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Innovation and Technology Based on Research on the Influence of Lead Toxicology towards Health to Create an Eco-Friendly Batik Industry in Achieving Sustainable Development Goals

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Abstract

Community welfare in Society 5.0 is the goal of sustainable development, so innovation and technology are expected to help humans without causing environmental damage. Batik is one of the original Indonesian cultural heritage arts recognized by UNESCO. However, the production process in the batik industry still poses some risks of contamination from dyeing waste. This pollution negatively impacts health, such as stunting, neurotoxins, and genetic mutations. Considering the risks posed to craftsmen and the surrounding environment, batik industries need to create innovation and technology to support a safer and environmentally-friendly batik production process. Thus, this effort will contribute to responsible production as well as maintain a healthy and prosperous life for the community. Innovation and technology are based on research results related to lead toxicology in batik dye waste. Some innovations are tea made of Meniran (Gale of the wind) leaves used as an antioxidant against lead-free radicals, a simple biofilter made of Oyong (Chinese okra) sponges, and hand soap made of used cooking oil as a cleanser for residual wax that sticks to hands. These innovations are expected to maintain clean water and proper sanitation in the batik industry. In addition, it is necessary to create appropriate technology like an innovative batik brush, a batik coloring tool with minimal spills and splashes, which can save ink containers and production costs. The results of the activities have been educated to the target villages with a batik industry community forum in Surakarta. Product innovation has been written in a pocketbook and easily applied by the community.

Keywords: neurotoxin, antioxidant, biofilter, sanitation, technology

1. Introduction

Community welfare in Society 5.0 is the goal of sustainable development, so innovation and technology are expected to help humans without causing environmental damage. Batik is one of the original Indonesian cultural heritage arts recognized by UNESCO. However, the production process in the batik industry still poses some risks of contamination from dyeing waste. This pollution negatively impacts health, such as stunting, neurotoxins, and genetic mutations.

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Research discussing the dangers of lead in brain damage was previously conducted by Susilowati et al (2022). In that study, it was proven that the accumulation of lead exposure due to motor vehicle pollution had a neurotoxin effect, including decreased cognitive function. This problem should be taken seriously, especially in industrial areas prone to it, which will lead to a dire situation if the area is close to settlements.

Batik cloth is famous throughout Indonesia, and each region has unique motifs inspired by local cultural characteristics depicting creativity and spirituality. The process of coloring batik is one of the stages in batik production. Batik coloring can use natural or synthetic materials. Synthetic dyes are widely used because of their affordable prices and more color choices to develop batik motifs and patterns. However, the use of synthetic dyes becomes a potential source of exposure to heavy metals such as lead (Pb) and chromium (Cr), found in batik dyes, particularly to workers in the dyeing (Hastuti, et al, 2018).

It can cause health problems. It can cause behavioral changes, hyperactivity, impaired concentration, and decreased IQ in children. Meanwhile, adults may experience hypertension, headaches, anemia, and other minor health problems (Needelman, 2004).

Considering the risks posed to workers and the environment around the batik industry, it is necessary to innovate products and technologies that make batik production safer and more environmentally friendly for responsible production and healthy life.

2. Method

The checking method includes examining the water quality. At the location of the batik home industry, the clean water quality testing, which is based on the criteria of the Regulation of the Ministry of Health No. 32 of 2017, showed that the results, physically, chemically, and inorganic chemically, still meet the standards but do not meet the requirements for clean water quality in microbiological tests, which is one indicator of water pollution.

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Figure 1. Sampling of water sources around the location

The next method is public health checks around the batik industry. This health check includes an examination of exposure to lead in the blood of batik craftsmen and an examination of haemoglobin levels in women of reproductive age. This examination was carried out in response to information that the incidence of stunting in children has increased in areas of the batik industry, which are vulnerable to lead exposure.

(a) (b)

Figure 2(a) Examination of batik craftsmen, 2(b) Examination of women

Health education was carried out to provide education and knowledge for SME entrepreneurs in the batik home industry and batik craftsmen who work in the dyeing and washing department, and the PKK (Family Welfare Program) meeting forum for women at the RW

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(Citizens Association) level. The community was given health education and training in making products to anticipate the impact of exposure to lead from synthetic batik dyes.

