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Regional Case Study

Differentiated of Batik Dyes and Environmental Effect in The Centre of Batik in Tasikmalaya City and Regency

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Abstract

The most extensive textile export product and one of the nation's cultural legacies is batik cloth. However, regarding environmental quality, West Java's growing demand for batik production results in garbage contaminating the nearby waterways. The type of dye is where the harmful properties of batik waste originate. With descriptive qualitative methodologies and the Miles and Huberman model, this study intends to explain the various types of dyes used by SMEs producing batik in the batik centre region of the City and Tasikmalaya Regency and their impact for environmental health. The findings revealed that small and medium-sized enterprises (SMEs) engaged in the batik industry in Tasikmalaya City (Cipedes) utilized synthetic dyes such as indigosol, reactive Procion and Remazol, dispersion, and direct (mostly monoazo and diazo). In the meantime, batik artisans at the Tasikmalaya Batik Center (also known as Sukapura batik in Sukaraja) work with reactive Procion and Remazol (diazo), indigosol, jolawe fruit peel (Terminalia bellirica), soga jambal bark (Peltophorum pterocarpum), and tingi as natural dyes (Ceriops condolleana). The impact of used the different azo dyes can change the level of pH extremely, also improve the level of BOD, COD, TDS, and heavy metal such as chromium hexavalent ((Cr(VI)) in the waters.

Keywords: Synthetic dyes; natural dyes; batik

1. Introduction

Small- and medium-sized batik businesses in Indonesia play a significant role in the nation's economic development, particularly during the epidemic. Batik, passed down from generation to generation in Indonesia, has been recognized by UNESCO as one of the intangible cultural heritages since 2 October 2009. Many people, both domestic and international, still enjoy purchasing batik fabric. It is clear from the January-July 2020 export achievement of USD 21.54 million, an increase compared to the first semester of 2019, which was valued at USD 17.99 million and contributed significantly to the nation's foreign exchange reserves (Ministry of Industry Press Release, 2020a). Batik fabric is one style of apparel that has expanded swiftly from centuries ago to the present. Diverse batik industries are dispersed throughout 101 locations throughout Indonesia, notably in the Java Island region (Ministry of Industry Press Release, 2020b). Historiographically, the origins of batik manufacture may be traced back to the Majapahit and Mataram kingdoms and the spread of Islamic doctrines on the island of Java. So that the existence of batik small and medium-sized enterprises in diverse regions, particularly on the island of Java, can contribute to the national economy.

Batik fabric combines historical and artistic value with various motifs and patterns. It cannot be isolated from the existence of more diversified dyes and different production procedures. In 1856, Willem Henry Perkin, a Dutch colonist who introduced synthetic dyes to the creation of batik cloth in Indonesia, initiated the revival of these two factors. Batik artisans have abandoned natural dyes obtained from bark and tree branches due to the introduction of synthetic dyes containing primarily azo pigments, which are characterized by more contrasted and varied hues. In response to the increased demand for batik production, numerous batik industries have been formed in various regions of the island of Java, giving rise to the designations Pekalongan batik, Surakarta batik, Yogyakarta batik, Lasem batik, Cirebon batik, and Sragen batik. Each batik from the region features a distinct design. Therefore, the aesthetic value of batik fabric is influenced by the type of dye used in different regions' evolution of batik fabric production techniques.

The existence of batik, particularly in the West Java region, is referred to as Priangan batik, which has significance in Sundanese culture. The distribution region is located in the west (Cianjur and Bogor) and east (Sumedang, Bandung, Tasikmalaya, arrowroot, Banjar, and Ciamis) (Sunarya et al., 2011). Tasikmalaya has long been the center of batik production in the southern part of Java. By tradition, the wives of rulers (dalem) and farmers must provide their husbands' clothing with beautiful cloth patterns and boast of their wives' work in front of the people, using spinning tools. Sewing in every home and discovering many thriving tarum trees (Indigofera tinctofera) are known as batik's natural dyes (Prijono et.al., 2021). However, batik production currently employs azo synthetic dyes, widely available in numerous places. Due to their toxicity and carcinogenicity, the presence of azo groups in synthetic dyes is hazardous to live beings. There are approximately 3000 azo dyes produced in the world for a variety of purposes (Selvaraj et al., 2021). The average dye concentration in textile dyeing effluent is 10 to 200 mg/L (O'Neill et al., 1999). Waste containing chromophore complexes such as azo is difficult for native microbes to break down naturally. Long-term mixing of azo dyes with water can lower dissolved oxygen levels, pH, and temperature, resulting in the death of aquatic species. It can induce various problems, including hypertension, bladder cancer, eye irritation, and even irreversible blindness (Sen et al., 2016; Yaseen and Scholz, 2019). Therefore, the presence of batik liquid waste in the batik center area of the Tasikmalaya region on a long-term basis can degrade the water quality of surrounding inhabitants.

The azo dyes used in batik manufacture challenge the waste liquid's toxicity. The fastness of azo dyes is attributable to the stable azo bonding on substrates such as cotton, polyester, and silk. The dye bond on the fabric is only 20-50%, and the remainder consists of waste (Selvaraj et.al., 2021). Utilizing physical, chemical, and biological techniques, various textile waste treatments, decolorization, and degradation of azo dyes are accomplished (Saratale et al., 2011). Several studies utilizing the three techniques have yielded varying efficiency values and are only beneficial in the short term, with the majority ranging from 1 to 6 days (Karim et al., 2018; Mahmood et al., 2015). The greater the number of azo linkages, the poorer the microorganisms' capacity to destroy them. The degradation of polyazo dyes (Reactive yellow 2 or Cibacron Brilliant Yellow 3G-P) using a consortium of bacteria Pseudomonas aeruginosa (RS1) and Thiosphaera pantotropha ATCC 35512 has an efficiency value 54%. Based on chromophore and auxochrome's structure and their application to specific fiber textiles, azo dyes come in various varieties and commercial products (Benkhaya et al., 2020). The azo linkages in the trash make breaking down the azo dyes used in batik manufacture challenge.

