ASEAN Journal of Chemical Engineering 2024, Vol. 24, No. 1, 65 – 78

Pigment Extraction Method for Anthocyanin Natural Resources in Indonesia: A Review

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Submitted 6 February 2024 *Revised* 19 March 2024 *Accepted* 26 March 2024

Abstract. Anthocyanin is the pigment that still attracts attention from food industries because of its abundance in Indonesian plants. Anthocyanins are produced in a variety of colors with unique stability properties. Through a systematic review, this review studied 40 scientific reports conducted in Indonesia over the last 10 years. The research objects included fruits, flowers, seeds, peels, and roots from the islands of Java, Sumatra, Kalimantan, Sulawesi, and Nusa Tenggara. Several methods are used to extract solvent-based anthocyanin compounds, including maceration, microwave, and reflux-soxhlet extraction. Microwave extraction, including ultrasonic extraction, is recommended for anthocyanin extraction. Spectrophotometry with the pH differential method was chosen as the anthocyanin quantification procedure, using 500 and 700 nm wavelenghts.

Keywords: Anthocyanin, Extraction, Indonesian Flora

INTRODUCTION

Indonesia is one of the countries with the greatest biodiversity in the world. Its natural wealth is marked by the abundance of ecosystems and biological genes spread throughout the province (Agus, 2020). Horticultural crops, plantation crops, fiber crops, sugar-producing plants, oil-producing plants, and fodder plants are types of plants cultivated in Indonesia (Widyowati & Agil, 2018). In addition to chlorophylls and carotenoids, several of these plants are reported to contain anthocyanins with many health benefits. The properties of anthocyanins are often associated with their functionalities as antioxidants and anti-inflammatories. The current research used anthocyanins as a therapy for cardiovascular disease and cancer (Pojer *et al.*, 2013). Consuming anthocyanins through food will positively impact the body, stopping the chain reaction in forming free radicals (Kostka *et al.*, 2020).

Anthocyanins are colored organic chemical compounds that are classified in the phenolic group. This compound gives a range of orange, red, blue, purple, and black colors in most flora (Fatonah *et al.*, 2016). Anthocyanins are often found in groups of fruits, vegetables, flowers, and tubers, such as berries, grapes, beets, red cabbage, shallots,

DOI: 10.22146/ajche.12097

butterfly pea flowers, purple sweet potatoes, and many others (Khoo *et al.*, 2017). They are completely non-toxic to humans and can be used as natural colorants for various applications due to their soluble nature in aqueous media compared the other, such as carotenoids (Mazza, 2007).

Anthocyanins have been studied as belonging to the benzopyrene family, with the main structure having two benzene rings connected to three carbon atoms (Charlton *et al.*, 2023). Often, they are found as glycosides and polymethoxy derivatives, which can be distinguished from one anthocyanin type from another based on the number of hydroxyl and methoxyl groups in the B-ring, the number of attached sugars, and the aliphatic acid. Initially, this compound consisted of 200 types of anthocyanins (Małgorzata, 2017). The number then increased to 539 types of anthocyanins that had been collected. From the variety of anthocyanins, researchers grouped them into six main types of anthocyanin, as stated in Figure 1 (Khoo *et al.*, 2017).

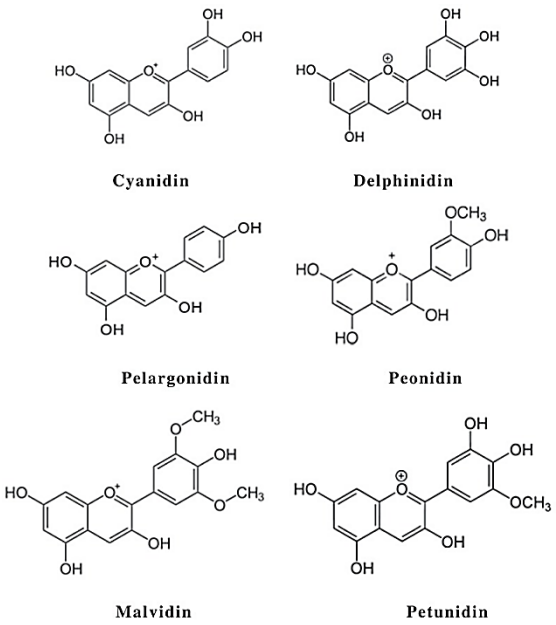

Fig. 1: Six main types of anthocyanin (Khoo *et al.*, 2017)

