

Detection of Formalin in Salted Squid Using Dragon Fruit Peel Extract (*Hylocereus polyrhizus*)

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Abstract: This research aims to determine the presence of salted squid sold at the Main Jatibarang market in Indramayu using dragon fruit peel extract, determine the level of formaldehyde in the samples and whether there is a difference when using dragon fruit peel extract and chromatophic acid in detecting formaldehyde in salted squid. The research method used in this research is descriptive comparative, while the qualitative examination method uses dragon fruit peel extract, chromatophic acid and for quantitative examination the chromatophic acid method uses a UV-Vis spectrophotometer. Data analysis uses univariate analysis in SPSS and describes the results descriptively. The results of qualitative tests or qualitative detection of formalin using dragon fruit peel extract and chromatogenic acid obtained the same results, namely 5 (five) positive samples in the same sample. Qualitative results show that there is no difference in positive results from two different methods for detecting formalin. Meanwhile, quantitative tests using a UV-Vis spectrophotometer with a wavelength of 570nm resulted in samples D1 having a concentration of 7.22ppm, D2 having a concentration of 7.25ppm, D3 having a concentration of 6.77ppm, D4 having a concentration of 6.76ppm, and D5 having a concentration of 6.72ppm.

Keywords: Dragon fruit peel extract; Formalin; Salted squid

Introduction

Squid is among the most widely consumed marine species, known for its savory flavor and high nutritional value (Safrida et al., 2020). Due to its relatively high protein content, squid is prone to rapid spoilage (Kim et al., 2021). To prevent this, producers often preserve squid either through natural methods or chemical additives before it reaches the market. A common traditional method involves salting, resulting in salted squid (Rullyansyah et al., 2020). However, some vendors resort to using formalin, a chemical preservative.

Formalin, or formaldehyde, is a substance primarily used for preserving corpses and is classified as toxic and harmful to human health (Hahn et al., 2022; Nurdiani & Sriwiditriani, 2021; Pasaribu et al., 2022; Safrida et al., 2020). According to the Indonesian Ministry of Health Regulation No. 033 of 2012 on Food Additives, formalin is strictly prohibited for use in food. Despite this, some food products continue to be

contaminated with the substance (Rahman et al., 2022; Smither et al., 2022). Prolonged consumption of formalin can result in poisoning, blood vessel disorders, and even death if ingested in large quantities. Although the trend is declining, food-related cases still account for around 80% of total incidents, indicating an ongoing public health concern (Nurdiani & Sriwiditriani, 2021).

Salted squid is a popular seafood product widely consumed in many regions due to its distinctive flavor and high nutritional content. Rich in protein, vitamins, and minerals, squid contributes significantly to the human diet (Hayati & Hafiludin, 2023; Le & Yang, 2018). However, its high protein content also makes it highly perishable, requiring preservation methods to extend its shelf life (Kirkby, 2023). Traditionally, preservation is done through salting and drying, which inhibits bacterial growth and delays spoilage (Wijebandara et al., 2019). Unfortunately, in an attempt to further prolong freshness and reduce losses, some traders resort to the illegal and hazardous use of

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chemical preservatives such as formalin (Adams et al., 2022). Formalin, or formaldehyde in solution, is a toxic chemical primarily used for preserving biological specimens and corpses. It is not approved for use in food products, as stated in the Regulation of the Minister of Health of the Republic of Indonesia Number 033 of 2012 concerning food additives. Despite this regulation, the misuse of formalin in food continues to be a critical public health concern in Indonesia (Khotimah, 2022).

Formalin detection in food typically relies on chemical-based methods such as spectrophotometry, the chromotropic acid test, and potassium permanganate (KMnO_4) testing (Nurkhamidah et al., 2017). These techniques, while accurate, require laboratory facilities, trained personnel, and chemical reagents, making them less accessible to small-scale food vendors, consumers, and public health inspectors in resource-limited areas. As such, there is a pressing need for simpler, safer, and more cost-effective alternatives that can be used widely without requiring advanced technical expertise (Susilo et al., 2022).