Batik manufacture requires a variety of instruments and raw ingredients, such as dyes, which contribute to the aesthetic value of batik fabric. The colors used by small and medium-sized enterprises (SMEs) in the City and District of Tasikmalaya are becoming increasingly diversified. They contain synthetic dyes that are harmful to the environment. The influence of stains on batik production can degrade the quality of nearby rivers, soils, and the health of local populations. Currently, azo dyes, such as naphthol, indigosol, and reactive salts, are commonly used to color batik fabrics (Ratna et al., 2018; Haedar et al., 2019; Priyani et al., 2018; Rashid et al., 2013). Additionally, the demand for Tasikmalaya batik production is expanding from diverse places, aided by e-commerce marketing (Darmawan et al., 2019; Rahadi, 2018). Some inhabitants in the vicinity of the batik center in the City and Tasikmalaya

Regency complained about the direct disposal of batik liquid waste into water bodies such as watersheds and ditches. It is because, several years ago, Cipedes residents polluted their fish pond water, and during the dry season, Sukaraja's sewers emit a pungent odor. An increase in the anaerobic microbial degradation process and a decrease in dissolved oxygen levels in the water are responsible for the presence of a strong smell (Kant, 2012). This study aims to describe the characterize of the various dyes used in batik manufacturing at the heart of batik production in Tasikmalaya and to analyze/explain the environmental impact of using these different dyes. So that in the future, it can provide the appropriate solution for enhancing the management of batik liquid waste that is detrimental to the environment for inhabitants in the vicinity of the City and Tasikmalaya Regency's batik center.

2. Methods

This study was conducted in the Tasikmalaya City Batik Center Area (Tasikmalaya Batik Village) and the Sukaraja Batik Center of the Tasikmalaya Regency. The Tasikmalaya City Batik Center Area, also known as "Batik Village," is located in Nagarasari Village, Cipedes District, Tasikmalaya City, and is 4.6 kilometers from the city's center. There are 19 MSMEs in the region, distributed among three villages: 4 in Cicariu, 11 in Ciroyom, and 4 in Cigeureung, and the majority already have a SIUP (Trade Business Permit). The area is characterized by densely populated areas drained by the Citanduy-Ciloseh watershed. The Batik Center Area of Tasikmalaya Regency is 16 kilometers from the city center in Sukapura Village, Sukaraja District, Tasikmalaya Regency. There is one Sukapura batik production house and eight craftsmen (home industry scale), the majority of which already have a SIUP (Trade Business Permit). The Ciwulan River drains the region, which consists primarily of woods and has only a few scattered towns. Interview-derived primary data sources are documented in writing, audio recording, and documentation.

This study employs observation, semi-structured interviews, and documentation as data gathering methods. This study's participants were 1) 19 owners of batik SMEs in Tasikmalaya City, 1 batik SMEs, and 8 home-scale batik artisans in Tasikmalaya Regency; and 2) 1 manager of batik-making cooperatives in Tasikmalaya Regency. The batik centre area of Tasikmalaya City for information on the types of dyes used by local batik SME owners. This study between January and March of 2021. This study employed qualitative research methods, which generated descriptive data. This study approach is also meant to provide a better understanding of anything that is not well known and discover fresh perspectives on widely recognized topics. This research seeks to determine the types of batik dyes containing azo compounds, how MSME owners utilize them in the two regions, and the monthly production of batik cloth. The technique for validating qualitative data employs triangulation. According to Moleong (2009), the strategy for determining the validity of the data might incorporate sources, methodologies, researchers, and theories. The triangulation approach utilized by researchers employs triangulation to direct researchers to obtain data from many data sources. The method is triangulated by comparing data from observations and conversations with the proprietors of batik SMEs. The Miles and Huberman paradigm includes data reduction, data display, and conclusion or verification drawing tools (Sugiyono, 2013). The effect type of Batik Dyes for environmental were analyzed by systematic literature review from many sources article such as Google Scholar, Web of Sciences, Scopus, etc. Figure 1 depicts the steps of the research as follows.

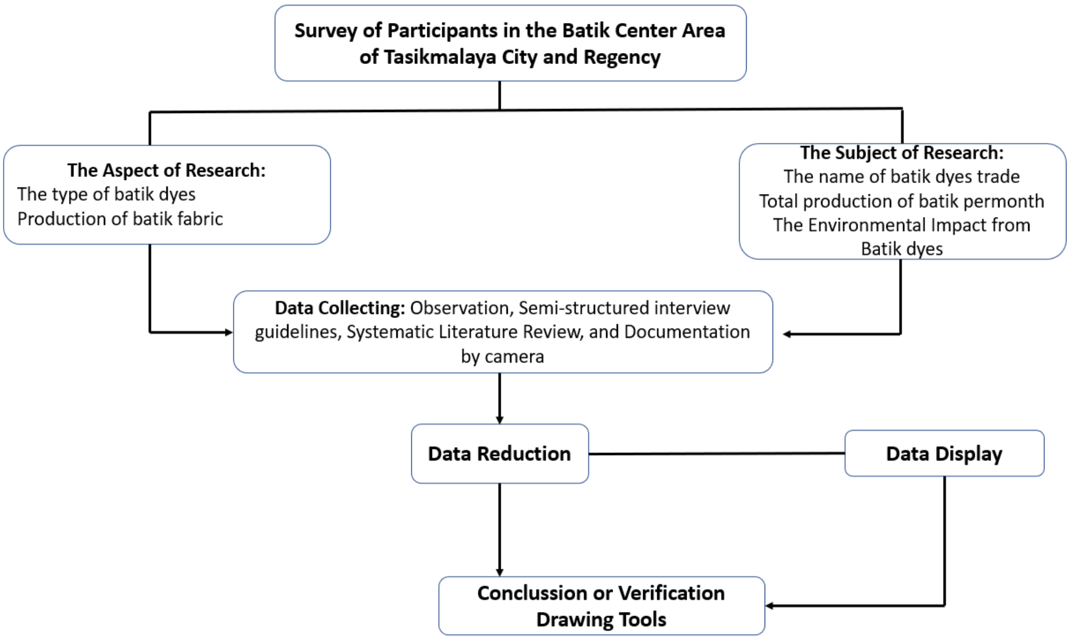


Figure 1. Research stage

3. Result and Discussion

3.1. Types of Dyes in the Batik Center Area of Tasikmalaya City

a b c

Figure 2. Types of dyes used in the batik center of Tasikmalaya Regency (Sukaraja) (a) Naphthol salt dyes on Deden SME batik; (b) Procion reactive dye on Sukapura MSME batik, and (c) Procion reactive dye on Sukapura MSME batik

