Scientific reconstruction of local plants as the basic materials of Batik Natural Dyes

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Abstract. The Ciwaringin batik has different features compared to other Cirebon Batik Tulis. It has a unique motif and soft batik color produced from natural dyes. This research aims to reconstruct the knowledge of the community in using local plants as basic material of natural dyes at Ciwaringin, Cirebon, becomes a scientific knowledge. This research was qualitative descriptive research. Data were collected through observation, in-depth interviews, discussion with batik artisans, documentation, and literature study. Data were analyzed by using verification, reconstruction, formulation, conceptualization, and documentation, to obtain scientific knowledge. The subject of this research is the batik artisans of Ciwaringin batik. The result showed that Indigenous knowledge to utilize the local plant as a natural dye of batik by Ciwaringin community is unique local wisdom to maintain environmental balance. Their scientific concepts that have been identified and documented systematically are scientific knowledge that has not been yet formalized. The cause and effect relationship was known through a verification process and then were reconstructed and conceptualized into formal scientific knowledge. The scientific knowledge can be used as a source of culture-based science learning in schools called ethnoscience. The implications of this research are environmental conservation and the increasing value of local wisdom.

1. Introduction

Batik is a cultural hereditary. Moreover, the younger generation starts to participate in batik making. The exoticism of Ciwaringin batik has a different appeal and uniqueness compared to other Cirebon written batik. Besides having unique motifs that depict flora with meaningful hereditary historical philosophy, it also has a soft batik color because it is made of natural dyes. When common people see it at first glance, the color of the batik looks faded and worn, but its look is the exotic characteristic of Ciwaringin batik. Batik activities in the Kebon Gedang block in Ciwaringin village have grown, along with the revitalization of Trusmi batik, which is more widely known by batik lovers. Ciwaringin batik is an inland batik that grows in the cultural community of Islamic Boarding School so that it is not touched by Pesisiran and Keratonan batik traditions. Besides using natural dyes, it also has a motif design that contains Islamic values, characterized by avoiding animate, using a simple design, and not carrying symbolic meaning as in Keratonan batik. Thus, Islamic aesthetics become a reference in the creation of Ciwaringin batik [1].
Ciwaringin villagers utilize several natural materials for natural dyes such as rambutan peel, mango bark, mahogany wood, mangosteen bark, Tegeran wood, Tingi wood, and Indigofera leaves [2]. They apply original scientific knowledge about the extraction of materials to take secondary metabolites from these materials used as batik dyes. However, so far, the implementation of their original knowledge has not been conceptualized to be a formal scientific science. The community especially students still considers that batik culture in Ciwaringin is not related to science lessons at school or college. The results of interviews of several students who come from Ciwaringin also stated that they did not know that the culture of Ciwaringin batik used the science concepts that they had been learning at school or college. There are many cultural traditions and customs, symbols, and so on that contain scientific concepts that have not been formalized [3].

The importance of the original knowledge of the Ciwaringin community in batik making that used natural dye was conceptualized into formal science in schools or in collages. It is hoped that future generations will respect and preserve ancestral culture that has scientific knowledge in it. [4] stated that by learning the community’s original knowledge in education will be useful to stimulate awareness of preserving the environment.

This study aims to reconstruct the indigenous knowledge Ciwaringin community related to the knowledge of the use of natural materials that are used as batik dyes, as well as the processes in batik making into scientific science knowledge and formalized in science education. Scientific reconstruction in this study involved prospective teacher students in the biotechnology class through the ethnoscience approach. Ethnoscience is an activity that transforms original science (the community knowledge) into scientific knowledge through a process of verification, reconstruction, and conceptualization into a formal scientific knowledge so that it can be used as a source of cultural-based science learning in schools or colleges [5]. There has been no previous research on the reconstruction of the original science in the Ciwaringin community into formalized scientific science.

