100-1000 µl), glass bottles dark, and filter paper.

The materials used in the research were mackerel (Scomberomorini), mackerel (Rastrelliger) and tuna mackerel (*Euthynnus affinis*) obtained from four traditional markets in Bandung City, namely Kosambi Market, Simpang Dago Market, Caringin Market, and Gedebage Market. Other ingredients are 37% formaldehyde, ammonium acetate, acetyl acetone, glacial acetic acid, and distilled water.

Research Procedure

Making Nash's Reagent

Making Nash's reagent refers to Nash (1953), namely 150 grams of ammonium acetate dissolved in 700 ml of distilled water. Added 2 ml of acetyl acetone and 3 ml of glacial acetic acid. All ingredients were homogenized and transferred into a 1000 ml measuring flask, then add distilled water to the mark.

Sample Preparation

Samples of marine fish were weighed at 5 grams, put into an Erlenmeyer flask, then 40 ml of distilled water was added. The Erlenmeyer was covered using gauze to prevent the formalin from evaporating. Heat for $\pm$ 30 minutes at $40 \pm 2°C$. Cool then filter using filter paper. Each filtrate was analyzed qualitatively (Yulianti & Safira, 2020).

Qualitative Formalin Testing

Qualitative formalin testing refers to Yulianti & Safira (2020). 5 ml of sample filtrate was taken and put into a test tube, then 5 ml of Nash reagent was added. The mixed filtrate and nash were heated for 30 minutes at 40°C, then cooled. Samples that are identified as positive for containing formaldehyde will change color to yellow after being heated. Samples containing formalin were continued with quantitative testing using a UV-Vis spectrophotometer. All samples were tested in three repetitions.

Preparation of 1000 ppm Formalin Main Solution

1 ml of 37% formalin solution was taken, then diluted with distilled water to a volume of 100 ml to make a 3700 ppm formalin solution. 27 ml of formalin solution with a concentration of 3700 ppm was taken and then diluted again using distilled water to a volume of 100 ml to make formalin with a concentration of 1000 ppm (Sari *et al*., 2017).

Determination of Maximum Wavelength

Maximum wavelength measurements were carried out using a standard 10 ppm formalin solution. 5 ml of 10 ppm formalin solution was taken, then 5 ml of Nash reagent was added. The absorption of the solution was measured at a wavelength of 400-500 nm using a UV-Vis spectrophotometer (Yulianti & Safira, 2020).

Creation of a Standard Curve

Standard solutions were prepared with concentrations of 0; 1; 3; 4; 7; 10; 13 and 15 ppm each amount to 10 ml. 1 ml of each standard solution was taken, then 5 ml of Nash reagent was added. The solution was heated for 30 minutes at 40°C then cooled. All standard solutions had their absorbance measured at the maximum wavelength using a UV-Vis spectrophotometer (Yulianti & Safira, 2020).

Quantitative Formalin Testing

Quantitative formalin testing was carried out on samples that were identified as positive for formalin in qualitative testing. Samples identified as formalin had their absorbance values

measured at the maximum wavelength using a UV-Vis spectrophotometer. Formalin levels were calculated using a regression equation obtained from a standard curve.

Data Analysis

Data obtained from the formalin testing results were analyzed descriptively comparatively. Comparative research is research that compares the existence of one or more variables in two or more different samples or at different times (Sugiyono, 2016). In this research, the variables compared were the results of formalin identification in marine fish samples in several traditional markets in Bandung City. Data from formalin testing results are presented in the form of tables and graphs.

RESULT
Results of Qualitative Analysis of Formalin in Marine Fish in Several Traditional Markets in Bandung City

Qualitative formalin testing on marine fish samples was carried out using the Nash reagent method (Yulianti & Safira, 2020). The types of fish used as samples were marine fish that are most consumed by the people of Bandung City, namely mackerel (Scomberomorini), mackerel (Rastrelliger) and tuna mackerel (*Euthynnus affinis*) (Badan Pusat Statistik, 2022). The marine fish comes from Kosambi Market, Caringin Market, Gedebage Market and Simpang Dago Market. The results of formalin testing on marine fish from several traditional markets are in Table 1.