Tasikmalaya City's batik center produces a monthly average of 5–100 stamped, printed, and written batik fabrics. Although written batik is still made in this region, stamp and printing techniques account for most batik output. This region's population is primarily artisans and ornamental fish growers. Based on the results of observations and interviews, Table 1 displays the various types of synthetic dyes that are often utilized by 19 small to medium-sized batik SMEs. Available at the SME Batik Cipedes cooperative and chemical stores around Tasikmalaya, most of the colors used are powders or powders blended with a specific quantity of chemicals. The vast majority of synthetic dyes used by batik artisans contain azo chemicals, which have been prohibited by the European Union and the United States because they contain carcinogenic ingredients that release aromatic amine compounds when the body perspires (Mo, 2020). Azo components such as benzidine, which can cause tumors and bladder cancer in people and mice, provide evidence (Kant, 2012). In addition to the fact that azo dyes are water-soluble and easily breathed, their quick absorption by the skin induces allergic responses (Sarkar et al., 2017). Including azo groups in synthetic dyes can enhance the color's ability to adhere to the fabric. The majority of the azo groups in this region's six varieties of batik dyes are classed as monoazo (Benkhaya, Harfi, & Harfi, 2018). Azo dyes bond to benzene or naphthalene groups with various substituents, including chloro (-Cl), methyl ($-CH_3$), nitro ($-NO_2$), amino ($-NH_2$), hydroxyl (–OH), and carboxyl (–COOH) (Saratale et al., 2011). The synthetic colors used by batik artisans in Tasikmalaya are azo dyes, mutagenic and carcinogenic.

Table 1. The use of types of batik dyes in the batik center area of Tasikmalaya City

SME	**Types of Dyes**						
	Salt Naftol	**Indigosol**	**Disperse**	**Direk**	**Reactive *Procion***	**Reactive *Remazol***	**Others (Naturals)**
Batik Tulis Rizky	√	√					
Batik cap Tedi					√		
Batik Tulis dan Cap Agnessa	√	√				√	
Batik Cap Deden	√				√		
Batik Tulis Sukapura		√			√		
Batik cap Nanda			√			√	
Batik Cap Nizar	√	√	√	√			
Batik Cap W.D	√						
Batik Cap Puteri Kembar					√		
Batik Cap Nagariharja	√						
Batik Cap Denok	√						
Batik Cap Yayat		√					
Batik Cap Elang Mas	√				√		
Batik Cap Rafsanjani	√	√					
Batik Tulis Sopiah	√						
Batik Cap Mekar Jaya		√					
Batik Cap Sumber Sari		√			√		
Batik Cap Putera	√	√					
Batik Tulis dan Cap Agnessa Putra	√						
Total	12	9	2	1	6	2	-

The three main home-scale batik businesses in the region, Agnessa, Rizky, and Deden Batik, use the same naphthol, reactive, and indigosol salts as other home-scale batik businesses. Due to several benefits of the use of three dyes are 1) fast attachment process and resistance to fading (Kulandaivel et al., 2014); 2) contrasting and varied colours (Priyani et al., 2018); 3) widespread availability so that it is simple to acquire; and 4) high colour binding capacity on fabrics (Karim et al., 2018). The classic Priangan batik motifs of Tasikmalaya are the Sukapura (Sukaraja), Tasikan, and Sawoan (Cicadas) designs (Muhaemin, 2019). Various batik fabric forms are silk, cotton, primisima, and calico (Budiyono, 2008). Each type of dye is utilized differently from preparation to use on batik fabric. Use sodium nitrite and hard water to fix the fabric's colour (fixation) (hydrochloric acid and sulfuric acid). By the features of the Tasikan pattern, which represents simplicity and grandeur for individuals who wear it, the majority of dyes used are red, yellow, and blue, as depicted in Table 2. Thus, the attractiveness of synthetic dyes that are frequently employed in the Cipedes region derives from the range of contrasting huges and resistance that are fitted to the qualities of batik patterns.

Table 2. Colours found in synthetic dyes in the Tasikmalaya City Batik Center Area

Colour	Synthetic Dyes
Black	Naphtol Black B
	Remazol Tie MS black
Red	Naphtol Red B
	Reaktif Procion Red
	Congo Red
Blue	Naphtol Blue B
	Indigosol Blue 04B
	Procion MX Dye Medium Blue
	Remazol Brilliant Blue
Yellow	Indigosol Yellow V
	Procion Yellow
	Procion Lemon Yellow
	Disperse Yellow 3
Orange	Indigosol Orange HR
	Cibacron Orange
Violet	Naphtol Violet B
	Indigosol Violet 2R
Pink	Reaktif Pink Rose

This region's monthly manufacturing capacity of stamped, written, and printed batik is between 20 and 100 fabrics. Figure 3 depicts the amount of batik fabric produced by each business unit in the Tasikmalaya City batik centre.