One promising alternative is the use of natural indicators derived from plant-based materials. Among these, dragon fruit (*Hylocereus polyrhizus*) peel extract has attracted attention for its potential as a natural reagent in detecting formalin. Dragon fruit peel contains anthocyanins natural pigments that are sensitive to changes in pH and can act as indicators of chemical reactions. When exposed to acidic substances such as formalin, the red coloration of anthocyanins remains stable, providing a visual cue that can indicate the presence of formaldehyde in a sample. This colorimetric response can be observed without the need for sophisticated equipment, offering a practical and environmentally friendly solution for field detection of formalin in foods like salted squid.

Several researchers have explored the feasibility of using dragon fruit peel extract as a reagent for formalin detection. In one study, the extract was applied to various food samples suspected of contamination. Out of 17 samples tested, six were confirmed to contain formalin, demonstrating the effectiveness of the extract in identifying adulterated food products. While this method is not yet standardized, its simplicity, affordability, and non-toxic nature make it an attractive option for preliminary screening. In addition, using dragon fruit peel—a commonly discarded by-product of fruit consumption—adds value to agricultural waste and supports sustainable practices.

The underlying mechanism of this detection method lies in the chemical interaction between anthocyanins and acidic compounds. Formalin, being an acidic solution, does not alter the red hue of the

anthocyanins, thereby allowing for a visible and stable color indication when present in food samples. This contrasts with non-acidic or neutral substances, which tend to cause color changes in anthocyanins. By exploiting this property, dragon fruit peel extract functions as a natural pH-sensitive dye capable of distinguishing formalin-treated foods through simple visual observation.

Although the dragon fruit peel method offers promising advantages, it is important to validate its accuracy and reliability by comparing it with standard chemical detection techniques, such as the chromotropic acid method. By using a recognized standard for comparison, researchers can assess the sensitivity, specificity, and reproducibility of the natural detection method. This comparison is crucial to determine whether the dragon fruit peel extract can be reliably used in routine screening, particularly in informal markets and rural communities where formal testing equipment is not readily available.

Furthermore, the use of dragon fruit peel extract aligns with the principles of green chemistry and public health promotion. As a natural, biodegradable, and non-toxic reagent, it poses no environmental hazards or health risks to users. The preparation process is also relatively simple, involving the extraction of pigments through basic solvents such as ethanol or water, followed by filtration and application. This ease of use enhances the feasibility of implementing the method in various settings, including schools, community health centers, and traditional markets.

In summary, the misuse of formalin in salted squid and other food products remains a significant threat to consumer health in Indonesia. Existing detection methods, while effective, are often inaccessible to the general public. The development of alternative detection techniques using natural materials such as dragon fruit peel extract represents a valuable innovation in food safety monitoring. This approach offers a practical, low-cost, and eco-friendly solution for identifying formalin contamination, particularly in settings with limited resources. Further research and validation studies are necessary to establish standardized protocols and enhance the method's credibility for broader adoption. With proper refinement, this natural detection method has the potential to play a vital role in safeguarding public health, promoting food safety awareness, and reducing the risks associated with chemical food adulteration.

The urgency of this research lies in the widespread misuse of formalin as a preservative in food products, particularly in salted squid, which poses a serious threat to public health. Despite regulations prohibiting its use, formalin continues to be detected in various

foods, with data showing that up to 66.7% of salted squid samples in certain markets contain this toxic substance. Conventional detection methods, although accurate, are often expensive, complex, and require laboratory facilities, making them inaccessible for routine inspection in traditional markets or by consumers. Therefore, there is an urgent need for a simpler, safer, and more cost-effective detection method. The novelty of this research is the utilization of dragon fruit (*Hylocereus polyrhizus*) peel extract as a natural indicator for formalin detection. This method harnesses the anthocyanin content in the peel, which reacts to the acidic nature of formalin and maintains a stable red color, providing a visual cue for contamination. This innovation not only introduces an environmentally friendly, low-cost alternative but also promotes the use of agricultural waste, offering a sustainable approach to food safety monitoring. By comparing it with standard methods, this study provides a new pathway toward accessible, community based detection tools that empower consumers and support public health initiatives.