Table 1. Results of Qualitative Analysis of Marine Fish Samples

Sources	Seller	Types of Fish	Replications		
			I	II	III
Kosambi Market	1	Mackerel (Scomberomorini)	Clear	Clear	Clear
		Mackerel (Rastrelliger)	Yellow	Yellow	Yellow
		Tuna Mackerel (*Euthynnus affinis*)	Yellow	Yellow	Yellow
	2	Mackerel (Scomberomorini)	Clear	Clear	Clear
		Mackerel (Rastrelliger)	Yellow	Yellow	Yellow
		Tuna Mackerel (*Euthynnus affinis*)	Yellow	Yellow	Yellow
Caringin Market	1	Mackerel (Scomberomorini)	Clear	Clear	Clear
		Mackerel (Rastrelliger)	Clear	Clear	Clear
		Tuna Mackerel (*Euthynnus affinis*)	Clear	Clear	Clear
	2	Mackerel (Scomberomorini)	Clear	Clear	Clear
		Mackerel (Rastrelliger)	Clear	Clear	Clear
		Tuna Mackerel (*Euthynnus affinis*)	Clear	Clear	Clear
Gedebage Market	1	Mackerel (Scomberomorini)	Clear	Clear	Clear
		Mackerel (Rastrelliger)	Clear	Clear	Clear
		Tuna Mackerel (*Euthynnus affinis*)	Yellow	Yellow	Yellow
	2	Mackerel (Scomberomorini)	Clear	Clear	Clear
		Mackerel (Rastrelliger)	Clear	Clear	Clear
		Tuna Mackerel (*Euthynnus affinis*)	Yellow	Yellow	Yellow
Simpang Dago Market	1	Mackerel (Scomberomorini)	Clear	Clear	Clear
		Mackerel (Rastrelliger)	Clear	Clear	Clear
		Tuna Mackerel (*Euthynnus affinis*)	Clear	Clear	Clear
	2	Mackerel (Scomberomorini)	Clear	Clear	Clear
		Mackerel (Rastrelliger)	Clear	Clear	Clear
		Tuna Mackerel (*Euthynnus affinis*)	Clear	Clear	Clear

Samples identified as formalin in qualitative testing using Nash's reagent as a reagent will experience a color change to yellow. The color of the sample identified as formalin after adding Nash reagent can be seen in Figure 1.

Figure 1. Formalin Positive Sample

Results of Quantitative Analysis of Formalin in Marine Fish in Several Traditional Markets in Bandung City

Marine fish samples identified as formalin in qualitative formalin testing were followed by quantitative analysis using the UV-Vis spectrophotometer method (Yulianti & Safira, 2020). The results of calculating formlain levels in marine fish samples identified as positive for formlain in qualitative testing are in Table 2.

Table 2. Formaldehyde Levels in Samples

Market Source*	Seller	Types of Fish	Formaldehyde Levels (mg/L)			Average (mg/L)
			1	2	3	
Kosambi Market	1	Tuna Mackerel (*Euthynnus affinis*)	1.82	1.77	1.79	1.79
		Mackerel (Rastrelliger)	1.04	1.09	0.90	1.01
	2	Tuna Mackerel (*Euthynnus affinis*)	0.56	0.61	0.61	0.59
		Mackerel (Rastrelliger)	0.60	0.32	0.51	0.48
Gedebage Market	1	Tuna Mackerel (*Euthynnus affinis*)	0.96	1.08	1.17	1.07
	2	Tuna Mackerel (*Euthynnus affinis*)	1.20	1.13	1.03	1.12

Note: *The sample was identified as positive for formalin from qualitative formalin testing

DISCUSSION
Qualitative Analysis of Formalin in Marine Fish Sold in Several Traditional Markets in Bandung City

The results of the qualitative test for formalin content in marine fish showed that of the 72 samples tested using Nash reagent, 18 samples (25%) showed positive formaldehyde. This is indicated by a change in the color of the sample to yellow after adding Nash reagent. A sample that does not change color indicates that the sample does not contain formaldehyde (Nash, 1953). The color change occurs due to the reaction between Nash reagent and formaldehyde which forms the compound 3,5-diacetyl-1,4-dihydrolutidine which produces a yellow color (Werner *et al*., 2022).

Qualitative test results showed that two of the four markets used as sampling locations were found to contain formalin, namely Kosambi Market and Gedebage Market. The number of positive formalin samples at Kosambi Market was 12 samples, while the number of formalin positive samples at Gedebage Market was 6 samples. Markets that do not have formalin marine

fish samples are Caringin Market and Simpang Dago Market.

