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Anthocyanins from Agro-waste as Time-Temperature Indicator to Monitor Freshness of Fish Products

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ABSTRACT

Fish products perish easily due to microbial contamination. Uncontrolled thawing will increase the rate of microbial activity at every 10°C increase in temperature. One of indicator that can detect food quality is the time-temperature indicator (TTI) with changes in pH. However, these indicators are generally made of synthetic chemicals which tend to pollute the environment. This study aimed to summarize various studies on anthocyanins from agro-waste as time-temperature indicator to monitor freshness of fish products. This research used systematic literature review (SLR) from various relevant research and resources. The SLR process includes practical screening, quality appraisal, synthesizing, and reviewing. Anthocyanins derived from agro-waste than can be developed into TTI are purple yam peel, black plums peel, blueberries peel, rambutan peel, sweet potato peel, dragon fruit peel. The TTI from agro-waste anthocyanins can be developed to monitor freshness of fish products.

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1. INTRODUCTION

Fish products perish easily due to microbial contamination (Rawat, 2016). About 6-10% of the world's total fish production is inedible due to rot during improper storage and distribution processes (Arvanitoyannis and Kassaveti, 2008). Uncontrolled thawing will increase the rate of microbial activity at every 10°C increase in temperature (Roiha *et al.,* 2018). Spoilage bacteria degrade fish protein into alkaline compounds which increase the acidity (pH) of fish, making it inedible (Omafuvbe *et al.,* 2000). Therefore, it is necessary to conduct a study to maintain quality of fish products by developing indicators.

One indicator that can detect food quality is the temperature time indicator or TTI with changes in pH (Zhai *et al.,* 2018; Shi *et al*., 2021a; Shi *et al*., 2021b). Fish protein decomposition in fish will release volatile compounds such as trimethylamine which is reactive to natural pH indicators (Kang *et al.,* 2018). The main principle of acid-based TTI is to detect changes in pH by displaying a gradual color change because of an irreversible chemical reaction (Bobelyn *et al.,* 2006). However, these indicators are generally made of synthetic chemicals which tend to pollute the environment (Syahirah *et al.,* 2018).

Current research has proven that natural anthocyanin pigments can be used as pH indicators since their sensitivity to pH changes that lead to color changes (Pakolpakçıl *et al.,* 2021). However, the anthocyanins used usually come from staple foods such as sweet potatoes, dragon fruit, and red cabbage. Therefore, this study aimed to summarize various studies on anthocyanins from agro-waste as time-temperature indicator to monitor freshness of fish products.

2. METHODS

This research used systematic literature review (SLR) from various relevant research and resources. The SLR process includes practical screening, quality appraisal, synthesizing, and reviewing (Peffers *et al.,* 2007). **Figure 1** describing the method of collecting data research from google scholar.

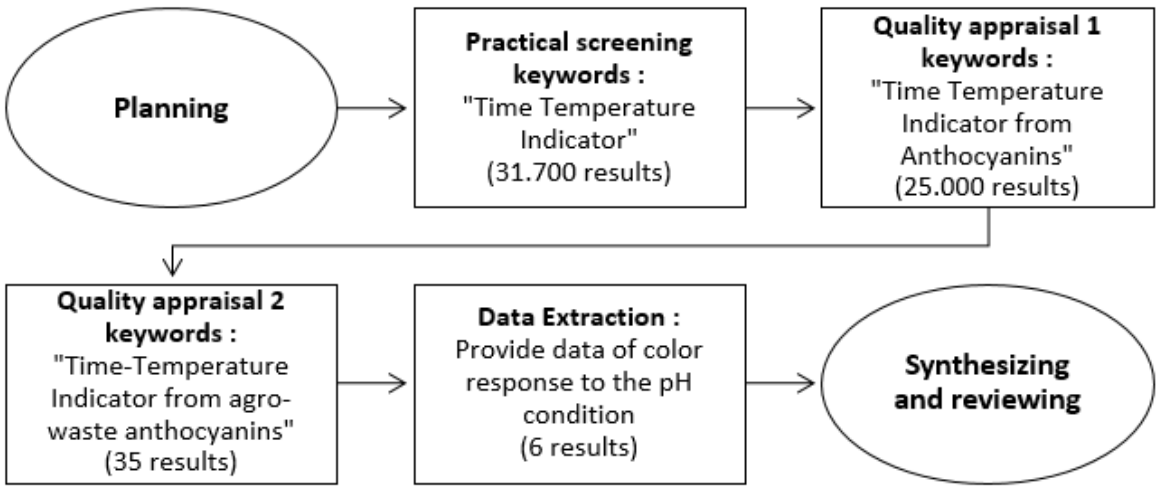

Figure 1. Method and process of SLR used.