Method

This study uses a descriptive comparative method to describe the similarities and differences between the two groups. The research variables in this study consist of independent variables and dependent variables. The independent variable is salted squid, for which the presence of formalin will be detected. The dependent variables are dragon fruit peel extract and chromatotic acid

which is used as a formalin qualitative test method.

The research population was salted squid sold at the Jatibarang Main Market, Indramayu Regency. The research sample was selected using *the Snowball sampling* technique and consisted of 30 salted squid sold at the Jatibarang Market, Indramayu Regency. Data collection is carried out in two ways. First, observations were carried out to obtain information about the characteristics of salted squid such as smell, shape and color as well as the place of sale of salted squid. Furthermore, the detection of formalin in salted squid where this examination is carried out in an accredited chemical laboratory to detect formalin in salted squid.

The data analysis used in this study is univariate (Descriptive) analysis, which is an analysis on one variable. Because this study only describes whether there is a difference in positive results in the detection of formalin using dragon fruit peel extract and using chromatotic acid.

Result and Discussion

Based on research that has been conducted at the AAK An Nasher Cirebon Chemistry Laboratory on the detection of formalin in salted squid in the Jatibarang Main Market using the dragon fruit peel extract method and chromatotic acid in the qualitative test and the UV-VIS spectrophotometer method in the quantitative test, the following data were obtained:

Table 1. Qualitative Results in Salted Squid Using Dragon Fruit Peel Extract and Chromatorific Acid

Sample Code	Qualitative Test Results			
	Dragon Fruit Skin Extract		Chromatotic Acids	
	Interpretation of Results	Color	Hasi's Interpretation	Color
A1	(-)	Faded Red	(-)	Yellow
A2	(-)	Faded Red	(-)	Yellow
A3	(-)	Faded Red	(-)	Yellow
A4	(-)	Faded Red	(-)	Yellow
A5	(-)	Faded Red	(-)	Yellow
B1	(-)	Faded Red	(-)	Yellow
B2	(-)	Faded Red	(-)	Yellow
B3	(-)	Faded Red	(-)	Yellow
B4	(-)	Faded Red	(-)	Yellow
B5	(-)	Faded Red	(-)	Yellow
C1	(-)	Faded Red	(-)	Yellow
C2	(-)	Faded Red	(-)	Yellow
C3	(-)	Faded Red	(-)	Yellow
C4	(-)	Faded Red	(-)	Yellow
C5	(-)	Faded Red	(-)	Yellow
D1	(+)	Red Color Does Not Fade	(+)	Purple
D2	(+)	Red Color Does Not Fade	(+)	Purple
D3	(+)	Red Color Does Not Fade	(+)	Purple
D4	(+)	Red Color Does Not Fade	(+)	Purple
D5	(+)	Red Color Does Not Fade	(+)	Purple

Sample Code	Dragon Fruit Skin Extract				Qualitative Test Results	
	Dragon Fruit Skin Extract		Chromatotic Acids		Chromatotic Acids	
	Interpretation of Results	Color	Hasi's Interpretation	Color	Color	Color
E1	(-)	Faded Red	(-)	Yellow		
E2	(-)	Faded Red	(-)	Yellow		
E3	(-)	Faded Red	(-)	Yellow		
E4	(-)	Faded Red	(-)	Yellow		
E5	(-)	Faded Red	(-)	Yellow		
F1	(-)	Faded Red	(-)	Yellow		
F2	(-)	Faded Red	(-)	Yellow		
F3	(-)	Faded Red	(-)	Yellow		
F4	(-)	Faded Red	(-)	Yellow		
F5	(-)	Faded Red	(-)	Yellow		