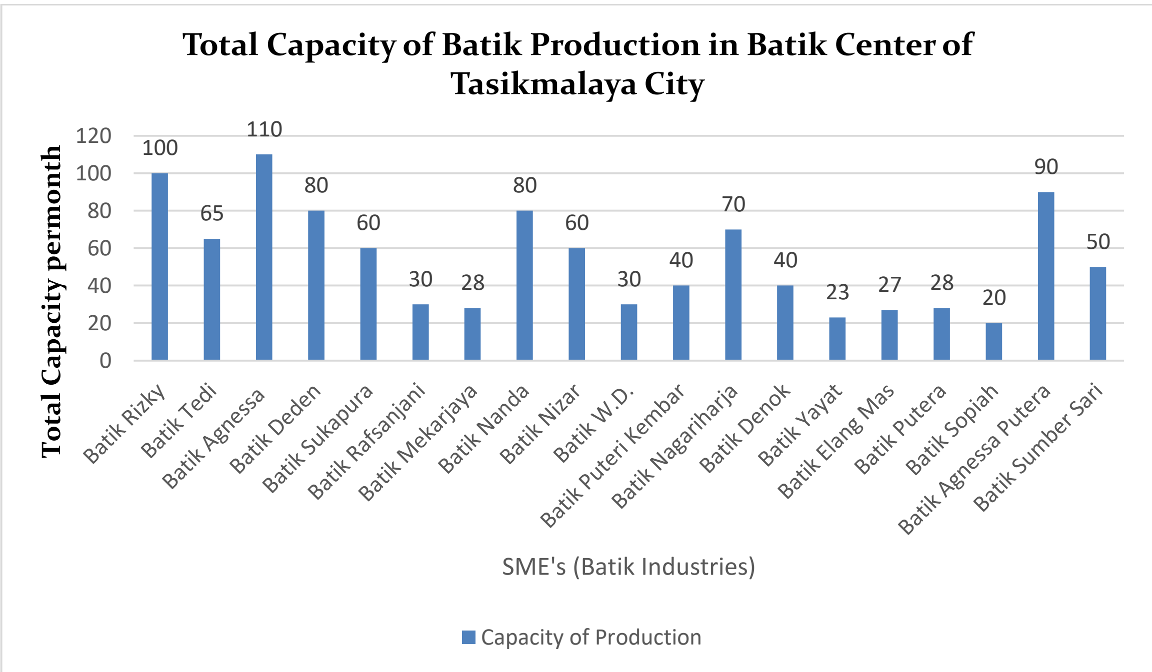


Figure 3. Monthly batik fabric production capacity at the Tasikmalaya City Batik Center

3.2. Types of Dyes in the Batik Center of Tasikmalaya Regency

a b c

Figure 4. Types of dyes used in the batik center of Tasikmalaya Regency (Sukaraja) (a) Naphthol salt dyes for SME Batik Written "GJM" belonging to Mr Edang; (b) The results of the dyeing of batik cloth using remazol dye, and (c) The dyeing of batik cloth with the writing technique of the batik craftsman Mr Uyung
Source: Personal Documentation

The utilization of the Sukapura motif is a defining characteristic of Sukaraja's batik output. The Sukapura motif has a long history because the core of batik production in the Priangan region originated in this region. The name Batik Sukapura derives from the location of batik manufacture in Sukaraja, previously known as Sukapura Village. Sukapura batik is influenced by Pekalongan batik, Banyumas, Tegal, and Kudus. Its origins date back to the eighteenth century when wives sewed as many unique garments as possible for their husbands to show off. Batik entrepreneurs from Central Java fled to West Java to avoid war, so Sukapura batik is still influenced by Pekalongan batik. Batik Sukapura is one of the national identities of the Indonesian people that exemplifies the way of life of the people of East Priangan, particularly Tasikmalaya. The trademark of the Sukapura batik business is that it maintains the originally written batik and the hue of soga (yellowish brown) so as not to be overtaken by stamped batik with nearly identical themes. Historically, producing cloth using natural colours takes 40 days per cloth for dyeing and dying so that the creation of Sukapura batik in the Tasikmalaya Regency area retains its aesthetic and historical features from generation to generation.

Table 3. The Use of types of batik dyes in the batik center area of Tasikmalaya Regency

SME	Types of Dyes						
	Salt Naftol	**Indigosol**	**Disperse**	**Direk**	**Reactive Procion**	**Reactive Remazol**	**Others (Naturals)**
Batik Tulis Sukapura "GJM"	√	√				√	Jolawe (Terminalia bellirica), Kulit Kayu Soga Jambal (Peltophorum Pterocarpum), kulit kayu Soga Tingi (Ceriops condolleana)
Craftsmen							
Batik Tulis dan Cap Bu Uun	√						
Batik Tulis dan Cap Pak Dadan	√		√				
Batik Tulis Bu To'ah	√						
Batik Tulis dan	√		√				

SME	Types of Dyes						
	Salt Naftol	**Indigosol**	**Disperse**	**Direk**	**Reactive Procion**	**Reactive Remazol**	**Others (Naturals)**
Cap Pak Uyung							
Batik Tulis Bu Kurnia	√				√		
Batik Tulis Pak Anang		√					
Batik Tulis Bu Rina	√						
Batik Tulis dan Cap Bu Ai		√					
Jumlah	7	3	2		1	1	1

Batik production in the centre of Tasikmalaya Regency's batik business is still a cottage sector dominated by the manufacture of written batik. Only eight families of artisans continue to make batik from generation to generation, while one MSME comprises twenty families of artisans. Craftsmen utilize synthetic and natural dyes to create Sukapura batik motifs, as evidenced by table 2's results, which are based on interviews and observations. Due to the characteristics of the predominant Sukapura theme in soil hues such as red and blue, as indicated in Table 4, naphthol salt dyes are commonly utilized in the Sukaraja region. The proprietor of the Sukapura batik SME "GJM" employed natural colours to determine the description of Sukapura batik in ancient times. However, natural dyes have poor colour fastness, which is a disadvantage (Lestari et al., 2018). Therefore, most Sukapura batik artisans currently employ synthetic colours, which are more practical, affordable, and accessible.

Table 4. Colours found in synthetic and natural dyes in the batik center area of Tasikmalaya Regency

Colour	Natural Dyes	Synthetic Dyes
Black	-	Naphtol Black B
Red	Soga Tingi (Ceriops tagal)	Naphtol Red B Remazol Red
Blue	-	Naphtol Blue B Indigosol Blue 04B
Yellow	Jalawe (Terminalia bellerica)	Procion Yellow
Violet	-	Naphtol Violet B
Brown	Soga Jambal (Peltophorum pterocarpum)	-

In this region, the monthly production capacity for stamped and written batik fabric ranges from 5 to 30 materials. Figure 5 illustrates the amount of batik fabric produced by each business unit in the Tasikmalaya Regency batik centre region.

