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Ethnochemistry: Exploring the Silk Ecoprint Steaming of *Kampung Sabbeta* as a Source of Learning Chemistry

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Abstract
Kampung Sabbeta is one of the community empowerment locations that is developing ecoprint techniques for natural materials as fabric dyes and eco-friendly motif printers in Soppeng Regency, South Sulawesi Province. Considering the importance of knowledge about the environment, it is necessary to provide environmental management using natural materials as an effort to foster awareness of learning that is integrated with local wisdom values. This research was carried out to reveal the chemical aspects contained in the process of making steamed ecoprint fabric starting from the scouring, mordanting, ecoprinting, steaming and fixation processes which can be used as a resource for learning chemistry. The aim of this research is to reveal the chemical aspects and fundamental chemical activities contained in the silk steaming ecoprint process in *Kampung Sabbeta*. This research uses a type of qualitative descriptive with ethnographic methods, observation, interviews, and documentation. Data analysis in this research uses source triangulation which was carried out inductively, so that in this study key informants, main informants and supporting informants were determined in each aspect that became the object of research. The results show that the fundamental activities involved in the process of making silk ecoprint steaming in *Kampung Sabbeta* include formulating, measuring, purifying, fabricating, and playing. The chemical concepts that can be uncovered are solution preparation, purification, unit conversion in chemistry, adsorption, natural oxidation reactions, heat transfer.

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INTRODUCTION

Silk textile crafts have become local wisdom in areas with high economic value, including in South Sulawesi. South Sulawesi is one of the highest silk producing areas, namely 80% of the total production in Indonesia (Nuraeni, 2017). South Sulawesi silk weaving is typical with conventional methods which means it is very identical to Non-Machine Weaving Tools (ATBM).

One of the best silk producers in South Sulawesi is located in Soppeng district, especially *Kampung Sabbeta*. The name of *Kampung Sabbeta* comes from the word *sabbe* which in Bugis language means silk so that *Kampung Sabbeta* is known as Silk Village. *Kampung Sabbeta* is also known as the location for community empowerment for various business activities related to the silk business. The community empowerment activities carried out in *Kampung Sabbeta* include processing silkworms into cocoons, spinning silk thread, weaving silk thread into silk fiber, as well as innovation in the development of silk fiber using the ecoprint technique.

The ecoprint technique as a technique for utilizing natural colors by transferring certain colors and shapes to fabric through direct contact is starting to be in great demand in the industrial world (Nuraeni et al., 2022; (Suharsono et al., 2022). The ecoprint technique has been widely used in the textile industry (Sedjati & Sari, 2019), including the *Kampung Sabbeta* silk industry. The *Kampung Sabbeta* ecoprint technique, which is environmentally friendly (Saptutyningsih & Wardani, 2019), uses selected fabrics from natural fibers, namely fiber from silkworms, dyeing fabrics using natural coloring pigments. It doesn't stop there, the leaves that have been used to form motifs on fiber can also be processed into fertilizer for plants, or humus for the soil to maintain soil fertility. Another uniqueness of the ecoprint technique is that the products produced are limited edition or very limited with 'one doing one product' (Mardiana et al., 2020) . Apart from that, the specialty of the ecoprint technique is that the colors and patterns produced are similar to the natural materials used (Naini & Hasmah, 2016; (Arifah et al., 2017). Even though they use the same type of natural materials and the same techniques, each product produced using the ecoprint technique is uniquely different (Anang Setiyo Waluyo et al., 2019; (Sari, 2022a). This is what makes this ecoprinting technique have high artistic value.

One type of ecoprint technique is ecoprint pounding. Much research has been done on the ecoprint pounding technique. Currently, this ecoprint technique is becoming a trend because it is in accordance with the rising issue regarding the production of environmentally friendly materials that do not cause environmental toxicity. This technique provides knowledge about the utilization of local potential, such as plants or natural materials around them through the pounding technique of teak leaves, cassava leaves, papaya leaves, butterfly pea flowers on the surface of cotton fiber (Clourisa et al., 2021). Other studies have revealed that the pounding technique on ecoprint is like printing leaf motifs on certain fabrics in a very attractive, simple and safe way. Ecoprint is defined as the process of giving color and shape to the fabric through direct contact. This study used a hammer to hit teak, katuk, kelor, and papaya leaves that had been placed on primisima fiber and totebag blacu covered with plastic to extract the color pigments. The result is a unique and attractive tote bag with a variety of leaf motifs (Octariza & Mutmainnah, 2021). Much research has been carried out on the application of ecoprint for making tote bags. One of the reasons why making tote bags using the ecoprint method using calico fabric is so popular is because it uses materials from the surrounding environment, namely leaves around the house, making it a profitable business (Aini et al., 2022). Considering that there is a recommendation from the government to reduce the use of plastic with the aim of reducing plastic waste which is difficult to decompose, the use of calico fabric to be used as a tote bag with an ecoprint using natural leaf motifs around it is one solution (Fadhli et al., 2023).