Figure 3. Pocketbook for making Meniran tea and soap

One of the methods to create eco-green batik is to collaborate with batik community forums. It is hoped that it become a form of responsible and sustainable production and consumption activities. Collaboration between academia and industry will produce appropriate technology. This appropriate technology is expected to be one of the solutions to the problem of environmental pollution due to the batik industry.

Figure 4. Establish collaboration with and accommodate the aspirations of the Village and Batik Community Forum

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Before being marketed, the appropriate technology was tested in an institutional-level competition (Krenovanas STIKES Nasional). Based on the judges' suggestions, it was later modified and perfected, then contested in the Surakarta City Krenova competition.

Figure 5. Appropriate Technology Expo for Batik Dyeing Tools at the Krenova Surakarta Event

With the support of the Surakarta City Government, the team was then invited to participate in a competition at the Central Java Province level. Currently, the product has been registered through the Balitbangkesda Surakarta based on community suggestions via the website http://moving.jatengprov.go.id/.

3. Result and Discussion

Innovation and technology are based on research results related to lead toxicology in batik dye waste. Examination of the quality of well and river water shows that the quality of well water does not meet the standard of clean water; based on the results of the questionnaire distributed, it is shown that 65% of the questionnaire results obtained still use well water for daily needs. The results of the health examination of batik dye workers from 21 samples show that there were 6 (28.57%) batik workers having blood lead levels exceeding the normal limit of (<10µg/dL) and 7 (33.33%) workers experiencing irritation after contact with batik dye. Anemia examination shows that 11% of respondents have the symptoms of anemia.

Lead is highly toxic to humans and potentially causes irreversible health effects. This is characterized by disturbances in several body functions, especially in the central nervous, hematopoietic, liver, and kidneys (Kalia & Flora, 2005).

Contact with synthetic dyes, as experienced by workers in the batik industry, can cause various skin disorders. One of the skin problems due to exposure to chemicals is skin irritation. The prevalence of skin irritation is 33.33% (7 people), with the most age characteristics being 40-70

years, the working period of more than 5 years, and the length of contact exposure of 0-3 hours/day. The most common symptom is itching on the palms, back of the hands, forearms, between the fingers, and the backs of the feet (Saroh et al., 2022).

Lead has adverse effects, including decreased intelligence, impaired hearing, impaired growth, and decreased hemoglobin levels, leading to danger for children (Dewi et al., 2023).

Low hemoglobin level in women of childbearing age causes a risk factor for stunting. According to Dewi et al. (2022), Family 4.0 needs to be carefully planned and educated, starting from teenagers, and prospective brides, to couples of childbearing ages. This is to support the formation of Indonesia Gold in 2045 with a generation free from stunting and ready to face global competition.

Exposure to lead is one of the free radicals that can cause ROS. Reactive Oxygen Species (ROS) in red blood cells is one of the main causes of anemia. Increased ROS on red blood cells can occur either by ROS activation or suppression of the antioxidant system. When red blood cells increase and cause excessive ROS, it will lead to oxidative stress (Luchi, 2012). Iron balance is very important to maintain normal erythropoiesis. Optimal balance is needed by pregnant women.

Stunting is a chronic nutritional problem caused by multi-factorial, which is intergenerational. Risk factors for stunting include problems with nutrient intake, growth hormone, and the occurrence of recurrent infectious diseases in toddlers (Harningsih et al., 2023).

According to Nurjazuli et al. (2021), exposure to lead sourced from the environment can cause stunting in toddlers due to the nature of the heavy metal that inhibits the absorption of nutrients from food and decreases cognitive scores in children.

Exposure to lead is a free radical that must be overcome to prevent ROS. According to Dhiya et al. (2023), in conditions with more free radicals and endogenous antioxidants that cannot fight back, exogenous antioxidants are needed, which can be obtained from food and drink intake. Antioxidants can absorb or neutralize free radicals.

Considering the risks posed to workers and the environment around the batik industry, it is necessary to innovate products and technologies that make batik production safer and more environmentally friendly for responsible production and healthy life. Product innovation and technology are made based on research results on lead toxicology in batik dye waste.