The difference in anthocyanin structure triggers a difference in the stability of the compound against external factors, mainly pH (Laleh *et al.*, 2006). Each anthocyanin compound will adapt (due to the deprotonation of the flavylium cation) based on the difference in the acidity factor, which affects the color appearance of the compound in the aqueous media (Purwaniati *et al.*, 2020). If anthocyanin is in an acidic environment, it will generally appear red. The purple color will be produced when the anthocyanin is in a neutral pH environment. If anthocyanin is acidic, it will generally turn blue (Khoo *et al.*, 2017). It is a unique claim of anthocyanin compounds as candidates for natural colorants that can be more widely applied to food products than other colorant compounds.

On the other hand, this compound is also sensitive to degradation reactions caused by increasing temperatures (Castañeda-Ovando *et al.*, 2009). This degradation causes anthocyanins to change color to brown. The presence of environmental temperature conditions of 35 °C has been shown to reduce the proportion of total anthocyanins in grapes, which is the object of research (Mori *et al.*, 2007). Anthocyanin instability can limit the extraction methodology of anthocyanins from target natural resources.

Research on anthocyanin extraction has been carried out using various methods and sources of anthocyanins as raw materials. In Indonesia itself, reviews regarding anthocyanins have never been discussed. This review summarises anthocyanin investigations, emphasizing important information regarding sources of anthocyanins, especially in plants often found in Indonesia, extraction methods, and the products obtained. Through this literature search, it is desired that it be used as a

reference for other researchers who are utilizing sources of anthocyanins, often found in Indonesia. The data presented in this review serve as a reference for prospective future research.

METHOD

The set of research is a literature review conducted by library research. All information was obtained from secondary data cited on official scientific publication websites such as PubMed and Google Scholar. The journal used as a reference was determined based on a report that displays anthocyanin extraction procedures from various plants in Indonesia. The data was supported by scientific publications on anthocyanins published by other world researchers. The publication date range was limited from 2012 to 2022 to know the development of anthocyanin studies, which have been rife in the last decade. This research method leads to a systematic review to collect, identify, and evaluate several insights into the sources and process of each anthocyanin extraction process. The acquirement of extraction yield would be highlighted.

RESULTS AND DISCUSSION

Origins of Anthocyanins in Indonesian Plants

This study reviewed 40 published reports on anthocyanin assemblies conducted in Indonesia in the last decades. Data about anthocyanin sources, extraction procedures, and reported results are acquired. All of them are summarized in Table 1 to Table 3. From the 40 local references obtained, it is known that the Indonesian researchers used natural sources of materials from various locations in Nusantara. Based on Figure 2, natural resources of anthocyanins were studied from the islands of Java (14 references), Sumatra (5 references), Kalimantan (3 references), Sulawesi (1 reference), and Nusa Tenggara (1 reference), after reviewing every raw material acquisition information from each reference. The other reports still need to state the location of the anthocyanin-resources specifically.

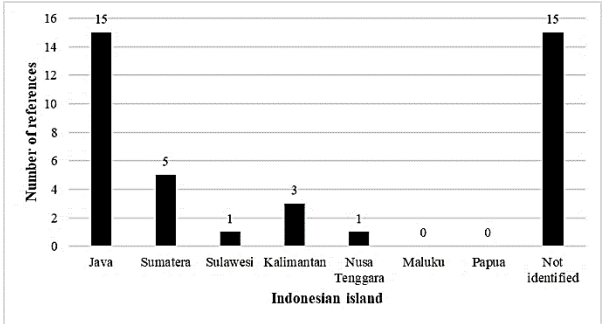

Fig. 2: Location of anthocyanin-producing resources that have been studied in Indonesia in the last 10 years

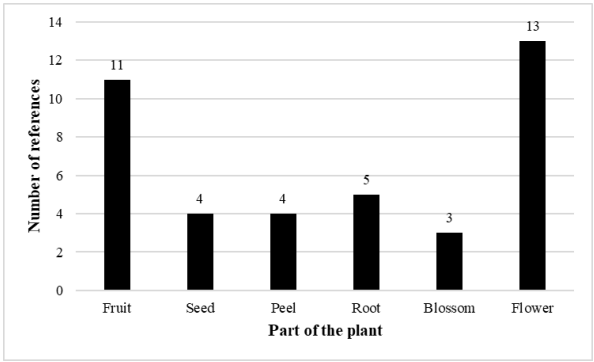

Fig. 3: The object of the anthocyanin-producing plant studied in Indonesia in the last 10 years.

