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Dragon Fruit Peel as an Eco-Friendly Whiteboard Marker: A Solution for Education

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Abstract

This research highlights its potential as a sustainable alternative to synthetic inks. The value of agricultural waste in promoting green chemistry and sustainable practices. It provides a practical example for environmental education, encouraging innovation in biodegradable materials and raising awareness about eco-friendly alternatives in the art and packaging industries. This study aims to develop an eco-friendly natural ink using natural ink from dragon fruit peel is an eco-friendly alternative, derived from the fruit's vibrant pigments, specifically betacyanin. The main pigment, betacyanin, is extracted from dragon fruit peel and combined with activated charcoal to enhance stability and formulated into ink, offering a biodegradable, non-toxic option. Experimental procedures included ink formulation and user trials in whiteboard applications. The resulting ink exhibits good adhesion properties on whiteboard surfaces. User testing showed satisfactory performance in artistic and packaging uses. However, the main challenge is stabilizing the natural pigments to ensure colour durability and prevent fading.

Keywords: *Education, Ink, Sustainable, Eco-friendly, Dragon fruit skin.*

Introduction

Seeing waste on the streets is not unusual, particularly in densely populated nations like Indonesia. Plastic garbage is not the only type that arises in daily life for citizens. Tons of organic garbage are dumped in landfills. By 2050, there will be 9.3 billion people on the planet, increasing food demand by 50% to 70%. Every year, almost 1.3 billion tons, or one-third, of the edible food produced for human use is lost or misused (Farahdiba et al, 2023).

Food waste can already be used in an abundance of ways. For example, it can be turned into a regular product that people use daily, such as ink made primarily of organic waste. With these environmentally friendly dry-erase markers, fewer dangerous chemicals will be used than with traditional markers, which include compounds that are easily inhaled (Castorina et al, 2016; Chua et al, 2020).

Making this purportedly "eco-friendly" ink requires work, but it's simple otherwise. Since organic waste is the main material to be used, it is imperative to dry

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it until it can be easily crushed. Depending on the kind of organic waste, there are variations in all other noteworthy stages. Boiling is one of the two procedures; the other entails sifting it and mixing the pigment with a thickening agent (Fazriyah et al, 2023).

The dragon fruit peels/rind, which constitutes approximately 30–45% of the fruit's total mass, are normally discarded as waste of the agricultural industry. Disposal of bio-wastes, such as dragon fruit peels, contributes to environmental pollution through the production of greenhouse gases and microbial contamination during decomposition in bulk amounts (Fatimah et al, 2020).

Dragon fruit skin, particularly from the species *Hylocereus polyrhizus*, contains several components that can be utilised to create eco-friendly inks. The primary pigments of interest are *betacyanins* and *anthocyanins*, both of which offer natural colouring properties suitable for various applications, including inks (Hariadi et al, 2023; Wichienchot et al, 2022; Hasanah et al, 2023)

Given the chance to make this product, reducing the food waste rate in Indonesia is the main objective. While also looking out for the citizens' health from excessive use of chemicals, this product can combat the food waste rate, one drop at a time. Ideally, ink should have maximum colour lightness, minimum viscosity, and fast drying speed. The objective of this study is to make an ink marker from dragon fruit skin (Hamid et al, 2022; Setyawan et al, 2023)

While previous studies have focused extensively on other organic sources—such as cassava peel, turmeric, or spinach—for natural ink production, few have explored the pigment potential of dragon fruit peel in marker ink applications. Compared to cassava, which primarily provides starch, dragon fruit peel offers a naturally pigmented, biodegradable, and antioxidant-rich source that reduces the need for synthetic additives or colorants (Kayiwa et al, 2021; Santoso et al, 2023)

This study addresses the lack of research into dragon fruit-based inks, particularly for dry-erase marker formulations, which require optimal color brightness and fast drying time. By utilizing dragon fruit peel, this research not only promotes sustainable practices in Indonesia's agricultural sector but also supports healthier, chemical-free alternatives in daily-use products.