The ecoprint pounding technique is used to make traces of natural materials on silk fiber by hitting the leaves one by one on the fiber (Marnengsih & Irdamurni, 2022), so that the colored pigments from the leaves are older and brighter with relatively long processing time (Musdalifah et al., 2022). Therefore, the ecoprint steaming technique can be used which is rarely applied in the textile industry. However, the advantage of ecoprint steaming is that the processing process is faster than the ecoprint pounding technique because it can be done simultaneously at a time, and produces monochrome colors that are in great demand and are capable of producing abstract motifs (Widhiastuti et al., 2022).

Various techniques applied in ecoprinting, in principle there are many benefits that can be obtained, especially for ecoprint steaming. Some of the practical benefits of the ecoprint technique include that the media used in ecoprint steaming is not limited to fabric alone, but as an object that is able to absorb natural colors from leaves and flowers that can be used (Soemadijo et al., 2022), then, compared to plain or patterned fabric with digital product

techniques the fabric produced using the ecoprint steaming technique is much more exclusive.

The sustainability of ecoprint steaming is not only applied to sheets of fabric (F. Lestari et al., 2022), but in principle the ecoprint steaming technique can also be applied to various clothing products (Dalimunthe et al., 2022) as well as complementary household products. Many ecoprint steaming products have been made into pashminas (Nisa et al., 2022), headscarves (Yuliana et al., 2022), tote bags (Fadhli et al., 2023) and masks (Ananda et al., 2022; Nafi'ah & Husna, 2021). Here are some examples of rarely seen ecoprint steaming products that can be made, namely, napkins, curtains, clothes, trousers, bed sheets, bags, shoes, mugs/glasses, fans, umbrellas, etc. according to your wishes and needs. The unique thing about ecoprint steaming is that it is not only environmentally friendly (Faridatun, 2022). This steaming ecoprint uses materials that are easily available. The technique can even be done at home (Jariah et al., 2023). The result, if it is well composed, will produce a natural and very attractive fabric. Apart from that, the next innovation is to use media other than cloth, such as the leather used can be sheepskin or other leather, and the paper that can be used is linen paper and cement paper (Utomo et al., 2021).

The process of ecoprint steaming is one of the potentials of local wisdom which can be a source of natural science learning related to environmental management (Widiantoro, 2020; Mutmainah et al., 2022; Ilyas et al., 2023). Given the importance of knowledge about the environment, environmental management is needed using natural materials (Situmorang, 2017; Nugroho et al., 2023). An effort to revive awareness of learning that is integrated with local wisdom values is important (Kurniati et al., 2021; Irdalisa et al., 2023). Related to this, a recommended lesson for Indonesia is ethnoscience (Purwoko et al., 2020; Yanti & Hamdu, 2021). Ethnoscience appears to provide an approach related to learning scientific knowledge that integrates a culture and creates a learning environment that describes learning experiences as part of the implementation of learning. The scope of ethnoscience includes several scientific disciplines, namely ethnochemistry, ethnobiology, ethnophysics, ethnomedicine, aspects of agricultural practitioners to food technology (Fahrozy et al., 2022). Ethnochemistry integrated learning is not only able to create a more meaningful learning, but also has an influence on efforts to preserve national culture (Azizah & Premono, 2021).

Based on the description above, there is a connection between the local wisdom of ecoprint steaming silk from Kampung Sabbeta with chemistry. In order that, the urgency of this research really needs to be carried out to reveal the fundamental chemical activities involved in the production of ecoprint crafts and reveal what chemical aspects are relevant to the activity of making ecoprint silk fabric crafts in Kampung Sabbeta.

METHOD

This research uses a qualitative descriptive research type by collecting data about facts, meanings, and relationships between the phenomena being studied. The main object in this research is the silk steaming ecoprint process. The selected research locations are concentrated in *Kampung Sabbeta*, Soppeng Regency, South Sulawesi Province.