The plant objects that have been the focus of the studies have been summarized. In general, anthocyanins were obtained from flowering plants (13 references), fruit (11 references), roots (5 references), peels and seeds (each 4 references), and blossom (3 references; specific for banana plants). Figure 3 shows the comparison chart from the part of the plant used for extraction. In scientific

journals, most resources own a purplish-red color. Flowers are the part of the plant that tends to be studied more in terms of anthocyanin content, followed by the fruit, root, and others.

Indonesian Anthocyanin Extraction Method

Figure 4 summarizes the extraction methods used by the researchers in the last ten decades of research reports observed. Overall, the researchers used solvent-based extraction methods to extract anthocyanins. Solvent extraction occurs to move the compound from one medium to another. Solvent extraction becomes effective when the target compound and the solvent have the same solubility or dielectric coefficient, so the distribution between the two materials is in balance (Zhang *et al.*, 2018). From the 40 references we found, we divided them into three groups of extraction methods: maceration (Table 1), Soxhlet-reflux (Table 2), and mechanical energy (Table 3).

Table 1 provides information specificially regarding the types of flora extracted using the maceration method. In general, it is known that fruit and flowers are parts of the plant that provide anthocyanin content in large quantities compared to other types of plants. The maceration method is still the procedure used by most studies in the last 10 years. Maceration is one of the traditional and simplest extraction methods compared to other extraction methods, considering the no additional energy required. Most of the anthocyanin maceration techniques use alcohol and water as solvents. From Table 1, it is known that 96% ethanol is the optimum solvent for extracting anthocyanins. Alcohol and water solvents are "like dissolves like" to anthocyanins, given the polar structure of anthocyanins. Ethanol solvent is recommended because it is less toxic than other organic solvents (Bae *et al.*, 2017). No reports are stating the use of other common organic materials, such as acetone, as a solvent.

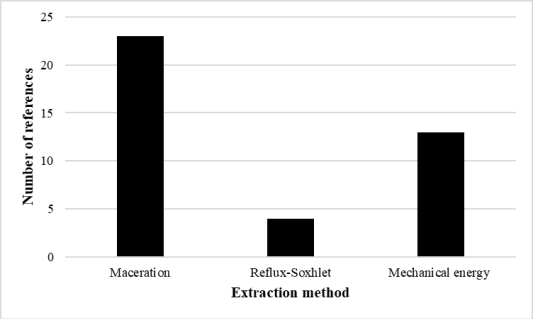

Fig. 4: The anthocyanin extraction method studied in Indonesia in the last 10 years.

Table 1. Summary of research publication reports related to anthocyanin extraction in Indonesian using the maceration method from 2012-2022

No	Object Sample	Origin	Solvent	Duration - Condition	Quantification Method	Anthocyanin content	Reference
1	Senggani fruit	Pemalang, Central Java	Main solvent: ethanol 70%, 80%, and 95%. Acid influences: hydrochloric acid 1%, citric acid 3%	24 hours	UV-Vis Spectrophotometer	The highest: ethanol 80%, cit. acid t 3% = 38.28 ± 2.88 mg/100 g	Kristiana *et al.* (2012)
2	Senggani fruit	Pontianak, West Kalimantan	Methanol with citric acid 3%, methanol with hydrochloric acid 1%,	-	UV-Vis Spectrophotometer	**Methanol with citric acid 3% = 0.880 mg/ L,** Methanol with hydrochloric acid	Fatonah *et al.* (2016)