Scientific reconstruction in this research is important to provide experiences for students in exploration such as observation, interview, and documentation related to Ciwaringin community culture as a source of learning. It supports that science is closely related to the culture of the Ciwaringin community especially in the utilization of natural materials as natural dyes. It can stimulate the desire of students to maintain the original culture of society. Further research, the process can be designed with current scientific technology without being replaced by modern culture. Thus, ethnics-based original science education can contribute to increase scientific knowledge and improve cultural and environmental conservation in Indonesia.

2. Method
This research used a descriptive qualitative method with an ethnoscience approach, namely research related to the cultural knowledge of the community that contains scientific knowledge [6]. The population of this research was Ciwaringin villagers, in Cirebon Regency, West Java. This research was conducted for six months, starting from March 2019 – August 2019. The object of this research was related to the use of natural material as batik dyes by Ciwaringin villagers as a local culture that contains scientific science. This research explored the types of local natural material and the process used by the community, as well as the reconstruction of the original science knowledge of the community to become scientific science. This, it can be formalized into science education at schools or universities, to enrich the scientific science (Figure 1). The subject of this research is Ciwaringin batik craft men.
Figure 1. Process of Reconstruction of Ethnoscience-based scientific science [7].

Data were obtained from exploration involved observation, in-depth interviews, having a discussion with craft person, documentation, recording, and literature study. Data was analyzed continuously (Figure 1) through three steps of identification, verification, formulation, conceptualization, and documentation to make it scientific science knowledge. Data was collected intensively then arranged to make a hypothesis. After that, the data were interpreted and discussed with a competent expert in original science (local culture). Next, the study was followed by the reconstruction of research findings to develop ethnoscience-based scientific science that can be integrated through science education at school.

3. Result and Discussion

3.1. Exploration of Types of Local Plants as Batik Natural Dyes in Ciwaringin Village

Exploring local wisdom of the Ciwaringin community in utilizing local plants as batik natural dyes is a step of creating scientific science knowledge based on cultural and local wisdom. In this exploration step, direct interview was conducted with some craft persons and public figures in Ciwaringin village, observation, documentation, and recording. Through exploration activities, the researcher directly analyzed and observed several types of plants, as well as practiced how to create natural dyes using each step of simple methods. Furthermore, the researcher also needs to analyze that this original knowledge of the community, regarding the use of local plants, is implemented hereditary.

A list of information obtained from this exploration step consists of the following points. The first one is (a) the origin of knowledge in making batik using natural dyes. The second one is (b) knowledge of processing various natural ingredients that will be used as natural batik dyes. The third one is (c) knowledge of the differences between batik natural dyes and batik synthetic/artificial dyes. The fourth one is (d) knowledge of the process/steps to make batik using natural dyes. The fifth one is (e) the reason for using natural ingredients as batik natural dyes. The sixth one is (f) knowledge related to the differences between natural batik of Ciwaringin and other natural batiks.

Some respondents that we interviewed in this research are Mr. H. Fatoni (45 years old; having experience as a craft person for 30 years), Ms. Rodiah (39 years old; having experience as a craft person for 20 years), Ms. Annisa (38 years old; having experience as a craft person for 15 years), and Ms. Ika (28 years old; having experience as a craft person for 10 years). The results of the interview and the schedule are presented in table 1.