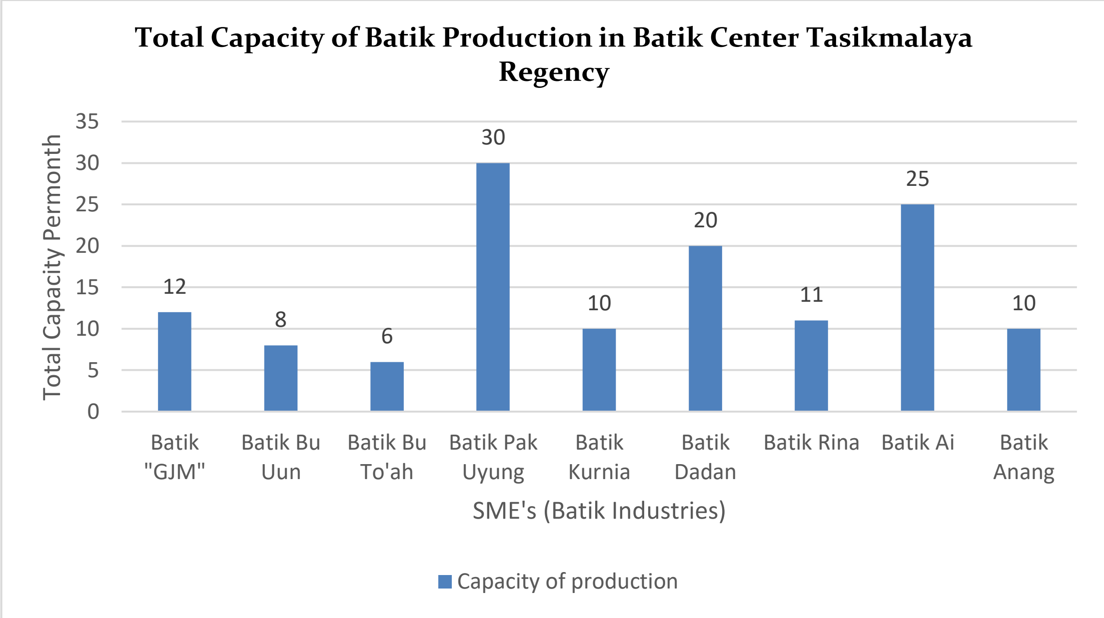
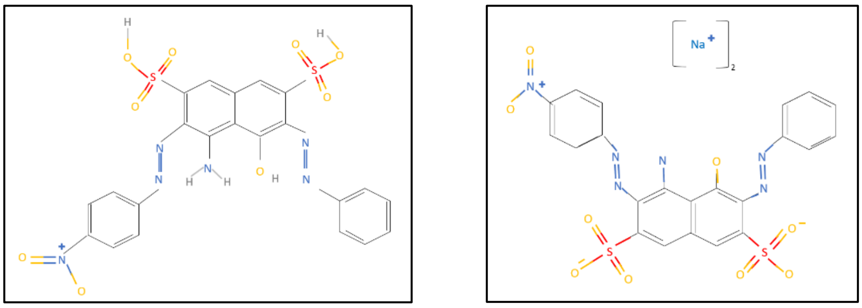


Figure 5. Production capacity of batik fabrics for each business unit monthly at the batik center of Tasikmalaya Regency

3.3. Characteristics of Batik Dyes in the Batik Center Area of Tasikmalaya City and Regency

a. Napthol Dyes

Water-insoluble fabrics are coloured with naphthol salt dyes, which consist of naphthol powder and diazonium salts. These dyes are frequently referred to as basic dyes, B.O., and "waragad" by Tasikmalaya batik artisans. They utilize by combining dissolved naphthol and caustic soda in boiling water with dissolved diazonium salt or organic base in cold water (Dewi et al., 2019). The sale of naphthol and diazonium salt is separate. Because the naphthol and salt have been stabilized with an azo group, most naphthol salt dyes are categorized as azo dyes (Luftinor, 2011). According to local batik artisans, the benefits of this dye include a quick dyeing process, various hues that tend to be dark, and resistance to fading (Jannah et al., 2017). The AS sign is followed by a colour code for several naphthol dyes' commercial goods, such as ASG (yellow), ASLB (brown), ASBO (black), etc. (Ledoh et al., 2019). And the brand of diazonium salt is denoted by the colour code, such as Blue B, Red B, Yellow GC, Violet, Black B, etc. (Wuryani, 2019). The naphthol salt dye brands utilized by batik SMEs in the Cipedes and Sukaraja regions are AS-BO naphthol and B black salt, AS-naphthol and B red salt, AS-LB naphthol and B red salt, AS-naphthol and violet B salt, and AS-OL naphthol and blue salt B. Based on the bond structure of azo or phenylazobenzene (N=N), as shown in Figure 3, the bulk of these dye brands belong to the diazo category. Black salt B is rich in the heavy metal chromium, strengthening the connection between dyestuffs and fabric (Benkhaya et al., 2018).



a b

Figure 7. Molecular structure of (a) red salt b dan (b) black salt B

b. Indigosol Dyes

Indigosol dye is a sort of water-soluble, clear-coloured vessel dye. It is utilized by dissolving the powdered dye in boiling water, then combining it with cold water and colour generators in the form of sodium nitrite and sulfuric acid for dying or picking. This dye's benefits include a light, reflective base and resilience to sunlight and friction. Indigosol Blue 04B, Indigosol Yellow V, Indigosol Violet 2R, and Indigosol Orange HR are among the indigosol dye brands utilized in the Cipedes region. And the indigosol dye brand utilized in the Sukaraja region, such as Indigosol Blue 04B. This dye belongs to the anthraquinone or vat dye (O=O) benzidine in its oxidized form, which is insoluble in water and most solvents.