No	Object Sample	Origin	Solvent	Duration - Condition	Quantification Method	Anthocyanin content	Reference
			Distilled water with Citric acid 3%, and Distilled water with Hydrochloric acid 1%. All rasio are 85:15.			1% 0.59 mg/L, distilled water with citric acid 3% = 0.14 mg/L, distilled water with hydrochloric acid 1% = 0.80 mg/L.	
3	Senduduk fruit	-	distilled water, ethanol, and citric acid (0%, 1%, 3%, 5% and 7%)	24 hours; 8 and 25 °C	UV-Vis Spectrophotometer	distilled water-ethanol with citric acid 1% = 13.22 mg/L	Tazar *et al.* (2018)
4	Purple eggplant	West Nusa Tenggara	ethanol 96%	7 days	UV-Vis Spectrophotometer	Anthocyanin crude = 13.41 %	Arifin *et al.* (2022)
5	Banana blossom	Wonoayu, East Java	ethanol 99,7% with hydrochloric acid 1%	6 and 24 hours	UV-Vis Spectrophotometer	0.063 – 0.119%.	Widyastutik *et al.* (2022)
6	Banana blossom	Batusangkar, West Sumatera	Ethanol, water, citric acid, acetic acid	-	UV-Vis Spectrophotometer	The highest = ethanol – acetic acid = 30.22 mg/L	Alvionita *et al.* (2016)
7	Red pitaya's peel	-	Distilled water, ethanol , ethyl acetate; citric acid 10%	1-3 days	UV-Vis Spectrophotometer	The highest = water – cit. acid 10% (1:6 ratio) with 3 days extraction time Yield = 62.68%	Lidya *et al.* (2014)
8	Black rice	Sleman, Yogyakarta	Ethanol 80% : citric acid 3% = 85 : 15 (v/v)	24 hours; 150 rpm of orbital shaker	UV-Vis Spectrophotometer	48.68 mg/g	Pasaribu *et al.* (2021)
9	Red dragon fruit peel	-	Distilled water, citric acid 2%,	2 x 24 hours (RTP)	UV-Vis Spectrophotometer	Yield = 45%.	Fathurahmi *et al.* (2022)
10	Beetroot	Jember, East java	Ethanol 70% with HCL 1%.	3 hours	UV-Vis Spectrophotometer	0.63 mg/400 g	Sari (2020)
11	Purple sweet potato	-	Ethanol 96 %	4,8,18, 24, and 30 hours.	UV-Vis Spectrophotometer	The highest level was obtained during maceration for 30 hours = 11.02 mg/L.	Armanzah & Hedrawati (2016)
12	Purple sweet potato	-	Methanol, acetic acid, water A1 = in ratio of 20 : 1 : 20; A2 = in ratio of 25 : 1 : 15 A3 = in ratio of 30 : 1 : 10	24 hours	UV-Vis Spectrophotometer	**A1 = 63.34 mg/100 g;** A2 = 39.53 mg/100 g; A3 = 34.40 mg/100 g.	Angelia (2019)
13	Purple sweet potato	-	1) Ethanol: glacial acetic acid: distilled water = 25:1:5 2) 1.5M HCl solvent in ethanol.	24 hours	UV-Vis Spectrophotometer	Maceration 1 =11.9 mg/L **Maceration 2 = 16.343 mg/L**	Zuri (2022)