As a first step in research, data about ecoprint was collected from various literature sources. Data analysis in this research uses source triangulation, so that in this research key informants, main informants and supporting informants are determined for each aspect that is the object of research. In determining informants, this research used purposive sampling by paying attention to the conditions that must be met to become an informant so that an informant was obtained who was able to work well together. The informants chosen in this research were the owner of the Kampung Sabbeta Ecoprint Production House, Mrs. Hasnah

M., the Kampung Sabbeta ecoprint craftsmen, Mrs. Musdalifah Riwayati and Mrs. Winda, and an ecoprint consumer in Kampung Sabbeta, namely Mrs. Suriani Tahir. This information is related to ecoprint steaming activities and chemical concepts. This research data collection technique was carried out by observing, interviewing and documenting. Data analysis was carried out inductively, namely an analysis based on the data obtained. The procedures in the research process include the stages of determining the scope of the research, selecting and determining informants, conducting interviews with informants, taking notes, recording data or documenting and analyzing the data obtained.

RESULTS AND DISCUSSION

Ecoprint is a printing technique with natural fabric coloring which is quite simple but can produce unique and authentic motifs (Nurliana et al., 2021). Based on information from observations and interviews obtained from informants, it is confirmed that the Kampung Sabbeta silk ecoprint uses the Kampung Sabbeta ecoprint steaming which is better than the pounding ecoprint. The production process for steaming ecoprint fabric crafts involves scouring, mordanting, ecoprinting, steaming and fixation processes. Therefore, the ethnochemical study carried out in this research includes an analysis of the fundamental chemical activities contained in the production process of the Kampung Sabbeta ecoprint crafts. Formulating activity is one of the activities that is often carried out by the community, related to the many things in the process of making a product (Fitriyah, 2021). Measuring activity is more related to the question word "how much" such as weight, length, temperature, time, and volume (Fitriyah, 2021). Purifying activities carried out by the community are related to cleaning fabrics from components that can inhibit the absorption of color. Fabricating activities carried out by the community related to design activities have been implemented (Hartoyo, 2013). Playing activity is an activity that is fun, has a certain pattern and encourages someone to set a strategy (Fitriyah, 2021). Therefore, the results of the analysis reveal that the ecoprint fabric production process includes five basic chemical activities, which will be discussed below.

Formulating

Formulating activity is found in the scouring process. Scouring is a cleaning process to remove residual dirt from the fabric to be made of ecoprint. The fabrics used are made from natural fibres, such as cotton, rayon, silk or other types of fabrics (Fidiana et al., 2023).

Figure 1. Types of fabrics in ecoprint process

The scouring process is done by soaking the fiber in a solution of TRO (Turkish Red Oil) (Kusumawati et al., 2018). The scouring process uses TRO mixed with plain water. The ratio

of TRO : water = 10 grams: 2 liters for 1 piece of fabric with a length of ± 1.5 meters (adjustable). Soaking was carried out for 30 minutes, then rinsed thoroughly and dried in the sun to dry.

Apart from that, the formulating activity is in the activity of formulating a comparison of tools and raw materials to make 1 piece of ecoprint fabric. The tools used in this case are silk fabric, with natural ingredients to make natural dyes, as well as plants to print ecoprint motifs on fabric. The more motives desired, the more natural materials and plant elements needed to form motifs (Cholilawati & Suryawati, 2021).

Figure 2. Scouring process

Before entering the steaming stage, plastic is used to wrap the ecoprint fabric which is measured according to the length of the fabric. For each production process, each pair of fabric and plastic is prepared (Khodijah et al., 2021). The chemical concept that arises during the process of cutting fabric and plastic is formulation.

The same thing was done in the mordanting process. Mordanting is the process of soaking silk fiber using alum for 24 hours and then continuing with tunjung powder for 5 minutes (Afrahamiryano et al., 2022). The ratio of alum, tunjung and water is alum: tunjung: water = 15 grams : 5 grams : 1 liter of water with a fabric length of ± 1.5 meters. The more fabric that has a motif, the more alum and tunjung will be used. This shows that formulating activities involve the process of making solutions, such as dissolving TRO. TRO is a chemical compound that functions as a wetting agent to facilitate the absorption of dyes in fabric. Through this soaking activity with TRO, a chemical bridge is formed between natural dyes and fabric fibers so that the affinity (attraction) of the dye increases towards the fabric fibers used (Filippi et al., 2023).

Measuring

Measuring activity is found when ecoprint craftsmen cut materials and plastics and measure the amount of solution. Measuring tools used include a fiber meter, thermometer, digital balance, and tablespoon. Meanwhile, when craftsmen make solutions for scouring, mordant, natural dyes, and fixation processes (P. Lestari & Sakti, 2022), the standard measurements used to measure natural ingredients and water are grams, liters, cc, and degrees celsius. Furthermore, the usual dose is to use a tablespoon measure. Meanwhile the time required for the creation cycle uses seconds, minutes, hours and days (Puspasari et al., 2021).