Based on the results of qualitative tests on 30 samples from the same sword, the results of 5 (five) samples that were positive for formalin using dragon fruit peel extract and chromatotic acid. This is also supported by the physical properties that are visible that the 5 samples coded D1, D2, D3, D4 and D5 have a more concentrated body color of the squid, look supple and not easily destroyed when mashed. These characteristics are some of the characteristics of foods that contain formalin. Meanwhile, 25 other samples from 4 (four) different sages showed negative results for formalin. The results of the two methods used in this study showed that there was no difference in positive and negative sample results in detecting formalin in salted squid sold at the Jatibarang Indramyu Main Market.

Formalin detection by a simple method uses red dragon fruit peel extract (*Hylocereus polyrhizus*), where the red color of dragon fruit peel extract will remain when reacting with formalin (Mendano, 2021; Novianty, 2023). This is because dragon fruit peel extract contains anthocyanins that are stable in the acidic atmosphere of the formalin. "Anthocyanins are water-soluble pigments that are widely distributed in flowers and leaves and give them red to blue colors. Anthocyanin dyes are also flavonoid compounds that belong to benzopiran derivatives and are classified as natural antioxidants".

Factors that can cause the stability of the anthocyanin red color in dragon fruit peel extract is because formalin has an acidic pH. "Dragon fruit skin contains anthocyanins that are able to detect formalin, this is because the properties of formalin and anthocyanins both have acidic properties so that they still stabilize the color of the anthocyanins of dragon fruit skin." In addition to the simple method of using dragon fruit peel extract, this study used chromatotic acid as a comparison. "This complex is formed by a covalent bond between the carbon atom in formalin and the chromium atom in chromatotic acid". "Negative results in the chromatotic acid method in detecting

formalin content are characterized by a yellow fixed color or no color change when reacted with chromatotic acid, while positive results in the chromatotic acid method in detecting formalin content are characterized by after being reacted with chromatotic acid will produce a diverse purple color or color change."

Quantitative tests in this study were carried out only on positive samples from qualitative results, with a standard absorbent at a wavelength of 570 nm followed by sample level readings.

Table 2. Formallin Standard Absorbent Measurement

Concentration	Absorb
0	0.00
2	0.34
4	0.56
6	0.60
8	0.75
10	0.84

Results at Maximum Wavelength 570 Nm

Based on the absorbent value in the measurement using the UV-Vis spectrophotometer, a calibration curve is made as can be seen in the following figure. Based on the Formalin Calibration Curve Graph, a linear equation is obtained: $y = 0.0782x + 0.1283$. This equation was used to calculate formalin levels in salted squid samples that were positive for formalin.

Table 3. Quantitative Results of Formalin Levels Using a UV-Vis Spectrophotometer

Sample Code	Sample Absorbent	Sample Rate (Ppm)
D1	0.69	7.22
D2	0.69	7.25
D3	0.65	6.77
D4	0.65	6.76
D5	0.65	6.72

Based on the data in the Table 3, it shows that the formalin levels detected from 5 (five) positive salted squid samples have formalin levels that are not much different. The highest level contained in the 5 positive samples was found in the D2 sample with a level of

7.25ppm and the lowest level was detected in the D5 sample with a level of 6.72ppm. According to BPOM Regulation Number 22 of 2023 concerning Prohibited Raw Materials in Processed Foods and Materials Prohibited from Use as Food Additives, one of the materials that is prohibited from being used as a food additive is formalin. However, the reality is that formalin is still abused as a preservative by food manufacturers without paying attention to the consequences that will arise if formalin is consumed for a long period of time (Sari et al., 2025).