| No | Questions (Craft person’s knowledge) | Original Knowledge of the people (Knowledge of Craft person of Ciwaringin Natural Batik) |
|----|------------------------------------|----------------------------------------------------------------------------------|
| 1  | The origin of the knowledge in making batik using natural dyes | Knowledge about making batik using natural dyes is received hereditary. In the beginning, it came from the activities of Babakan Islamic Boarding |
| No | Questions (Craft person’s knowledge)                                                                 | Original Knowledge of the people (Knowledge of Craft person of Ciwaringin Natural Batik)                                                                                                                                                                                                                     |
|----|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | No Questions (Craft person’s knowledge)                                                           | School in Ciwaringin. Then, the Islamic Boarding School grows rapidly and has many students (*santri*), so the activity is given to the community of Kebon Gedang, Ciwaringin village, until now.                                                                                           |
| 2  | The origin of knowledge about plants that can be used as natural dyes for Ciwaringin batik       | This knowledge comes from the family, which is heritage. It is stated that all plants in this earth, including leaf, stems, roots, fruit, and even waste (fruit peel) can be useful and contain dyes that can be used, so they do not pollute the surrounding environment and do not result in a lot of garbage. |
| 3  | The knowledge about several types of plants (local name) that can be used as natural dyes       | According to the message from ancestors or parents, almost all plants on this earth can be used as natural dyes. Thus, I was a part of the Ciwaringin community as well as a craft person who just do trial and error. Plants that we usually use are mango, mangosteen, *Tingi*, Indigofera, *Jengkol*, *Tegeran*, and rambutan. For example, we cannot use *Mengkudu* (*Morinda citrifolia*) because the source of dyes is its root. In fact, if we take the root, we will damage the nature. |
| 4  | Knowledge about the part of plants that can be used as natural dyes                               | Parts of plants that can be used as batik natural dyes, based on the information from family, are mango (we use its bark, that has not been used anymore), mangosteen (the peel), rambutan (the peel), *jengkol* (the peel), mahogany (the bark), *tegeran* (the bark), *tingi* (the bark), and indigo (the leaves).  *Intine kabeh limbah sampah sing wis bli dinggo maning, dingo ning kita kanggo pewarna batik* (We use all the waste as the batik natural dyes) |
| 5  | Knowledge about colors produced by each natural material                                           | There are a lot of colors, based on the mixture and the colors, but there is the basic color belongs to each of these plants, namely; mango (light brown), mangosteen (cream to faded brown), mahogany (brown), *tingi* (brown), indigo (blue), *tegeran* (yellow), and rambutan (light brown). |
| 6  | Cultural values in techniques used to take the plants that will be used as natural dyes (to produce a better result) | A certain technique to take indigo leaves is it should be done before sunrises or dawn. It is called “taboo”                                                                                                                                                                                                 |
| 7  | Knowledge about the uniqueness of motifs of Ciwaringin                                               | From the ancestors, we use floral motifs that have their own symbolic meaning such as the motif of a thousand leaves with vines, have a sense of togetherness in protecting the environment to preserve mangoes, which are the local plants of Cirebon. The motifs are *uceungan*, *udeul bodong*, *mataharian*, *pecutan*, *pring sedapur*, *ganepo*, and soon. |
| 8  | Knowledge about treatment for some plants during the process of making natural dyes               | - “Drying”: All ingredients should be dried for 4-7 days before being processed.  
- “Soaking”: After then, all ingredients are soaked for about 2-3 days.  
- After being soaked, the ingredients are “boiled” in the pan for about 4-6 hours. The pan is filled by all |
| No | Questions (Craft person’s knowledge) | Original Knowledge of the people (Knowledge of Craft person of Ciwaringin Natural Batik) |
|----|--------------------------------------|---------------------------------------------------------------------------------|
| 5  | No Questions (Craft person’s knowledge) | ingredients passing the quarter of the volume. Turn off the heat after the water is half of the volume. However, for *colet* batik, the water should be a quarter of the volume. Let it cold then filter it. |
| 9  | Knowledge about the duration of processing each plant as the natural material for batik dyes | It depends on the ingredients. For example, indigo leaves should be treated differently from others. They should be soaked in cold water for 24 hours. After that, the green color on the surface is taken while stirring until the water is foamy. The more you stir while pouring the water from the top, the better the color you produce. |
| 10 | The experience about modifying mixed colors from one color ingredient to another color ingredient | Color modification depends on the boiling duration and the substance to preserve the color during the process of making batik on the cloth. To produce green color, we mix the first dye with *tegeran* then preserved using alum (*tawas*). Meanwhile, the second dye is dipped into indigo leaves and is preserved (“locked”) using vinegar. To create a darker color, we “locked” or preserve it using lotus. |
| 11 | Knowledge about the difference between natural batik and non-natural batik: color produced, the process of making batik, and production waste | That is different. The color of natural batik is faded, soft, and the process is more complex because the dyeing process is done 8-12 times for each cloth. Moreover, there is no waste because the remaining dye will be used again for the next dyeing. It is different from non-natural batik that has brighter color. Furthermore, the dyeing process is fast because only in one dyeing, the desired color has been seen. However, the dye is only used once, of which the waste can pollute the environment. |
| 12 | Knowledge about the process/step of making batik using natural dyes | 1. Kneading process (early mordanting)  
   - Soaking the water into water that has been given 2 grams of detergent solution for each liter of water for about 12 hours.  
   - Washing and drying the cloth  
   - Boiling the cloth in water (approximately 17 liters) containing 100 grams of alum for one hour  
   - Letting the cloth after one-hour boiling for a night  
   - Rinsing the cloth and drying it by aerating it  
  2. “Nyanting” (Putting wax): it has its own technique including the duration of *nyanting*, blowing the *canting*, the sitting position, the heat of wax, and the shape of *canting*.  
  3. “Coloration”: the cloth is folded into four, and each fold should be dipped and stirred in the water in order to penetrate the dye into the cloth. However, it depends on the type of cloth and the result of color. The longer the cloth is dipped and aerated, the sharper the color resulted.  
  4. The color is “locked” or preserved using three substances, namely lotus (for dark color), alum, |
Knowledge about the difference between natural batik of Ciwaringin and other types of natural batik