The chemical concepts seen in this measuring activity are length, weight, volume, temperature and time, which are units often used in chemistry. Unit conversions are important in all sciences, although they may seem more important in chemistry because many calculations use more units of measurement. This measuring activity can be seen when using

grams, moles and kilograms, which are units that describe the amount of matter, while kelvin and celsius describe temperature.

Purifying

The purifying activity involved in this ecoprint process is at the scouring stage. Scouring is done by soaking the fiber in TRO solution. TRO serves to remove chemical substances contained in the fabric. In addition, TRO is also used as a wetting agent which then facilitates the absorption of dyes (Kusumawati et al., 2018)

Figure 3. Mordanting process using $Al_2(SO_4)_3$

The next purifying activity is also found in the mordant process. The mordant on this ecoprint uses alum (Al2(SO4)3) which functions to clean the fabric and open the pores of the fabric so that the colors can be absorbed properly and the pattern is printed perfectly .

Alum with the chemical compound name Al2(SO4) is a group of alum (Al) salts in the form of crystals that dissolve easily in water, and have a pH lower than 7 (Jubaedi, 2017). Alum is the best mordant for burial because it is not dangerous, unless used in large doses. The mordanting process with alum can produce colors that tend to be lighter, this is based on the chemical structure of alum which can purify water (D. S. & Alvin, 2019). The chemical compound in alum has a complex reaction combining orthophosphate compounds with metal cations (Al3+, Fe3+, Ca2+) (Jubaedi, 2017). The following is the water purification reaction in alum:

$$Al_2SO_4 + 6H_2O \longrightarrow Al(OH)_3 + 6H^+ + SO_4^{2-}$$

This reaction causes the release of high levels of H+ ions and is enhanced by the presence of aluminum ions. If these substances are dissolved in water, dissociation of the salt will occur into metal cations and anions. Metal ions will form a layer in the solution with a lower concentration than water molecules, this is caused by the strong positive charge on the surface of the metal ion (hydration) by forming hexoquo molecules (6 H2O molecules) or called (H2O6), namely [Al(H2O6)] (Febrina et al., 2019).

This ion is stable and acidic, for Al at a pH of less than 4 and for Fe at a pH of less than 2. The coagulant solution is in the form of trivalent (3 valence) Fe3+ or Al3+, producing a pH of less than 1.5 (Tadesse, 2017). When the alum solution is added to H2O, a hydrolysis reaction occurs, as follows:

Hydrolysis reaction : $Al^{3+} + H_2O \longrightarrow Al(OH)_3 + 3H^+$

After that, the mordant process was continued by immersing the fabric in tunjung or bow solution (FeSO4). Bow serves to bind and remove tannins. In addition, bow is also used for the fixation process in the process of dyeing fiber (Saptutyningsih & Kamiel, 2020). The use of this bow will produce a fiber with a stronger fastness on the fabric. This is related to the occurrence of dye bonds that are able to enter the fabric fibers to the maximum and bind

strongly to the fabric fibers. The more FeSO4 used, the lower the solubility of tannin in water, the higher the bound tannin, the stronger the fastness (Pratiwi & Sulistyati, 2022).

Figure 4. Mordanting process using $FeSO_4$

Bow can oxidize natural dyes where Fe2+ is oxidized by Fe3+. Oxidation reactions are reaction that occur which then cause an increase in the oxidation number of an atomic ion due to the release of electrons and/or the addition of oxygen (Nurmasitah et al., 2022). An illustration of the interactions that can occur between fabric fibers and alum and tunjung mordant compounds can be seen in Figure 1.

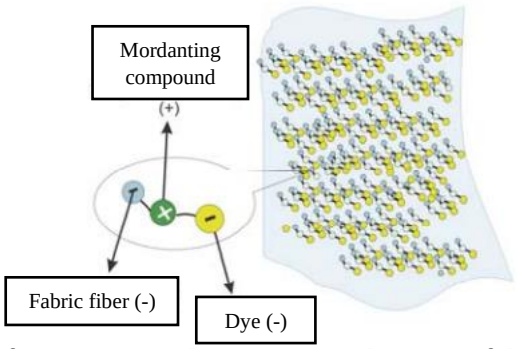

Figure 5. Illustration of interactions that can occur between fabric fibers with mordant compounds (Kusumawati et al., 2018)

The mordant compound acts as an intermediate compound that allows interaction between negatively charged fabric fibers and natural coloring compounds which are also dominated by the same charge. One of the positive charges of the mordant compound will interact with the negative charge of the fabric fiber and the remaining positive charge will interact with the negative group of the coloring compound. The greater the positive valence possessed by the mordant compound, the higher the quantity of dye bound, resulting in higher strength and color fastness (Kusumawati et al., 2018).