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3. RESULTS AND DISCUSSION

3.1. ANTOCYANINS FROM AGRO-WASTE

Anthocyanins are naturally found in plants, fruits, and vegetables in the form of water-soluble pigments (Arruda *et al.,* 2021). Anthocyanins consist of several conjugated phenolic rings. When the pH changes, the protonation and deprotonation of the hydroxyl groups along the phenolic rings of the anthocyanin molecule change the conjugation pattern across the molecule causing the color change (Khoo *et al.,* 2017). In general, anthocyanins can give a blue, red, or purple color. Therefore, anthocyanins may also be found in parts that are not eaten, such as fruit skins.

3.2. ANTHOCYANINS FROM AGRO-WASTE AS TIME-TEMPERATURE INDICATORS TO MONITOR FRESHNESS OF FISH PRODUCT

Fish products potentially contaminated at temperatures above 10°C by the bacteria *Vibrio Parahaemolyticus, Escherichia coli, Aeromonas, Salmonella, Staphylococcus, Clostridium botulinum*, and others (Novotny *et al.,* 2004). Damage to fish is characterized by the formation of trimethylamine (TMA) from the reduction of trimethylamine oxide (TMAO). The breakdown of protein by bacteria will release volatile compounds such as trimethylamine. pH <7.6 indicates fresh quality, pH 7.6 - 7.9 indicates edible but not number one quality, and pH> 7.9 indicates rotten value.

By knowing these parameters, anthocyanins can act as a Time-Temperature Indicator to detect changes in pH by displaying a gradual color change because of an irreversible chemical reaction (Bobelyn *et al.,* 2006). **Table 1** summarizes some agricultural limes that contain anthocyanins and have the potential to be used as indicators of fish freshness.

Table 1. Response of anthocyanins fom agro-waste to different pH condition.

No.	1.	2.	3.	4.	5.	6.
Source of Anthocyanin	**Purple yam peel *(Dioscorea alata L)***	**Black plums peel *(Syzygium cumini)***	**Blueberries peel *(Cyanococcus)***	**Rambutan Peel *(Nephelium lappaceum L.)***	**Sweet potato peel *(Ipomoea batatas L.)***	**Dragon fruit peel *(Selenicereus undatus)***
Type of Anthocyanin	cyanidin-3-glucoside	cyanidin-3-glucoside	cyanidin-3-glucoside	cyaniding-3-glucoside	peonidin-3-glucoside	betacyanin
Total Anthocyanin Content	155 mg/L	23.3g/100g fresh weight	300 mg/L	39.27 mg/L	6.93 mg/L	0.85 mg/100 g fresh weight
Response on different pH **1**		No Data	No Data	No Data		No Data
2				No Data		
3				No Data		No Data
4						
5				No Data		No Data
6				No Data		
7						No Data
8				No Data		

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No.	1.	2.	3.	4.	5.	6.
Source of Anthocyanin	**Purple yam peel *(Dioscorea alata L)***	**Black plums peel *(Syzygium cumini)***	**Blueberries peel *(Cyanococcus)***	**Rambutan Peel *(Nephelium lappaceum L.)***	**Sweet potato peel *(Ipomoea batatas L.)***	**Dragon fruit peel *(Selenicereus undatus)***
9						No Data
10				No Data		
11			No Data	No Data		No Data
12			No Data	No Data		No Data
13	No Data		No Data	No Data		No Data
14	No Data	No Data	No Data	No Data	No Data	No Data
Reference	(Aquino & Morales, 2021)	(Sun *et al.*, 2021)	(Bilgiç *et al.*, 2019)	(Jing *et al.*, 2012)	(Capello *et al.*, 2020)	(Apriliyanti *et al.*, 2018)

4. CONCLUSION

Time-Temperature Indicator (TTI) can be made from agro-waste anthocyanins. Agro-waste than can be developed into TTI are purple yam peel, black plums peel, blueberries peel, rambutan peel, sweet potato peel, dragon fruit peel. The TTI from agro-waste anthocyanins can be developed to monitor freshness of fish products.

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5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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