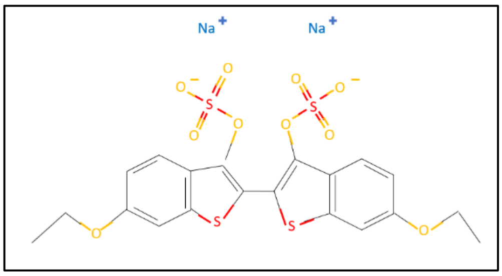
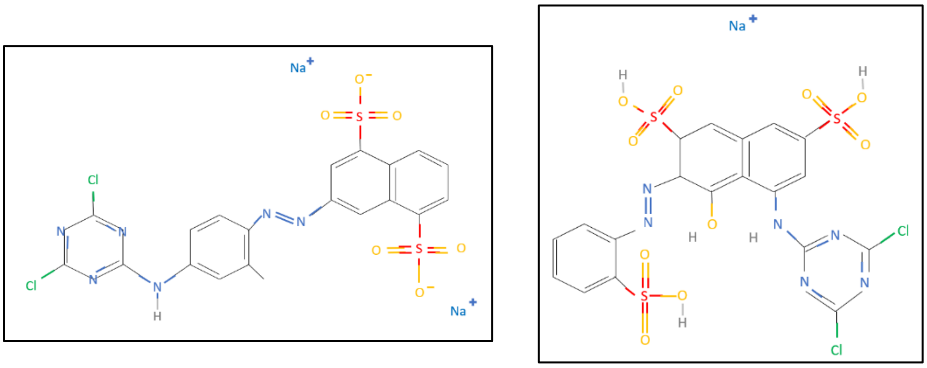


Figure 7. Molecular structure of *indigosol orange HR*

c. Reactive *Procion Dyes*

Procion dyes are reactive dyes that can be bonded directly to the fabric without additional colour generators and undergo ester-bonding substitution reactions on fibres (Agustina and Amir, 2012). Other reactive dyes comparable to Procion include Cibacron, Drimarin, and Lavafix. Use it by dissolving the dye powder with hot water at a temperature between 40 and 60 degrees Celsius and caustic soda, dipping the fabric in the solution, and reheating it to 100 degrees Celsius before washing. The advantages of this dye include its short dyeing period, which results in a stronger colour, its predominance of light hues, and its ability to immediately attach the colour to the fabric (Joshi et al., 2015). This dye is unsuitable for picking procedures due to the short immersion time required (Yusup, 2012). Due to the strong covalent connections between the carbon atoms of the dye and the O, N, or S atoms of the hydroxy, amino, or thiol groups of the polymer, these dyes are difficult to remove from their application (Dewi et al., 2018; Safitri et al., 2020). The downside of reactive dyes is that their fixing strength is lower than other synthetic dyes (Saratale et al., 2011). Procion MX Dye Medium Blue, Procion Red, Cibacron Orange, Reactive Pink Rose, and Procion Lemon Yellow are some of the Procion dyes used in the Cipedes batik centre region. But, Procion Yellow dyes are utilized in the Sukaraja batik centre. According to the structure of the azo bond (N=N), the bulk of these dyes is classed as monoazo. Small chemical structure and molecular weight characterize reactive dyes (Agustina and Amir, 2012).

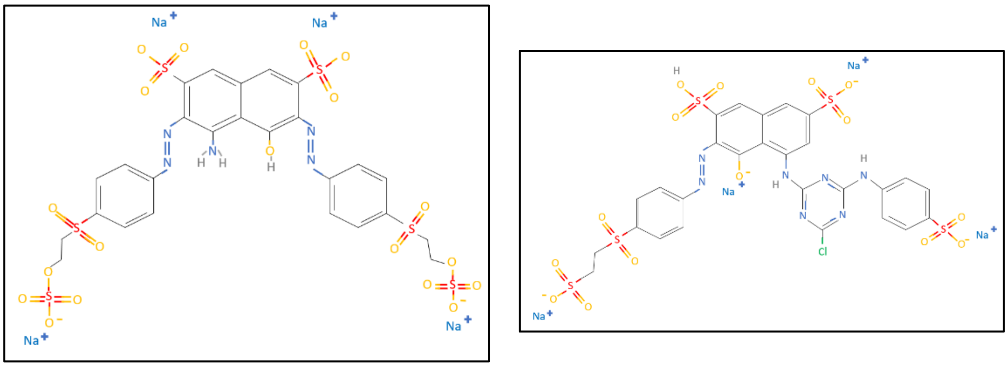


a **b**

Figure 8. Molecular structure of (a) *procion lemon yellow* dan (b) *procion red*

d. Reactive *Remazol Dyes*

Remazol dyes are water-soluble reactive dyes that can be readily absorbed by the fabric and create ether bonds with fibres via substitution reactions (Agustina and Amir, 2012). Numerous additional reactive dyes comparable to Remazol, include Reactive Briliant, Remalan, and Primazin. The colour of this dye is less distinct than other dyes due to its poor colour affinity, which makes it susceptible to fading, how to use it by dissolving it straight in cold or hot water, which reveals its real colour without the addition of colourants. To prevent remazol dye from fading, they use one cc/litre of Matexil wetting agent can be used with sodium silicate and caustic soda as a fixative. Remazol Tie MS black and Remazol Brilliant Blue are two remazol dye brands utilized in the Cipedes batik centre region. Remazol Red is the brand of dye used at the Sukaraja batik centre. Based on the structure of the azo bond (N=N), the bulk of these dyes is classified as diazo. In addition, according to Hunger, (2007) it was found that a number of reactive dyes can cause allergic reactions, rhinitis, or asthma for textile industry workers because of the ability of these dyes to combine with albumin fibers which function as antigens that cause allergic reactions.



a **b**

Figure 9. Molecular structure of (a) *remazol tie MS black* and (b) *remazol red (B)*

e. Disperse Dyes

Synthetic anthraquinone disperses insoluble dyes in the water yet is easily suspended by water. The dye powder is dissolved in boiling water and a carrier (carrier) during the dyeing process. This dye's properties allow it to colour "hydrophobic" fibres, such as polyester, that lack solvent groups in their molecular structure, have excellent fastness, and may be fixed by high temperatures or thermosols in the absence of carriers (Sunarto, 2008). Disperse Yellow 3 is the dispersion dye used in the Cipedes batik centre region. The bulk of these dye brands is classed as monoazo based on the azo bond structure (N=N) (Hao et al., 2000). The azo dye Disperse Blue 291 has genotoxic, mutagenic, and cytotoxic effects on micronucleus formation and DNA fragmentation in human hepatoma cells (Tsuboy et al., 2007).