This purifying activity shows that the process involves a purification process to remove chemical substances that can inhibit the color absorption process on the fabric.

Fabricating

The fabricating activity seems to determine what natural colors will be used. In addition, fabricating activities are also carried out while determining natural raw materials to be used for the mordanting and fixation processes (Gunawan & Anugrah, 2020). The mordant process

has various procedures, both regarding the composition of the material and its stages. Because between one method and another method will produce different shading.

Fabricating activities can also be found at the printing stage, namely the activities of arranging leaves, flowers and stems on the fabric to make motifs. Leaves that have a fairly high tannin content are able to release color and follow the texture into a single unit that does not need treatment (adsorption) (Puspasari et al., 2021). Some leaves and flowers that do not have a low tannin content require prior treatment (Pratiwi & Sulistyati, 2022).

Figure 6. Leaf arrangement (Ecoprint Process)

After the leaf absorption process is carried out, the next leaves, flowers and stems are arranged on the fiber. The laying of leaves is very free, because they can be made into different structures (Azizah et al., 2022). This will add variations in the design of the motif arrangement, as well as the different and unique sizes of the leaves, so that when combined they will form good results. By providing a little "feel" of the ideal, it would set a fun example.

The absorption of color from plants on the fabric is called the adsorption process (Nurmasitah et al., 2022). Adsorption is a method that is most widely used by utilizing natural resources which are still abundant, or using agricultural, livestock and fisheries waste which is often wasted and even activates or modifies it to increase porosity and expand the surface area of absorbent material (Simanungkalit & Syamwil, 2020). Adsorption in the fabricating process is one of the chemical activities in the ecoprint process.

The leaves that have been used to form motifs on fabric can also be processed into fertilizer (Widhiastuti et al., 2022). Apart from being processed into fertilizer, the leaves can also be used as wall decorations. This is one of the reasons ecoprint is environmentally friendly (Sifaunajah et al., 2020).

Playing

Playing activity is contained in determining the ecoprint method used. To get good results, each ecoprint process has its own strategy or rules, just like the steaming method with the following steps.

Before the ecoprint fiber is steamed, first prepare a fiber covering plastic according to the length and width of the fiber. Then the plastic is spread over the ecoprint fiber in a flat and adequate place.

Figure 7. Laying of fabric and leaves

The leaves are arranged as desired which can form unique motifs which can also be dynamic. Then covered with fiber and then plastic. Then the fiber is folded symmetrically and rolled into a lontong to make it easier to enter the steam pan. Put it in the steamer/steamer for 2 hours.

Figure 8. Steaming process

After 2 hours, the fiber was removed from the steamer and opened carefully. Leaves attached to the fiber are cleaned and air-dried to dry (natural oxidation process).

Figure 9. Ecoprint results

This playing activity can be seen in the steaming process through heating, namely heat transfer using water vapor in a closed container to transfer plant pigments to the fabric media (Sedjati & Sari, 2019). In addition, playing activities also involve a natural oxidation process by binding to oxygen or releasing electrons. When oxygen is involved, the oxidation process depends on the amount of oxygen present in the air and the properties of the material it

affects (Naini & Hasmah, 2016). Therefore, playing activities in the steaming process are closely related to chemical aspects

Based on several fundamental chemical activities in the ecoprint production process, it is confirmed that ecoprint is a printing technique that uses natural materials as raw materials. Therefore, the benefit of this technique is to produce environmentally friendly products (Sari, 2022b). Do not pollute the environment with waste released from textile factories. So that the environment remains clean and sustainable. Apart from that, the products produced prevent craftsmen and consumers from health problems that might arise from dangerous chemicals.

CONCLUSION

The process of making ecoprint steaming silk contains fundamental chemical activities and chemical concepts. The fundamental activities that can be found in the production of silk steaming ecoprint in *Kampung Sabbeta* include formulating, measuring, purifying, fabricating, and playing activities. While the mathematical concepts found in the ecoprint production process are solution preparation, purification, unit conversion in chemistry, adsorption, natural oxidation reactions, heat transfer.

RECOMMENDATIONS

The suggestion describes the things to be done related to the next idea of the study. Obstacles or problems that can affect the results of the study are also presented in this section. The use of chemicals in the production process of a material needs to be considered. This can be used as an improvement for future research that the use of natural materials in the ecoprint manufacturing process is maximized compared to the use of chemicals that can harm the environment. Henceforth further exploration is needed regarding ecoprint and product development.

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