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The first innovative product includes tea from Meniran leaves as an antioxidant in counteracting free radicals of lead. Meniran (Phyllanthus niruri L.) has many benefits for health used as an antioxidant, antibiotic, hepatoprotection, antipyretic, antitussive, antiplatelet, anti-inflammatory, antiviral, diuretic, expectorant, antidiabetic, antibacterial, anti-urolithiasis, anti-hyperuricemia, antineoplastic, anti-amnestic, and immunostimulants (Adnan, M et al., 2016). The mechanism of flavonoids and vitamin C as antioxidants in Meniran is different but will complement each other to reduce the impact of cell damage. The mechanism of flavonoids is by capturing free radicals, breaking free radical chains, binding metals, inhibiting oxidase enzymes, releasing oxygen molecules, and donating electrons. Meanwhile, vitamin C acts as a secondary antioxidant, functioning as a superoxide destroyer (O2 -), peroxyl radical scavenger, and lipid peroxidation inhibitor (Winarsi, 2011).

Figure 6. Meniran Tea

Making the Meniran (Gale of the wind) tea begins with making the Meniran leaves simplicia. First, wash the leaves under running water, then drain and cut them into pieces to speed up the drying process. After being cut into pieces, they were stored at room temperature for one week, then dried in the sun for an hour as the final drying step. Finally, the dried leaves are stored in a jar at room temperature. A way to make the tea is by brewing one teaspoon of gale-of-the-wind with 240 ml of warm water and then adding sugar or honey according to taste.

The first appropriate technology is a simple biofilter from a natural Oyong sponge (Chinese okra). Biofilter is a process of treating leftover batik dyeing wastewater into water suitable for use with a method carried out systematically. Biofilters use a particular container to maintain

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environmental quality (Filliazati, 2013). This biofilter is used before the waste is discharged into water bodies; it is processed first to reduce heavy metal levels.

Research by Ashari (2016) shows that the combination of Gracilaria sp biofilter, Zeolite, and activated charcoal significantly reduces the concentration of the heavy metal lead. The combination of Gracilaria sp biofilter, Zeolite, and activated charcoal was recorded to have a value range of 0.0002-0.945 ppm. Natural ingredients other than Gracilaria sp, which can also reduce Pb levels, are Oyong (Luffa acutangula). This plant belongs to the Curcubitaceae family (Margareta, 2013). Fiber from Oyong comprises 60% cellulose, 30% hemicellulose, and 10% lignin (Mazali & Alves, 2005). This cellulose content influences metal absorption (Yoseva et al., 2015). Research by Susilowati et al. (2018) and Oboh et al. (2011) proved that Oyong sponge can be used as an effective natural adsorbent for several metals.

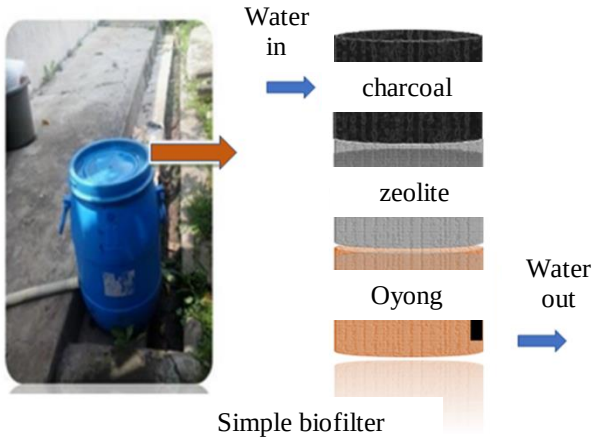

Figure 7. Biofilter made from sponge of Chinese okra

This condition motivates the second innovative product: making soap from used cooking oil to clean wax residue and dyes that stick to hands. This soap is made using economical materials that are easy to obtain. The method of preparation is to pour 60 ml of water into a container, then pour 30 gr of NaOH into the water, then stir until it dissolves, then pour 250 ml of oil and stir again until the texture is like mush, then add grated orange peel to taste, then stir again, then put it in the mold, and wait a few days until it hardens.