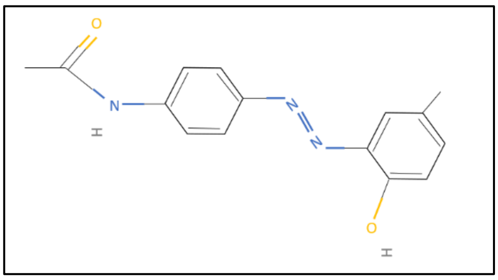


Figure 10. Molecular structure of *disperse yellow 3*

f. Direct Dyes

Direct dyes are azo dyes that absorb cellulose directly without needing mordant chemicals. They are referred to as concrete dyes since they may be absorbed by cellulose and salt dyes during the dying process. This dye is advantageous because it expedites the dying process, saving time. In addition, it is less resistant to washing, oxidation, reduction, and sunshine. Congo Red is the direct dye trade commodity utilized in the Cipedes batik centre region. According to the structure of the azo bond (N=N), the bulk of these dyes is classed as monoazo.

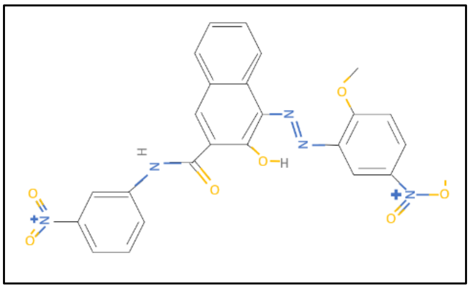


Figure 11. Molecular structure of *congo red*

g. Natural Dyes

Environmentally friendly plant parts, such as leaves, fruits, and seeds, are typically extracted to produce natural colours. The bark of the jalawe tree (Terminalia bellerica), twigs of jambal wood (Peltophorum pterocarpum), and soga tingi (Ceriops tagal) are used to colour cotton garments in the Sukaraja Batik Center Area. All three produce hues ranging from greenish yellow to black, brown, and brick red. The bark of jambal and tall trees is marketed as a paste for a price range of Rp 20,000 to Rp 45,000 per kilogram on the local e-commerce market. Sukapura village's Tasikmalaya Batik undergoes an extensive soaking process that complicates the fabric-dyeing procedure. The fabric is coloured by washing and rinsing it up to twenty times in a solution of clean water, straw, and peanut oil. It is performed to close the fabric's fibres so that the colour is more firmly attached to the material. However, the outcome is a colour that fades rapidly and lacks contrast. As seen in Figure 13, the proprietor of the SME "GJM" once blended natural dyes from the jambal tree with Remazol Red salt dye, which resulted in the colour gradually fading and less contrast. Consequently, batik artisans in the Sukaraja region utilize natural dyes infrequently.

Figure 12. Batik fabrics using B.O. blue and red naphthol salt dyes, natural dyes, and a combination of natural dyes and *remazol red*

3.4. The Environmental Impact From Batik Dyes

The use of synthetic batik dyes has a negative effect on the quality of the environment and the safety of living things. This can not be separated from the components of the azo group (N=N) which are mostly found in the textile dyes used. The azo group as a chromophore structure (gives color) binds to auxochrome structures (which reflect color) such as hydroxyl (-OH), amino (-NH2), and sulfonate (R-SO_3^-) (Benkhaya et al., 2020; Saratale et al., 2011). The impact caused by the presence of dyes in batik waste that is disposed of directly without being processed can damage the level of transparency of water bodies in absorbing sunlight. So that it can interfere with the process of photosynthesis at the bottom of the water. The presence of azo groups in waters is also toxic to plants (Ayed et al., 2011). In addition, the presence of batik waste containing synthetic dyes can threaten the existence of aquatic organisms, both prokaryotic organisms (natural microbial communities) and eukaryotes (fish) caused by the presence of azo groups and harmful heavy metals such as chromium, nickel, cadmium, lead, and cobalt which into a dye composition inhibits the natural degradation of pollutants. The absorption of batik waste in the soil can clog the soil pores so that it can reduce the level of soil fertility (Božič and Kokol, 2008). The presence of batik liquid waste in riverines close to residential areas is mutagenic and carcinogenic which in the long term can cause a number of diseases such as bladder cancer, extreme allergic reactions on the skin, to permanent blindness (Khattab et al., 2019). Thus, the negative effect of synthetic dyes in dyeing batik cloth on the environment and health requires a number of efforts to minimize it.