The objective of this study is to develop an eco-friendly marker ink from dragon fruit skin, demonstrating both environmental and health benefits while addressing the pressing issue of organic waste in Indonesia.

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Method

For centuries, ink has been made from natural products such as berries, bark, and extracts of leaves. These have been used as raw materials to create various colours and to produce ink, dye, or paint when mixed with other substances. Early records showed that tea leaves had been used to make ink due to their shades that were able to produce yellow, green, brown, or black ink (Ibrahim et al, 2023; Pratiwi et al, 2021)

The goal of this research is to develop a sustainable, environmentally friendly ink substitute for those made of chemicals. Because of the pigments in its peel, dragon fruit has a vivid colour that could be used as a natural dye to make ink.

Research: A review of the literature on ink production, combined with the utilization of organic waste materials, has been applied in the development of this product.

Development: During the experimental sessions, various approaches to ink formulation were explored. Initially, the mixture consisted of dried dragon fruit skin, 70% alcohol, gum arabic, citric acid, and water. However, the resulting ink displayed low viscosity, resembling water, and failed to produce a vibrant color. To address this limitation, a binding agent such as PEG was incorporated, along with charcoal, to achieve a deeper black pigment (Rahayuningsih et al, 2021; Li et al, 2021; Ekoh et al, 2018; Amakoromo, 2021)

Materials:

Table 1. Materials and Function

Materials	Function
1. Dragon fruit peel	The main ingredients with specific chemical properties provide the color
2. Gum Arabic	The natural gum that primarily sourced from two trees, such as the African acacia species: Acacia Senegal and A. seyal. Typically used in inks to ensure the substance lingers on a non-oily surface. Gum Arabic is crucial to make sure the ink flows smoothly from the marker tip and adheres well to various surfaces. The ability of Arabic gum is less maximal in binding to pigment particles, so there are downward

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Materials	Function
	pigment particles that cannot attach to the substrate.
3. Polyethylene glycol (PEG)	Used as a releasing agent in the manufacture of organic inks. PEG will make the ink more easily removed from the whiteboard. The use of PEG should not be more than 10% of the mass of the ink composition because it will make its viscosity higher and difficult to remove.
4. Citric acid	Facilitates color changes in inks, particularly those utilising pH-sensitive dyes, enhancing their functionality. Citric acid can also be part of inkjet ink formulations, which helps control pH levels.
5. Charcoal	As a pigment in the natural ink, due to its black colour, it is used as a vivid colour in the ink mixture and makes the outcome more black and more visible on the whiteboard or paper.
6. Alcohol 70%	As a solvent to help dilute the solution when it is too thick and unable to be used.
7. Water	As a solvent in the mixture. Solvents dissolve pigments to make a homogenous mixture to create dissolving pigments.

(Imani, 2023; Sekarlita, 2019)

Tools:

1. Watch glass
2. Beaker
3. Measuring cylinder
4. Hot plate
5. Magnetic stirrer
6. Pipette
7. Glass stirrer
8. Sieve
9. Filter paper

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10. Glass funnel
11. Porcelain cup

Procedures:

Image 1. Procedure Dragon Fruit Natural in Process

The diagram illustrates a flowchart of the production process of natural ink from dragon fruit peel. The steps are as follows:

1. Cut the dragon fruit peel into small dices. The dragon fruit peel is cut into small pieces to facilitate further processing.
2. Roast and sift the dragon fruit peel. The diced peel is roasted and then sifted to obtain fine powder.
3. Prepare a citric acid solution. Five grams of citric acid are measured and dissolved in water, serving as a solvent and natural preservative.
4. Add dragon fruit peel powder and charcoal powder. While the solution is being stirred, the dragon fruit peel powder and charcoal powder are added. Charcoal functions to enhance the color intensity and durability of the ink.
5. Incorporate gum arabic and PEG. Gum arabic, acting as a binder and thickener, and polyethylene glycol (PEG), functioning to maintain moisture and ink stability, are added to the mixture and thoroughly mixed.
6. Filter the solution. The mixture is then strained using filter paper to remove coarse particles, resulting in a smoother solution.