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Figure 8. Soaps from used cooking oil to clean craftsmen's hands from wax

There is also an appropriate technology, such as a batik brush, an innovation of a batik coloring tool that minimizes spills and splashes and is more efficient in terms of space and production costs.

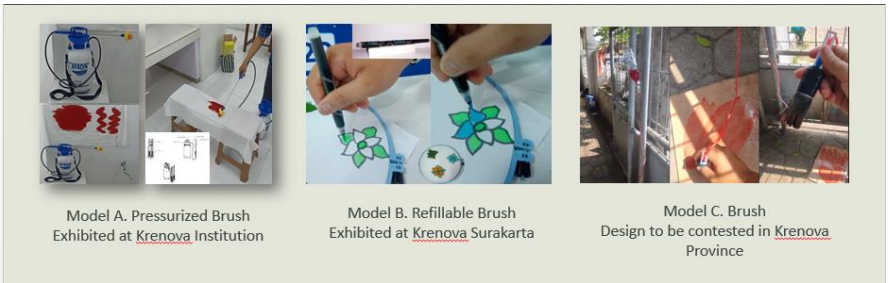

Figure 9. Innovation of environmental-friendly tools for coloring batik

The activity results have been educated to the sub-districts under guidance which have a batik industry community forum in Surakarta. Innovative products have been made in the form of pocketbooks that the community applies. The technology has been contested at the regional level of Surakarta and is currently continuing to perfect innovation at the provincial level of Central Java.

4. Conclusion

UNESCO has acknowledged batik as Indonesia's cultural heritage. Hopefully, the production of batik cloth will become a sustainable activity. A sustainable production must consider environmental continuity, the welfare of its workers, and the people who live in the vicinity. Eco-green batik is a step toward making the art of batik sustainable. The embodiment of eco-green batik is carried out by producing appropriate technology and innovative products to

minimize the toxicological risk of the heavy metal lead from dyeing and washing waste in the production of batik cloth. The implementation in the post-educated society is in the form of pocketbooks distributed to them as partners, so it is hoped that this will continue.

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6. References

Adnan M. A, Fernandez AR, Jeevaratnam K, Mahalingam TP, Lee YSN, Khoo WKS. (2016) The Pharmalogical potential of Phyllanthus niruri, *Journal Pharmacy and Pharmalogical, 68, pp. 953-969*

Dewi, N., Semartini, A., & Rosita, R. (2022). Edukasi Siaga Family 4.0 dan Pentingnya Kesehatan Reproduksi pada Kader Kesehatan dan Tim Penggerak KB. Jurnal Peduli Masyarakat, 4(2), 339-346. https://doi.org/10.37287/jpm.v4i2.1179

Dewi, N., Susilowati, I.T., & Widhiyastuti, E. (2023). Edukasi Bahaya Timbal pada Sekolah Rentan Polusi terhadap Prestasi Akademik dan Kesehatan Siswa. Jurnal Surya Masyarakat, 5(2), 201-207. https://doi.org/10.26714/jsm.5.2.2023.201-207

Dhiya, S., Ramadhan, I., Qurrohman, M., Dewi, N., & Ariyanti, A. (2023). Pencegahan Kerusakan Hati dan Penyakit Alzheimer Akibat Konsumsi Alkohol Terselubung dengan Pola Hidup Sehat. Jurnal Peduli Masyarakat, 5(2), 409-416. https://doi.org/10.37287/jpm.v5i2.1821

Filliazati, M et al. (2013). Pengolahan Limbah Cair Domestik Dengan Biofilter Aerob Menggunakan Media Bioball dan Tanaman Kiambang. Jurnal Teknologi Lingkungan Basah

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Harningsih, T., Dewi, N., Harini, S., Suryo, D., Choirunisa, D., & Damayanti, E. (2023). Penyuluhan Stunting dan Pemberian Makanan Tambahan bagi Keluarga yang Berhak di Kelurahan Pucangsawit, Jebres, Surakarta. Jurnal Peduli Masyarakat, 5(1), 13-16. https://doi.org/10.37287/jpm.v5i1.1509

Hastuti, P, et al. (2018). Hubungan timbal dan krom pada pemakaian pewarna batik dengan kadar hemoglobin dan packed cell volume pada pengrajin batik di Kecamatan Lendah Kulon Progo. Journal of Community Empowerment for Health, Vol 1(1) November 2018 DOI: 10.22146/jcoemph.39156

Kalia K, Flora SJ. (2005). Strategies for safe and effective therapeutic measures for chronic arsenic and lead poisoning. J Occup Health 47: 1–21.