The use of formalin in marine fish samples obtained from Kosambi Market and Gedebage Market was caused by the low level of awareness of traders regarding health. This is in accordance with Harahap (2019) statement, the use of formalin preservatives in fish is caused by the low level of public health awareness, as well as a lack of information about formalin and its dangers. The low level of public awareness regarding health can be seen from the poor handling of fish during the transportation process where traders do not use ice blocks and the containers used only use black plastic. Apart from that, compared to traders at Caringin Market and Simpang Dago Market, the conditions of the fish sales places where samples were taken at Kosambi Market and Gedebage Market paid less attention to hygiene and sanitation. During the sales process, the table where the fish was stored was contaminated by fish waste and blood. A dirty fish environment will give rise to putrefactive microorganisms which are dangerous for human health (Ndahawali, 2016).

Quantitative Analysis of Formalin in Marine Fish Sold in Several Traditional Markets in Bandung City

Quantitative formalin testing aims to determine the level of formalin in the sample. The use of the UV-Vis spectrophotometer method in quantitative testing is carried out because this method is simpler, faster and more economical (Suryadi *et al*., 2010).

Based on data from quantitative formalin testing results on marine fish that were identified as positive for formalin, it was found that the formalin levels in the samples ranged from 0.48 – 1.79 mg/L. The use of formalin in food has been prohibited in the Republic of Indonesia Minister of Health Regulation No. 33 of 2012. Based on this regulation, the level of formaldehyde in food must be 0 ppm. According to the International Program on Chemical Safety (IPCS), the safe limit for formalin that can be accepted by the body is 0.1 mg/L (Iftriani *et al*., 2016). Formalin levels in samples identified as positive for formalin have exceeded the safe limit for formaldehyde that can be accepted by the body, making it unsafe for consumption.

Tuna mackerel (*Euthynnus affinis*) is the type of fish that contains the most formaldehyde and has the highest formalin content, namely 1.79 mg/L. Compared to mackerel (Scomberomorini) and mackerel (Rastrelliger), tuna mackerel (*Euthynnus affinis*) is the type of fish that rots the fastest. This is because the water content and fat content in tuna mackerel (*Euthynnus affinis*) are higher than mackerel (Scomberomorini) and mackerel (Rastrelliger). Widyanti *et al*. (2021) stated that tuna mackerel (*Euthynnus affinis*) contains 74.7 grams of water and 3.79 grams of fat; mackerel (Rastrelliger) has a water content of 71.4 grams and fat of 3.4 grams; mackerel (Scomberomorini) has a water content of 68.1 grams and fat of 2.6 grams. Fish fat contains a lot of long chain polyunsaturated fatty acids which are very easily oxidized and cause a rancid odor (Astawan, 2004). High water content will reduce the quality of fish because it can accelerate spoilage (Muliapriliyani *et al*., 2018).

Lema & Jacob (2020) in their research regarding the identification of formaldehyde in marine fish in several traditional markets in Kupang City, found that there was a higher formaldehyde content in tuna mackerel (*Euthynnus affinis*) at 3.36 ppm compared to other fish. Harahap (2019) also in his research at Pasar Pagi Lawe Bulan Kutacana, Aceh found a higher formaldehyde content in tuna mackerel (*Euthynnus affinis*), namely 0.13 mg/kg. Surahman *et al*. (2019) stated that fish that rot quickly are more at risk of having formalin added by traders as a preservative. This is done to prevent losses.

Mackerel (Scomberomorini) is a type of fish that has not been positively identified as containing formaldehyde. This is because mackerel (Scomberomorini) is much needed by the community, especially the fishing industry, so it is quickly sold on the market. Mackerel (Scomberomorini) is used as raw material for making fishery products such as pempek, fish balls, dumplings and other types of food (Susanti *et al*., 2011). Mackerel (Scomberomorini)

has a delicious taste and has a fairly high meat content, namely around 57.23-58.57%, so it is widely used as raw material for making fishery products. Kasim & Triharyuni (2016) stated that mackerel (Scomberomorini) is the type of fish with the highest demand both domestically and globally.

The use of formalin on marine fish is still widely used by some individuals. Several factors that cause the widespread use of formaldehyde are that sellers do not know that there is a prohibition on the use of formaldehyde in food, there is no good control from authorized institutions, lack of guidance, and the seller's intention to gain maximum profits (Matondang et al. 2015). Apart from that, the cheap price of formaldehyde is one of the strong reasons for using formaldehyde in food (Mardiyah & Jamil, 2020).

Formalin is not a food additive. The use of formalin in food is prohibited in the Republic of Indonesia Minister of Health Regulation No. 33 of 2012 because it can be dangerous if it enters the body. Short-term effects can cause vomiting and diarrhea, hypotension (low blood pressure), headaches and stomachaches, seizures, damage to the central nervous system, liver, spleen, kidneys and pancreas. The long-term effects caused are damage to the respiratory tract, itching in the chest and a decrease in body temperature (Rian, 2014).