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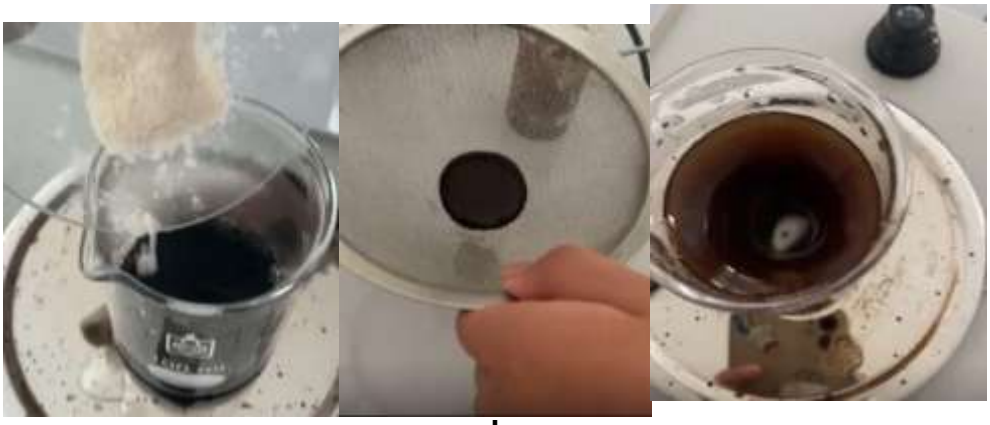
7. Cooling and storage. After cooling, the natural ink is transferred into the body of a marker for use.

Result



a b c

Image 2. Experimenting
(2(a) shows the step of putting Gum Arabic into the beaker of the heated dragon fruit. 2(b) shows the step of straining the solution to make it smooth. 2(c) shows the step of heating the dried dragon fruit to extract it)

a b

Image 3. Result
(3(a) shows a student using the final product of the ink. 3(b) shows a teacher using the final product of the ink to teach in English class to 7th-grade students)

To evaluate the effectiveness and reception of the eco-friendly marker, a questionnaire was distributed to 100 teachers and students. The questionnaire was designed using a rubric that assessed several key aspects, including product concept, safety, environmental contribution, health impact, educational value, and practical usability.

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Table 2. Criteria and Response

Criteria	Response
1. Concept of the product	The concept is excellent, especially because it is environmentally friendly and promotes sustainability.
2. Safety aspect	The ink is safer compared to conventional markers since it uses fewer harmful chemicals.
3. Environmental contribution	Helps reduce greenhouse gas emissions by reusing food waste as raw material.
4. Health impact in classrooms	Provides a healthier option for students and teachers, as it avoids strong odors and VOCs found in regular markers.
5. Educational value	Inspires students to think creatively about sustainability and demonstrates the principle of turning waste into valuable products.
6. Practical usability	Easy to use and suitable for classroom environments.

Discussion

Based on the data gathered from the questionnaires distributed to 100 teachers and students, the eco-friendly marker received highly positive feedback. Respondents consistently emphasized that the marker is a strong innovation because it combines three essential aspects: safety, practicality, and environmental responsibility. This combination makes it not only a functional writing tool but also a product that directly supports sustainable practices and education. The overall conclusion from the data shows that the marker is regarded as a valuable improvement over conventional options.

One of the main reasons the marker is well-received is its safety. Traditional markers often contain harmful chemicals and volatile organic compounds (VOCs) that can negatively impact health when used continuously in classrooms. In contrast, the eco-friendly marker is formulated with fewer harmful substances, which reduces health risks for both teachers and students. This makes it a safer alternative for everyday use, especially in learning environments where markers are frequently utilized for teaching and presentations.

Another important aspect is the practical usability of the marker. Respondents noted that the marker is easy to use, produces clear results, and functions effectively

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in classroom conditions. Unlike some eco-friendly products that compromise on performance, this marker maintains a good balance between sustainability and functionality. Teachers appreciated that it could be seamlessly integrated into their daily teaching routines without inconvenience, while students found it reliable for classroom activities.