In our opinion, our motifs are unique, in terms of flora motifs and colors, and each craft person has its own motifs. Thus, all kinds of natural batik have different colors but have the same basis.

Figure 2. Interview and Observation with Some Craft persons of Ciwaringin Batik

After exploration activity, the data was reconstructed through identification, verification, formulation, and conceptualization of scientific knowledge through accommodation, assimilation, and interpretation, so the scientific knowledge can be formalized [8].

3.2. Reconstruction of the Community Science and Scientific Science in Using Batik Natural Dye

Reconstruction is the original knowledge of the community (indigenous knowledge) coming from their ancestors and being interpreted into the concept of scientific [9]. Reconstruction is needed to change the perception of the community so that it can be accounted for [8]. Based on the results of exploration, several things that can become the focus of this research to be reconstructed are the use of some natural ingredients and the process of making natural dyes. The knowledge of using natural ingredients and making natural dyes comes mostly from heritage knowledge, and personal experience, as well as counseling from the Indocement CSR program in Palimanan-Cirebon. This shows that the second focus of this research is a culture that developed from time to time as local wisdom in Ciwaringin Cirebon District.

The first focus is the knowledge of the craft person about several plants that can be used as natural dyes, which can be explained scientifically in Table 2:

| No | Questions (Craft person’s knowledge) | Original Knowledge of the people (Knowledge of Craft person of Ciwaringin Natural Batik) |
|----|-------------------------------------|------------------------------------------------------------------------------------------|
| 13 | Knowledge about the difference between natural batik of Ciwaringin and other types of natural batik | In our opinion, our motifs are unique, in terms of flora motifs and colors, and each craft person has its own motifs. Thus, all kinds of natural batik have different colors but have the same basis. |

Table 2. Reconstruction of Original Science and Scientific Knowledge of Natural Dye