From the various types of synthetic dyes found in the two areas of Batik Tasikmalaya, almost all synthetic dyes contain azo bond groups. When observing a number of MSMEs in batik dyeing and rinsing pools, it was seen that the residual wastewater was thick in color, smelled of ammonia or metal, and during the coloring process using synthetic dyes there was thick smoke and when it touched the eyes it stings). Berbeda halnya dengan penggunaan pewarna alami pada proses pewarnaan yang terlihat berwarna agak pudar. The presence of dyes in batik waste can change water physicochemical parameters such as increasing levels of a number of harmful heavy metals, levels of BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), TDS (Total Dissolved Solid), TSS (Total Suspended Solid), TOC (Total Organic Carbon), as well as changing pH levels to extremes. Based on the results of the literature review, a number of dyes used by batik craftsmen in the batik center area of Kota and Tasikmalaya Regency affect the water quality as shown in Table 5. The five types of dyes affect the physicochemical parameters of the waters which are still far from the environmental quality standard threshold. The pH level of batik waste is mostly alkaline although some are acidic. Through the use of natural dyes derived from plants, physicochemical parameters such as pH, BOD levels, and COD still exceed environmental quality standards with lower toxicity than synthetic dyes (Sari et.al., 2011). Of the various heavy metals in waste, the presence of chromium metal in the form of total chromium and hexavalent chromium (Cr(VI)) has been widely reported by various researchers. Chromium heavy metal is also more commonly found in diazo dyes (Natalina and Firdaus, 2018). In addition, the use of naphthol dyes in dyeing causes an increase in chromium heavy metal in batik waste (Oktaviani, 2018). Hexavalent chromium is more toxic than trivalent chromium related to the number of oxidation numbers and carcinogenic effects (Dwisandi et al., 2021; Yatera et al., 2018). Thus, batik liquid waste containing synthetic dyes is more harmful to the environment and health than natural dyes.

Table 5. The environmental effect of batik synthetic and natural dyes

Type of Batik Dyes	The Condition of Contanminated River by Batik Wastewater	The Regulations of Standard Environmental Quality in Indonesia (PP Number 05 of 2014)	References
Naphtol Black (diazo)	pH 10 BOD5 377 mg/L COD 568 mg/L TSS 1180 mg/L Cr $^{6+}$ (Chromium Hexavalent) 2,3 mg/L		(Fidiastuti et al., 2020)
Indigosol blue (anthraquinon)	pH 14 Cr $^{6+}$ (Chromium Hexavalent) 10,1181 mg/L		(Fuji et al., 2020)
Naphtol dyes and Disperse (diazo and monoazo)	pH 10,4 BOD5 2710 mg/L COD 3855 mg/L	pH 6,0-9,0	(Tangahu et al., 2019)

Type of Batik Dyes	The Condition of Contanminated River by Batik Wastewater	The Regulations of Standard Environmental Quality in Indonesia (PP Number 05 of 2014)	References
Reactive Procion Red 2 (monoazo)	TSS 1180 mg/L Total of chromium 0,46 mg/L pH 9,4 BOD5 278 mg/L COD 5280 mg/L TDS 760 mg/L	BOD <50 mg/L COD <100 mg/L TSS < 50 mg/L Total of Chromium 1,0 mg/L	(Handayani et al., 2018)
Natural dyes (Mahagony and Myrobalan extract)	TSS 1890 mg/L pH 5,0 BOD5 385 mg/L COD 1280 mg/L		
Reactive Remazol Black, Red, and Golden Yellow (diazo)	TSS 800 mg/L pH 6,95 BOD5 164 mg/L COD 400 mg/L		(Suprihatin, 2014)
Reactive Remazol (diazo)	TSS 160 mg/L Chromium total 0,06 mg/L pH 2 Cr^{6+} (Chromium Hexavalent) 74,298 mg/L		(Sunardi, 2011)

The negative impact of batik liquid waste caused by synthetic dyes can be minimized by removing the dye, known as decolorization. The decolorization process can be carried out through physical (flotation), chemical (coagulation, adsorption, chlorination, reverse osmosis) and biological (bioremediation) methods. Handling batik waste with bioremediation is more environmentally friendly and has been recommended by various researchers because it produces fewer secondary pollutants and lower maintenance and operating costs (Khan et al., 2013; Saratale et al., 2010). Utilization of microbiological agents such as bacteria, microscopic fungi, and microalgae as well as phytoremediation with plants can reduce dyes as well as degrade azo groups in minimizing the toxicity of batik waste. Utilization of bacteria in the form of pure isolates or consortia is more popular considering that microbial communities exist naturally in waste that utilize microbial metabolic processes to degrade and break azo bonds under aerobic and anaerobic conditions as well as static or shaking conditions (Fatmawati et al., 2010; Fidiastuti et al., 2020; Imran et al., 2014). Meanwhile, another way that can be done to minimize the toxicity of batik waste is by increasing the use of natural cotton fiber using colored cellulose material known as FoxFibre Natural Cotton which consists of various color choices such as green, blue, brown, cream, and others as batik cloth material and then added with natural dyes from various types of plants so that the colors look contrasting and attractive (Premalatha, 2021). Utilization of naturally colored cotton is more environmentally friendly and the color fastness is genetically found in *Gossypium* sp. when the coloring process does not require a large amount of water use (Suparna and Antony, 2016). Thus, through the process of decolorization with bioremediation and the use of natural colored organic cotton, it is hoped that it can be an alternative solution used in an effort to minimize the negative impact of batik liquid waste in the present and the future.

4. Conclusions

In Tasikmalaya City (Cipedes) Batik Center Area and Tasikmalaya (Sukaraja) Regency Batik Center Area, synthetic dyes such as naphthol salts known as base or waragat, indigosol, reactive Procion, reactive Remazol, Direk, and Dispersion are utilized for the majority of batik production. These dyes have nearly identical benefits, mainly variable colour, rapid fabric adhesion, and durability. The monthly batik textile production capacity of the City and Tasikmalaya Batik Centers is 20-100 fabrics and 5-30 fabrics, respectively. The bulk of dyes employed in the two regions is monoazo and diazo based on their azo molecular structures. It indicates that the greater the number of azo linkages, the greater the toxicity of the dye. In addition, one MSME in Sukaraja uses natural dyes derived from the jolawe plant (*Terminalia bellerica*) for yellow, wood twigs of the soga tingi tree (*Ceriops tagal*) for red, and soga jambal (Peltophorum pterocarpum) for brown colour. When drenched in colour, contrast and fading are simple. The manufacturing of Sukapura motif batik has the advantage of preserving the historical significance of his family lineage and the integrity of the surrounding environment. The impact of the use of synthetic dyes contained in batik waste is quite significant on water quality in changing water physicochemical parameters which include levels of pH, BOD5, COD, DO, TDS, TSS, and found heavy metals such as total chromium and hexavalent chromium (Cr(VI)).

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