No	Object Sample	Origin	Solvent	Duration - Condition	Quantification Method	Anthocyanin content	Reference
14	Purple sweet potato; Purple yam	Gowa, South Sulawesi	Ethanol 70%, 2.5 L with hydrochloric acid 1% 100 mL.	3 days (dark condition)	UV-Vis Spectrophotometer	**Purple sweet potato = 5.0 mg/100 g.** Purple yam = 1.6 mg/100 g	Utami *et al.* (2016)
15	Purple sweet potato	-	Ethanol, acetic acid, distilled water	3 minutes	UV-Vis Spectrophotometer	The highest is 51.47% wiith ethanol:acetic:water. ratio of 5:1:5	Fitriani (2017)
16	Telang flower	Neusu Banda Aceh.	ethanol with citric acid	120, 150, and 180 minutes.	UV-Vis Spectrophotometer	Yield = 2.8 to 5.5% with averages 4.12%. The highest content = at 180 minutes.	Husna *et al.* (2022)
17	Telang flower (Fresh, Dried, and as a Tea Product)	Dago, Bandung, West Java	Distilled water	15 minutes; 25, 50, and 80 °C.	UV-Vis Spectrophotometer	Fresh (25 °C) = 0.13 % ± 0.005 Fresh (50 °C) = 0.164% ± 0.005 **Fresh (80 ^{O}C) = 0.193 ± 0.003** Dried (25 °C) = 0.108 % ± 0.005 Dried (50 °C) = 0.136 % ± 0.008 **Dried (80 ^{O}C) = 0.149 % ± 0.006** As Tea (25 °C) = 0.124 % ± 0.006 As Tea (50 °C) = 0.129 % ± 0.002 **As Tea (80 ^{O}C) = 0.161 % ± 0.005**	Purwaniati *et al.* (2020)
18	Roselle flower	-	70% ethanol: citric acid (88:2 w/w), water: 70% ethanol: citric acid (50:44:2 w/w/b), water: ethanol (100:2 w/w)	-	UV-Vis Spectrophotometer	Anthocyanin levels in mg/100 g of material at various solvent conditions: Ethanol 70%-citric acid (88:2 b.b) = 781.78; Water:ethanol 70%:citric acid (50:44:2 w/w/w) = 883.87; Water: citric acid (100:2 w/w) = 578.75	Choiriyah (2017)
19	Rosella flower	Pontianak, West Kalimantan	Ethanol: citric acid = 1:10	24 hours (4°C)	UV-Vis Spectrophotometer	921.56 mg/l	Amperawati *et al.* (2019)
20	Red flower of 4 tropical shrubs: *Bougainvillea glabra; Jatropha integerrima; Melastoma malabathricum;*	Samarinda, East Kalimantan	Ethanol 96% with hydrochloric acid 1%		UV-Vis Spectrophotometer	in cyanidin-3-glucoside /100 g unit Eth. 96% + HCl 1% *M. philipica* = 12.68, *M. malabathricum* = 6.61, ***J. integerrima* = 15.83,** *B.glabra* = 11.70	Kuspradini *et al.* (2016)

No	Object Sample	Origin	Solvent	Duration - Condition	Quantification Method	Anthocyanin content	Reference
	and *Mussaenda philippica.*					Eth. 96% without acid *M.philipica* = not detected *M.malabathricum* = 30.42, ***J. integerrima* = 102.38,** *B.glabra* = 0.15	
21	Rose, Hibiscus, Rosella flower	-	Polar solvent	30 minutes; 10-20 °C	UV-Vis Spectrophotometer	hibiscus 0.38%; rosella 0.80%; rose 0.93%;	Sangadji *et al.* (2017)
22	Hibiscus flower	-	Distilled water – ethanol 60, 70, 80, 90, 96% (v/v)	24 hours (RTP)	UV-Vis Spectrophotometer	in mg/ 25 gr raw material Ethanol 60% = 42.44; Ethanol 70% = 45.79; Ethanol 80% = 46.35; Ethanol 90% = 47.98; **Ethanol 96% = 48.26.**	Agustin & Ismiyati (2015)
23	Banana blossom	Sumbang, Central Java	methanol with 1% hydrochloric acid	maceration = 24 hours	UV-Vis Spectrophotometer	87.31 mg/L	Widyapuri *et al.* (2022)

*The bold statement indicates a highest content of anthocyanin

Table 2. Summary of research publication reports related to anthocyanin extraction in Indonesian using the soxhlet-reflux method from 2012-2022

No	Object Sample	Origin	Solvent	Duration - Condition	Quantification Method	Anthocyanin content	Reference
Soxhlet							
1	*Syzygium cumini* (L.) fruit	Krueng Raya, Aceh	Ethanol	1-3 days – 60 °C (Soxhlet)	Based on collected volume	28 ml (soxhlet)	Zulfajri & Muttakin (2017)
2	Avocado seed	-	Methanol -distilled water 1:3 (v/v) with 3% of Hydrochloric acid	30, 60, 90, 120 minutes	UV-Vis Spectro-photometer	Range = 0.016 – 0.119 ml antho. /ml solv.	Achmad & Sugiarto (2020)
3	Nypa fructican husk (peel)	Talawi, West Sumatera	distilled water and ethanol with citric acid 3%)	30, 45 and 60 minutes	UV-Vis Spectro-photometer	The highest = 226.04 mg/L (ethanol – cit. acid; 30 minutes)	Herfayati *et al.* (2020)
Reflux							
1	Rambutan fruit	-	Ethanol - hydrochloric acid 1%	2 ,4, 6, and 8 hours. 30, 40, 50, 60, and 70 °C	UV-Vis Spectro-photometer	Fluctuating data = 19.77 mg/L to 72.22 mg/L	Siahaan *et al.* (2014)