The marker's environmental contribution was also highlighted as a key strength. By utilizing food waste specifically dragon fruit peel as a raw material, the ink not only reduces the amount of organic waste that would otherwise contribute to greenhouse gas emissions but also transforms it into a useful product. This aligns with circular economy principles, showing that waste materials can be creatively repurposed to address real-world problems. Such an approach contributes to broader environmental awareness and responsibility in the education sector.

Finally, the educational value of this innovation is significant. Both teachers and students saw the marker as more than just a tool; they recognized it as a practical demonstration of sustainability in action. It inspires students to think critically about how science and creativity can solve environmental challenges. One testimony from a teacher emphasized that the concept of the ink itself is excellent because it is environmentally friendly and beneficial in many ways, such as being safer and reducing greenhouse gases. Overall, the eco-friendly marker is not only a successful product but also a meaningful step toward promoting sustainability in education.

Conclusions

In conclusion, this research demonstrates that eco-friendly ink can be produced from organic waste, such as dragon fruit peels and charcoal, to create a safer alternative to normal dry-erase markers. By utilising natural pigments and binders, the markers are not only effective but also help reduce the environmental impact of food waste. Without the use of harmful chemicals, these markers are safe for everyday use, especially in educational settings. This approach presents a sustainable solution to food waste management, contributing to both environmental preservation and public health in Indonesia and even around the world.

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an alternative ink marker derived from dragon fruit peel, aimed at promoting safer and more sustainable education. Their continuous support, encouragement, and expertise have been instrumental in shaping this research.

Referensi

Amakoromo, T. E., Abumere, O. E., Amusan, J. A., Anye, V., & Bello, A. (2021). Porous carbon from cassava peels waste for charge storage applications. *Current Research in Green and Sustainable Chemistry*, 4, 100098. https://doi.org/10.1016/j.crgsc.2021.100098

Castorina, R., Tysman, M., Bradman, Å., Hoover, S., Iyer, S., & Russell, M. (2016). Volatile organic compound emissions from markers used in preschools, schools, and homes. *International Journal of Environmental Analytical Chemistry, 97*(13), 1247–1263. https://doi.org/10.1080/03067319.2016.1250892

Chua, B. L., Tang, S. F., Ali, A., & Cho, Y. H. (2020). Optimisation of pectin production from dragon fruit peels waste: Drying, extraction and characterisation studies. *SN Applied Sciences, 2*, 621. https://doi.org/10.1007/s42452-020-2415-y

Ekoh, G., Ilaboya, I. R., & Umukoro, L. O. (2018). Activated carbon from cassava peel as adsorbent of lead (Pb^{2+}) in water. *Jurnal Kartika Kimia*, 1(1), 21–28. https://doi.org/10.26874/jkk.v1i1.8

Fatimah, S., Mustika, N., & Pratiwi, S. (2020). Carbon ink characterization from banana and cassava peels by carbonization method. *Jurnal Kimia dan Pendidikan Kimia*, *5*(2). https://doi.org/10.20961/jkpk.v5i2.33386

Farahdiba, A. U., Warmadewanthi, I. D. A. A., Fransiscus, Y., Rosyidah, E., Hermana, J., & Yuniarto, A. (2023). The present and proposed sustainable food waste treatment technology in Indonesia: A review. *Environmental Technology & Innovation, 32*, 103256. https://doi.org/10.1016/j.eti.2023.103256

Fazriyah, S. N., Arilisa, L. K., & Setyawan, M. (2023). Organic pigment from cassava peel as intermediate material marker ink. *Indonesian Journal of Chemical Engineering, 1*(1), 11–18. https://doi.org/10.26 555/ijce.v1i1.470

Hamid, N., Abdul Munaim, M. S., & Abu Seman, M. N. (2022). Regression analysis for the adsorption isotherms of betacyanin extracts from the dragon fruit peel onto the spun silk yarn. *International Journal of Engineering Technology and Sciences*, *9*(1), 70–81. https://doi.org/10.15282/ijets.6.2016.1.7.1057