Luchi, Yoshihito. (2012). Anemia Caused by Oxidative Stress. In Tech:Croatia.

Margareta, Defira. (2013). Pengaruh Dosis Pupuk NPK Nature Dan Dosis Pupuk Npk Organik Mashitam Terhadap Pertumbuhan Dan Produksi Tanaman Gambas (Luffa acutangula) Varietas Prima. Skripsi. Fakultas Pertanian. Universitas Islam Kediri. Kediri.

Mazali, I. O., & Alves, O. L. (2005). Morphosynthesis: high fidelity inorganic replica of the fibrous network of loofa sponge (*Luffa cylindrica*). Anais Da Academia Brasileira de Ciências, 77(1), 25– 31. https://doi.org/https://doi.org/10.1590 /S0001-37652005000100003

Needleman, H. (2004). Lead Poisoning. *Annual Reviews Med, 55:209-222, doi: 10.1146/annurev.med.55.091902.103653*

Nurjazuli., Darundiati, Y.H., Wardoyo, S. (2021). Paparan Plumbum (Pb) sebagai Pemicu Stunting pada Balita. Poltekita: Jurnal Ilmu Kesehatan, 15 (3), 37-43 https://doi.org/10.33860/jik.v15i3.508

Oboh Innocent, Emmanuel O. Aluyor dan Thomas O. K. Audu. (2011). Application of Luffa Cylindrica in Natural form as Biosorbent to Removal of Divalent Metals from Aqueous Solutions. Kinetic and EquilibriumStudy, Waste Water - Treatment and Reutilization. Nigeria.

Saroh, D., Purwati, P., & Harningsih, T. (2022). Description of the Event of Irritant Contact Dermatitis in Employees of the Home Industry Batik. *Indonesian Journal of Global Health Research*, *4*(3), 535-542. https://doi.org/10.37287/ijghr.v4i3.1200

Susilowati, I. T., & Susilowati, S. (2018). Pemanfaatan Handsanitizer Dan Biofilter Biji Kelor Serta Spons Oyong Sebagai Solusi Preventif Pencemaran Air Dan Peningkatan Prilaku Hidup Bersih Dan Sehat Di Kismosari Desa Gadingan Kecamatan Mojolaban Kabupaten Sukoharjo. Jurnal Pengabdian Kepada Masyarakat, 24(3), 755–761. https://doi.org/https://doi.org/10.2411

4/jpkm.v24i3.11590

Susilowati, I., Dewi, N., Trikusumaadi, S., & Saputri, D. (2022). The Impact of Exposure to Blood Lead Levels on Online Ojek Driver Students on Intelligence and Communication Anxiety. Indonesian Journal of Global Health Research, 4(2), 309-314. https://doi.org/10.37287/ijghr.v4i2.1043

Susilowati, I., Dewi, N., Widhiyastuti, E. (2023). Edukasi Bahaya Timbal pada Sekolah Rentan Polusi terhadap Prestasi Akademik dan Kesehatan Siswa. Jurnal Surya Masyarakat, 5(2), 201-207. https://doi.org/10.26714/jsm.5.2.2023.201-207

Winarsi, H. (2011). Antioksidan Alami dan Radikal Bebas. Yogyakarta: Kanisius.

Yoseva, P. L. dan M. Akmal, S. Halida. 2015. Pemanfaatan Limbah Ampas Tebu Sebagai Adsorben untuk Peningkatan Kuliatas Air Gambut. Jurnal Online Mahasiswa Fakultas Matematikan dan Ilmu Pengetahuan Alam Universitas Riau 2 (1), 56-62.