CONCLUSION

Based on the results of identifying the formaldehyde content in marine fish sold in several traditional markets in Bandung City, it can be concluded that the use of formaldehyde in marine fish in Bandung City is still carried out by several traders. Formalin use in marine fish was found in fish samples obtained from Gedebage Market and Kosambi Market. The type of fish that contains the most formaldehyde is tuna mackerel (*Euthynnus affinis*) with the highest formalin content, namely 1.79 mg/L.

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REFERENCES

Adawyah, R. (2007). *Pengolahan dan Pengawetan Ikan*. Jakarta: Bumi Aksara.

Andhikawati, A., Junianto, A., & Permana, R. (2021). Komposisi Gizi Ikan terhadap Kesehatan Tubuh Manusia. *Marinade*, *4*(2), 76–84.

Berliana, A., Abidin, J., Salsabila, N., Maulidia, N. S., Adiyaksa, R., & Siahaan, V. F. (2021). Penggunaan Bahan Tambahan Makanan Berbahaya Boraks dan Formalin Dalam Makanan Jajanan. *Jurnal Sanitasi Lingkungan*, *1*(2), 64-71. https://doi.org/10.36086/salink.v1i2.952

Buton, H., Pontoh, O., & Manoppo, V. E. N. (2017). Kontribusi Pedagang Ikan Segar di Pasar Bersehati Kelurahan Calaca terhadap Lapangan Kerja di Kota Manado Provinsi Sulawesi Utara. *Akulturasi (Jurnal Ilmiah Agrobisnis Perikanan)*, *5*(9), 655-666. https://doi.org/10.35800/akulturasi.5.9.2017.16990

Cengristitama., & Sari, Y. I. P. (2019). Identifikasi Formalin pada Ikan Laut yang Dijual di Pasar Antri Cimahi. *Jurnal TEDC*, *11*(2), 126-130.

Deni, S. (2015). Karakteristik mutu ikan selama penanganan pada kapal KM. Cakalang. *Agrikan: Jurnal Agribisnis Perikanan*, *8*(2), 72–80. https://doi.org/10.29239/j.agrikan.8.2.72-80

Iftriani, I., Wahyuni, S., & Amin, H. (2016). Analisis Kandungan Bahan Pengawet Formalin pada Tahu yang Diperdagangkan di Pasar Tradisional Kota Kendari (Pasar Panjang, Pasar Anduonohu, Pasar Basah Dan Pasar Baruga). *Jurnal Sains dan Teknologi Pangan*, *1*(2), 125-130.

Kasim, K., & Triharyuni, S. (2016). Status Pemanfaatan dan Musim Penangkapan Ikan Tenggiri (*Scomberomorus* sp.) di Laut Jawa. *Jurnal Penelitian Perikanan Indonesia*, *20*(4), 235-242. https://doi.org/10.15578/jppi.20.4.2014.235-242

Lema, A. T., & Jacob, J. M. (2020). Deteksi Formalin dan Logam Berat pada Ikan Segar di Pasar Tradisional Kota Kupang. *Jurnal Kimia*, *14*(2), 147. https://doi.org/10.24843/JCHEM.2020.v14.i02.p07

Lokollo, E., & Mailoa, M. N. (2020). Teknik penanganan dan cemaran mikroba pada ikan layang segar di pasar tradisional Kota Ambon. *Jurnal Pengolahan Hasil Perikanan Indonesia*, *23*(1), 103-111. https://doi.org/10.17844/jphpi.v23i1.30923

Mailoa, M. N., Savitri, I. K. E., Lokollo, E., & Kdise, S. S. (2020). Mutu Organoleptik Ikan Layang (*Decapterus* sp.) Segar selama Penjualan di Pasar Tradisional Kota Ambon. *Majalah BIAM, 13*(5), 5-10.

Mardiyah, U., & Jamil, S. N. A. (2020). Identifikasi Kandungan Formalin Pada Ikan Segar Yang Dijual Dipasar Mimbo dan Pasar Jangkar Kabupaten Situbondo. *Samakia: Jurnal Ilmu Perikanan*, *11*(2), 135-140. https://doi.org/10.35316/jsapi.v11i2.827

Matondang, R. A., Rochima, E., & Kurniawati, N. (2015). Studi Kandungan Formalin Dan Zat Pemutih Pada Ikan Asin Di Beberapa Pasar Kota Bandung. *Jurnal Perikanan Kelautan*, *6*(2), 70-77. http://jurnal.unpad.ac.id/jpk/article/view/8781

Muliapriliyani, A., Santoso, H., & Syauqi, A. (2018). Potensi Kadar Air terhadap Pembusukan Surimi Ikan Layang (Decapterus russelli) setelah dibekukan. *Jurnal Ilmiah Biosaintropis (Bioscience-Tropic)*, *3*(3), 26-31. https://doi.org/10.33474/e-jbst.v3i3.156

Nash, T. (1953). Colorimetric Estimation of Formaldehyde by Means of Hantzch Reaction. *Biochem J.*, *55*(3), 417–418.