Hariadi, H., Nissa, R. C., Anggara, C. E. W., Hidayat, H., Ferdiansyah, A. E., & Rifqi, M. (2023). Utilization of dragon fruit (*Hylocereus polyrhizus*) peels waste as a

natural dye. *IOP Conference Series: Earth and Environmental Science*, *1241*, 012075. https://doi.org/10.1088/1755-1315/1241/1/012075

Hasanah, U., Suryani, A., & Sundari, S. (2023). Microencapsulation of betacyanin from dragon fruit (*Hylocereus polyrhizus*) peel by foam-mat drying for natural food colorant application. *International Journal of Design & Nature and Ecodynamics*, *20*(3), 771–777. https://doi.org/10.18280/ijdne.200316

Ibrahim Grema, M. H., Konan, A. T. S., Kouassi, E. K. A., Amadou Kiari, M. N., Brou, Y. C., & Yao, K. B. (2023). Characterization of cassava peelings as a precursor for biochar preparation. *J. Mater. Environ. Sci.*, 14 (12), 1582, 1594.

Imani Lazuardi & Haryanto. (2023). Pengaruh variasi volume pewarna dan massa Gum Arab pada kecepatan pengeringan dan viskositas tinta dari kulit buah naga. *Envirotek: Jurnal Ilmiah Teknik Lingkungan, 12*(1). https://doi.org/10.33005/envirotek.v12i1.26

Kayiwa, R., Kasedde, H., Lubwama, M., & Kirabira, J. B. (2021). Mesoporous activated carbon yielded from pre-leached cassava peels. *Bioresources and Bioprocessing*, 8(1), 53. https://doi.org/10.1186/s40643-021-00407-0

Li, L., Li, Y., Liu, Y., Ding, L., Jin, X., Lian, H., & Zheng, J. (2021). Preparation of a novel activated carbon from cassava sludge for high-efficiency adsorption of hexavalent chromium in potable water: Adsorption performance and mechanism insight. *Water*, 13(24), 3602. https://doi.org/10.3390/w13243602

Pratiwi, D. S., Udaibah, W., & Kustomo, K. (2021). Synthesis of hydrochar from cassava peels via hydrothermal carbonization and its application as a hard water softener. Journal of Natural Sciences and Mathematics Research. ISSN: 2460-4453

Rahayuningsih, E., Setiawan, F. A., Rahman, A. B. K., Siahaan, T., & Petrus, H. T. B. M. (2021). Microencapsulation of betacyanin from red dragon fruit (Hylocereus polyrhizus) peels using pectin by simple coacervation to enhance stability. Journal of Food Science and Technology, 58(9), 3379-3387. https://doi.org/10.1007/s13197-020-04910-8

Santoso, V. R., Pramitasari, R., & Anugrah, D. S. B. (2023). Development of Indicator Film Based on Cassava Starch–Chitosan Incorporated with Red Dragon Fruit Peel Anthocyanins–Gambier Catechins to Detect Banana Ripeness. *Polymers*, 15(17), 3609. https://doi.org/10.3390/polym15173609

Sekarlita Hapsari Nolandi & Adhi Kusumastuti. (2019). Kelayakan buah naga super merah sebagai bahan dasar dalam pembuatan tinta body art. *Beauty and Beauty Health Education, 8*(1). https://doi.org/10.15294/bbhe.v8i1.32737

Setyawan, M., Fazriyah, S. N., & Arilisa, L. (2023). Organic pigment from cassava peel as intermediate material marker ink. *Indonesian Journal of Chemical Engineering*, *4*(1), 10–18. https://doi.org/10.26555/ijce.v1i1.470

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Jurnal Inovasi Pembelajaran

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Wichienchot, S., Jatupornpipat, M., Oonmetta-aree, J., & Sirilun, S. (2022). Production of colorant powder from dragon fruit (*Hylocereus polyrhizus*) peel: Bioactivity, heavy metal contamination, antimutagenicity, and antioxidation aspects. *Journal of Food Processing and Preservation*, *46*(6), e15044. https://doi.org/10.1111/jfpp.15044