| No | Local Name | The color produced | Scientific name | Description of Plant |
|----|------------|---------------------|-----------------|----------------------|
|    | (indigenous knowledge/ original science) | (original science) | (Scientific Knowledge) | (Scientific Knowledge) |
| 1  | Indigofera leaves | Blue | *Indigofera tinctoria* | This plant contains *indican* |
| No | Local Name (indigenous knowledge/ original science) | The color produced (original science) | Scientific name (Scientific Knowledge) | Description of Plant (Scientific Knowledge) |
|----|--------------------------------------------------|--------------------------------------|----------------------------------------|--------------------------------------------|
| 2  | Mango Bark                                      | Brownish-yellow                     | *Mangifera indica*                     | Mango is a family of *Anacardiaceae*. The leaves and bark of mango trees can be used as natural dyes [14]. The dye content found in mango bark comes from flavonoids [15] and tannins, while the resulting color is brownish yellow [16]. |
| 3  | Rambutan peel                                   | Light brown                         | *Nephelium lappaceum*                  | Rambutan is a tropical plant included in the *Sapindaceae* family. Rambutan peel contains *anthocyanin pigments* [17, 18], and the resulting color is light brown [2]. |
| 4  | Mangosteen                                      | Light brown (cream)                 | *Garcinia mangostana*                  | Mangosteen is included in the *Clusiaceae* family. The fruit contains anthocyanin pigments [19] The resulting color is brownish yellow [20] or light brown [21], or dark brown [22]. |
| 5  | Tegeran Wood                                    | Dark yellow                         | *Cudrania javanensis*                  | Tegeran belongs to the *Moraceae* family. It contains a *phenolic* compound (flavonoid and tannin). The color produced is yellow [23]. |
| 6  | Tingi                                           | Brown                               | *Ceriops tagal*                        | This plant belongs to the *Rhizophoraceae* family. The main content of tingi bark is tannin. reddish-brown color [24]. |
The second focus of this research is the knowledge about the process of making natural dye, the knowledge of community science referring to the steps of the process, while the scientific explanation is a scientific science of the process of making natural dyes that will be explained below:

- The process of “drying” is an initial process that is carried out by drying the materials in the sun for approximately 4-7 days (except for Indigofera). This means that scientifically what crafts-person does is essentially to eliminate the water content, so the concentration and coloring become more optimal. Thus, during the extraction process, the materials are no longer mixed with water in the cell.

- The soaking process is carried out for 3 days. The scientific purpose of the soaking activity is to ease the extraction process of dyes contained in each ingredient. The drying process of the material is also needed (except for Indigofera) so that the dyes produced are more optimal.

- The next step is the boiling process. This process is scientifically called extraction process that can use several types of polar solvents such as water and ethanol. Water extraction is the best extraction method for Indigofera leaves [10]. However, plants containing tannin such as the extraction of tingi wood using ethanol can extract tannin higher than using water [24]. The simplest and easiest method of extraction is by using water. During extraction, the diffusion process transports substances from inside and outside the cell. Extraction by boiling in water helps the process of transportation of these substances because heating helps the process of opening cell walls [21]. If it is used as a dye in colot method, it is extracted until a quarter remains. Extraction temperature affects the dyes obtained, and the levels of dyes obtained increase as the increasing temperature [20]. Extraction temperature can affect the color that is formed from tegeran wood. Extraction temperature affects the acidity of tegeran wood extract. The higher the extraction temperature, the lower the pH will be [23]. The extraction duration also affects the absorbance value of the resulting color. The results of the research on Tingi wood conducted by [24] state that the extraction duration of 3 hours produces higher absorbance values and tannin levels.

- After all, ingredients are extracted using boiling water, let them cold then filter, to continue to the next stage.

Some of the principles of science education in the context of local culture proposed by [26] are (a) the object of research must have a connection between culture and science; (b) the original knowledge of the community is very useful in daily life; (c) there is a place in science education content, and (d) the use of methodology in bridging conventional knowledge to scientific knowledge. These four principles are used as a reference in this study, so the knowledge of people related to the use of natural materials as batik dyes can be reconstructed as a scientific knowledge that is formalized and can be integrated with science education in schools or colleges.

4. Conclusion
The community knowledge related to the use of natural materials as batik dyes is very related to the concept of science and can be reconstructed as scientific knowledge formalized. The utilization of local plants as the basic ingredients of batik dye is unique local wisdom to preserve environmental
balance. Thus, it can be used as a source of cultural-based science learning at school (ethnoscience). The implication of this research is to implement environmental conservation and to uphold the values of local wisdom. The result of this study can be used as basis for further research, the process can be designed with current scientific technology without being replaced by modern culture.

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