Ndahawali, D. H. (2016). Mikroorganisme Penyebab Kerusakan pada Ikan dan Hasil Perikanan Lainnya. *Buletin Matric*, *13*(2), 17–21.

Noorrela, L., & Munggaran, I. P. (2021). Analisa Kualitatif Formalin pada Sampel Ikan Asin di Pasar Sederhana Kota Bandung. *Food Scientia: Journal of Food Science and Technology*, *1*(1), 49–57. https://doi.org/10.33830/fsj.v1i1.1332.2021

Rian, F. R. (2014). Kajian Keamanan Pangan Bakso dan Cilok yang Berdar di Lingkungan Universitas Jember Ditinjau dari Kandungan Boraks, Formalin dan TPC. *Jurnal Agroteknologi*, *8*(1), 67–73.

Sari, T. M., Dira., & Shinta. (2017). Analisis Formalin pada Ikan Asin Kembung di Beberapa Pasar di Kota Padang dengan Metoda Spektrofotometer UV-Vis. *UNES Journal of Scientech Research*, *2*(2), 159–166.

Simanjuntak, H., & Silalahi, M. V. (2022). Kandungan Formalin Pada Beberapa Ikan Segar di Pasar Tradisional Parluasan Kota Pematangsiantar. *JST (Jurnal Sains Dan Teknologi)*, *11*(1), 223-228. https://doi.org/10.23887/jstundiksha.v11i1.45285

Sugiyono. (2016). *Metode Riset Kualitatif, Kuantitatif, R & D*. Bandung: Alfabeta.

Surahman, Z. M., Hanningtyas, I., Aristi, D., Cahyaningrum, F., & Laelasari, E. (2019). Factors Related to the Presence of Formaldehyde in the Salted Fish Trade in Ciputat, Indonesia. *Malaysian Journal of Medicine and Health Sciences*, 15(3).

Suryadi, H., Kurniadi, M., & Melanie, Y. (2010). Analisis Formalin dalam Sampel Ikan dan Udang Segar dari Pasar Muara Angke. *Pharmaceutical Sciences and Research*, *7*(3), 16-31. https://doi.org/10.7454/psr.v7i3.3458

Susanti, L., Zuki, M., & Syaputra, F. (2011). Pembuatan Mie Basah Berkalsium dengan Penambahan Tulang Ikan Tenggiri (*Somberomorus lineolatus*). *Jurnal Agroindustri*, *1*(1), 35–44. https://doi.org/10.31186/j.agroind.1.1.35-44

Suseno, S. H., Suman, A., & Al Fanany, F. (2006). Kandungan Gizi dan Potensi Antibakteri Ikan Laut Dalam di Selatan Jawa. *Jurnal Perikanan Universitas Gadjah Mada*, *8*(1), 57–67.

Werner, J., Zgoła-Grześkowiak, A., & Grześkowiak, T. (2022). Deep Eutectic Solvent-Based Coating Sorbent for Preconcentration of Formaldehyde by Thin-Film Solid-Phase Microextraction Technique. *Processes*, *10*(5), 1-14. https://doi.org/10.3390/pr10050828

Widyanti, W., Haryati, S., & Sudjatinah, M. (2021). Pengaruh Berbagai Jenis Ikan Laut terhadap Karakteristik dan Sensori Bakso Ikan. *Jurnal Mahasiswa, Food Technology and Agricultural Product*, 1–8.

Yulianti, C. H., & Safira, A. N. (2020). Analisis Kandungan Formalin pada Mie Basah Menggunakan Nash dengan Metode Spektrofotometri UV-Vis. *Journal of Pharmacy and Science*, *5*(1), 7–14. https://doi.org/10.53342/pharmasci.v5i1.156

Yuliantini, A., Sakiba, L., & Andriatna, W. (2019). Analisis Kadar Formalin dalam Daging Ayam dan Ikan Menggunakan Metode Kolorimetri. *Jurnal Mitra Kesehatan*, *1*(2), 113–119. https://doi.org/10.47522/jmk.v1i2.21