*The bold statement indicates the highest content of anthocyanin

Table 3. Summary of research publication reports related to anthocyanin extraction in Indonesian using the mechanical energy method from 2012-2022

No	Object Sample	Origin	Solvent	Duration - Condition	Quantification Method	Anthocyanin content	Reference
Sonication							
1	Murbei fruit	-	distilled water : citric acid 3% = 1:7 (w/v).	5,10,15,20, 25, 30 and 40 minutes.	UV-Vis Spectro-photometer	13.23-99.91 mg/L	Handaratri & Limantara (2016)
Microwave Assited Extraction							
2	Tamarillo (Terung belanda)	Aceh	Distilled water : citric acid = 1:10	30, 40, 50 s; 900 watt	UV-Vis Spectro-photometer	Peel = 69.64 mg/L; **Seed = 119.35 mg/ L;** Peel and seed = 72.27 mg/L.	Ulya *et al.* (2018)
3	Red dragon fruit waste	Cimahi, West Java	Ethanol:distilled water (4:1)	2, 4 and 6 minutes.	UV-Vis Spectro-photometer	The greatest concentration 52.184 mg/100g (4 minutes in the Microwave Assisted Hydro Distillation method)	Shiddiqi & Karisma (2021)
4	Strawberry	-	Distilled water–citric acid 2% (w/v)	1,2,3 minutes; 80 Watt,	UV-Vis Spectro-photometer	12.31 to 13.02 ppm	Sumarlan *et al.* (2018)
5	Mangosteen peel waste	Malang, East Java	Distilled water, citric acid 2%	5,10, 15 minutes; 160 W	UV-Vis Spectro-photometer	Range of 95.46 – 177.56 ppm. The highest is aan material:solvent ratio of 1:20 (w/v).	Rita and Choirun (2015)
6	Dadap merah flower	Semarang, Central Java	Ethanol with citric acid 4% (1:5; 1:15; 1:25)	3, 6, 9, and 12 min (300 W)	UV-Vis Spectro-photometer	The highest in ratio of 1:15 ratio (12 min) = 9.51 mg/L.	Alvionita (2020)
7	Dadap merah flower	Semarang, Central Java	Ethanol with acid (4% citric or 4% tartaric or 1% chloride) (in ratio of 1:25)	3, 6, 9, 12 and 15 min (600 W)	UV-Vis Spectro-photometer	<u>Ethanol - 4% cit. acid</u> 3 min = 0.83 mg/L ; 6 min = 1.50 mg/L; 9 min = 2.59 mg/L; **12 min = 3.67mg/L;** 15 min = 1.00 mg/L <u>Ethanol - 4% tar. acid</u> **3 min = 8.10 mg/L;** 6 min = 6.55 mg/L; 9 min = 5.01 mg/L; 12 min = 1.84 mg/L; 15 min = 1.75 mg/L <u>Ethanol - 1% chl. Acid</u> 3 min = 4.88 mg/L; 6 min = 12.29 mg/L; 9 min = 20.41 mg/L; **12 min = 28.52 mg/L;** 15 minutes = 24.98	Damayanti *et al.* (2020)
Microwave Assited Extraction; Ultrasonic Assited Extraction							
8	Murbei fruit	Malang, East Java	Distilled water – citric acid (1:7 and 1:6 w/v)	80 s and 30 min; 40°C	UV-Vis Spectrophotometer	Microwave (80 s; 1:6 ratio) = 2434.74 ppm. Ultrasonik (40°C, 30 min; 1:7 ratio) = 3383.48 ppm.	Handaratri & Yuniati (2019)
Ultrasound-Assisted Extraction							

Citric acid, tartaric acid, and hydrogen chloride are added as supporting material. The acidified organic solvent destroys the cell membrane, simultaneously dissolves the anthocyanin, and stabilizes the anthocyanin. In this case, the flavylium cations are stabilized under acidic conditions (Priyadarshi *et al.*, 2021). The acid used is a weak acid because the use of strong concentrated acids can cause anthocyanin molecule instability. Strong acid media can promote hydrolysis of glycoside side bonds (Tena & Asuero, 2022). From 40 journals, it appears that the percentage of solvent and acidity of organic solvents are important determinants of extraction efficiency. Adding acid (around 3%) in the solvent is important to support the anthocyanin extraction process, thereby producing a greater yield. pH control is a factor that is relevant to the quality of the extracted anthocyanins.