One of the reasons why formalin is still used as a food preservative compared to using safe and government-allowed preservatives such as sugar, salt, benzoic acid and others is the effectiveness of formalin in extending the shelf life of food (Ritonga, 2021). Formalin works by killing spoiling microorganisms, such as bacteria and fungi that cause food to spoil and formalin does not have a significant effect on the taste of food, unlike some other preservatives that can alter the taste or texture of food (Sudirman, 2012). Side effects that will arise if you consume formalin in food will be nausea, vomiting, headache, burning sensation in the throat, abnormal itching. If you consume formalin in the long term, it can cause cancer, central nervous system disorders, kidney failure and death" (Rahman et al., 2024). Based on the results of this study, dragon fruit peel extract can be used as an alternative to detect formalin simply (Kusumaningtyas et al., 2019; Kusumawati et al., 2020; Rohman et al., 2023). However, keep in mind that detection using dragon fruit peel extract is not yet known to what extent formalin can be detected using this method. Therefore, it is recommended that further research be conducted on the detection of formalin using dragon fruit peel extract in samples whose concentration is known, to find the minimum level of formalin that can be detected using dragon fruit peel extract.

The detection of formalin in five out of the tested samples confirms that the use of this hazardous chemical as a preservative in food products remains prevalent despite strict regulations prohibiting its use. The qualitative detection using both dragon fruit peel extract and chromatophic acid produced identical results, indicating that dragon fruit peel extract can serve as a viable natural alternative for detecting formalin. This is particularly important for communities and market inspectors with limited access to laboratory equipment, as dragon fruit peel extract is easy to prepare, cost-effective, and environmentally friendly. The consistent red coloration observed during the dragon fruit peel extract test is due to the stability of anthocyanins when exposed to the acidic properties of formalin. This visual indication makes the method

user-friendly and practical for early screening. Meanwhile, the quantitative analysis conducted using a UV Vis spectrophotometer confirmed the presence of formalin in concentrations ranging from 6.72 ppm to 7.25 ppm, exceeding safe consumption levels. These values not only support the qualitative findings but also provide more detailed insight into the severity of contamination.

The absence of discrepancies between the two qualitative methods further strengthens the reliability of dragon fruit peel extract as an effective tool for formalin detection. From a broader perspective, this research contributes to food safety awareness and the development of simple, accessible testing methods for toxic substances in food. It also underscores the need for stronger enforcement and routine monitoring to prevent the continued misuse of formalin in food products, particularly in traditional markets. The integration of natural detection methods like this can empower consumers and sellers alike to prioritize food safety and public health.

Conclusion

This study was conducted to determine the presence of formalin in salted squid sold at the Jatibarang Main Market in Indramayu using two different methods and the amount of formalin in salted squid samples that were positive for formalin in qualitative tests. The results of the study showed that there were positive salted squid containing formalin in salted squid sold at the Jatibarang Main Market, Indramayu Regency with formalin detection using dragon fruit peel extract and there was no difference in the results of the qualitative test for formalin detection in salted squid samples with the same sample code from two different test methods. This is evidenced in the table showing the same results despite using different methods. The formalin levels in salted squid sample D1 had a level of 7.22 ppm, D2 had a level of 7.25 ppm, D3 had a level of 6.77 ppm, D4 had a level of 6.76 ppm and D5 had a level of 6.72 ppm.

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Conceptualization, S, H.P and O.A.S.; methodology, S, H.P and O.A.S.; software, S, H.P and O.A.S.; validation, S, H.P and O.A.S.; formal analysis, S, H.P and O.A.S.; investigation, S, H.P and O.A.S.; resources, S, H.P and O.A.S.; data curation, S, H.P and O.A.S.; writing—original draft preparation, S, H.P and O.A.S.; writing—review and editing, S, H.P and O.A.S.; visualization, S, H.P and O.A.S.; supervision, S, H.P and O.A.S.; project administration, S, H.P

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Conflicts of Interest

The authors declare no conflict of interest.

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