The Soxhlet and reflux extraction methods are a form of method development from the maceration procedure. This method uses a solvent that flows to the sample cyclically and continuously under heat. The difference between the Soxhlet and reflux methods only lies in the contact between the raw material and the solvent. Suppose the soxhlet method uses an indirect contact system (the raw material is put into a tube and the solvent in an extraction flask) (Herfayati *et al.*, 2020). Then, the reflux method involves a direct mixture of sample and solvent (Siahaan *et al.*, 2014). Table 2, which contains four research reports on anthocyanin extraction using these two methods, is presented below. Soxhlet extraction is considered capable of producing better anthocyanins, collecting 226.036 mg/L

The maceration method has the disadvantage of being a less effective method. This is based on the use of large amounts of solvent. Using heat in reflux-soxhlet extraction is also a challenge because high temperatures can potentially cause anthocyanin degradation (Silva *et al.*, 2017). Therefore, other extraction method options have also been developed in the last 10 years. Extraction methods that use ultrasonic waves, such as Microwave Assisted Extraction (MAE) and Ultrasound Assisted Extraction (UAE), are being pursued (Handaratri & Yuniati, 2019). The existence of ultrasonic waves helps the mass transfer of anthocyanins into a given solvent in a reasonable amount. Lower energy consumption is also the benefit of using these methods, creating good reproducibility. Table 3 provides information regarding the types of flora extracted using this extraction method. The ultrasonic extraction method is capable of producing anthocyanins up to 558.76 ppm.

Anthocyanin Quantification Method

As seen in Table 2, 39 references used spectrophotometer as a measurement tool. Anthocyanins can specifically absorb light in the ultraviolet (UV) to violet absorption region but are stronger in the visible region of the spectrum. Anthocyanins are absorbed at a wavelength of 250 – 700 nm, with 2 peaks as a sugar group (glycone) at a wavelength of around 278 nm and the main peak as anthocyanin (aglycone) at around a wavelength of 490-535 nm. At pH 1, indicating the presence of flavylium cation species (AH^+), anthocyanins can absorb wavelengths varying from 508 nm to 548 nm (Pedro *et al.*, 2016). Figure 5 shows UV-Visible anthocyanin spectra (Demir *et al.*, 2015).

The differential pH method is a quick and easy procedure for measuring anthocyanins. It was introduced by Sondheimer and Kertesz in 1948 after they researched anthocyanin instability issues. The differential pH method

measures the wavelength absorbance at two different pH values. This was observed from theanthocyanin chromophore's structural transformation as a pH function. The shape of the resulting spectrum states the number and position of glycosidic substitutions, and the number of cinnamic acid acylations of anthocyanins (Giusti & Wrolstad, 2001).

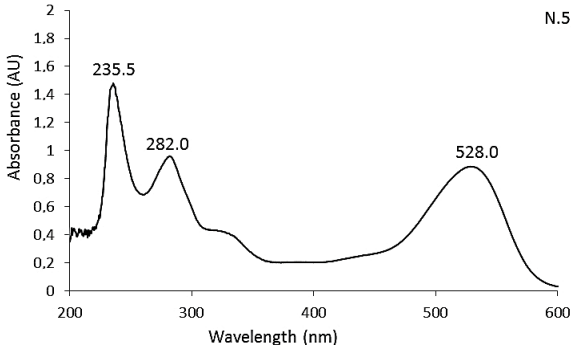

Fig 5: UV-Vis spectra of the total anthocyanins from cherry in one publication report (Demir *et al.* 2015)

CONCLUSIONS

This research has conducted a literature review of 40 scientific reports conducted in Indonesia from 2012 to 2022. The plants used as research objects included fruits, flowers, seeds, peels, and roots from Java, Sumatra, Kalimantan, Sulawesi, and Nusa Tenggara. There are six methods reported for extracting solvent-based anthocyanin compounds. Polar materials with added acids in a few percents are used as extraction solvents. Almost all research reports use spectrophotometry to quantify anthocyanins. As a result, the anthocyanin value of a study object is obtained in a measurably

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