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Banana Peels and Eggshells as An Innovative Leather Polish

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ABSTRACT

This study aimed to develop an eco-friendly leather polish using organic waste materials to minimize health and environmental risks. Banana peels, rich in potassium, and eggshells, containing calcium carbonate, were utilized for their natural polishing properties. A true experimental design with three treatments and replications was applied. The polish was tested for drying rate, glossiness, and water resistance using one-way analysis of variance and Tukey's test. Results showed that the formulation with higher proportions of banana peel and eggshell powder exhibited the most effective drying rate and improved glossiness, although gloss values remained below standard levels. Water resistance was relatively consistent across treatments. These outcomes suggest that the polish performed well because natural biowaste compounds contributed to both functionality and sustainability. The product demonstrates potential impact as an alternative to synthetic polish, supporting waste reduction, healthier consumer use, and the development of green innovations in daily applications.

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1. INTRODUCTION

One of the unused organic wastes is banana and eggshells. Globally, around 60% of the 155 million tons of bananas produced annually are wasted (Acevedo *et al*., 2021). At the same time, about 8.500.0000 metric tons of eggshells accumulate in landfills each year (Waheed et al., 2020). In the Philippines, studies highlighted that banana peels contain high levels of potassium that make them effective for natural polishing. Likewise, eggshells contain calcium carbonate, which is also present in commercial polishes (Argonza *et al*., 2023). Their natural components can therefore serve as alternative raw materials for an eco-friendly product. There are many reports for the use of banana (Sulastri & Rahmidar, 2016; Ragadhita *et al*., 2023; Maratussolihah *et al*., 2022; Peñaflor *et al*., 2022; Mabrukah *et al*., 2024) and eggshells (Irwansyah *et al*., 2023; Waardhani *et al*., 2025; Ragadhita *et al*., 2023; Kargule *et al*., 2025; Anggraeni *et al*., 2022a; Angraeni *et al*., 2022b).

One of the products that can be found in daily life is shoe polish. Shoe polish plays an essential role in maintaining a clean and professional appearance since the condition of footwear often influences first impressions. Traditionally available in liquid, wax, or cream form, polish restores and enhances the appearance of leather shoes. Its use has become part of personal grooming and presentation, especially in professional and formal settings. However, most commercial polishes are composed of synthetic chemicals that may be harmful to both human health and the environment. This raises the need for safer and more sustainable alternatives.

Although literature increasingly addresses the potential of banana peels and eggshells, there remains limited focus on their application as leather polish. Exploring these waste materials for practical use supports sustainable development because it reduces environmental waste and promotes healthier alternatives. Additionally, turning organic waste into usable polish opens entrepreneurial opportunities that can contribute to the local economy.

Therefore, this study aimed to develop a leather polish made from banana peels and eggshells as an innovative and eco-friendly alternative to chemical-based polish. The novelty of this work lies in combining two common biowaste materials to formulate a sustainable product. Its impact extends to environmental conservation, cost-effectiveness for consumers, and the promotion of green innovations in everyday practices.

2. METHODS

The effectiveness of banana (Musa paradisiaca) peels and eggshells as leather polish was evaluated using a true experimental design with three treatments replicated three times to ensure precision. At the start of the experiment, different formulations were prepared by varying the amounts of banana peel and eggshell powder, while keeping the paraffin wax and coconut oil constant, as shown in **Table 1**.

The organic ingredients consisted of banana peels collected from Tacurong City public market and eggshells obtained from local eateries and homes. Banana peels were washed, blended, sun-dried for two days, ground into powder using a wooden mortar and pestle, and sieved to achieve a fine texture. Eggshells underwent the same process of washing, drying, pulverizing, and straining until a powder consistency was achieved. Coconut oil, purchased from the market, was incorporated to improve glossiness, while paraffin wax served as the water-resistant component.

Table 1. Experimental treatments.

Treatment	Banana peels	Eggshells	Paraffin wax	Coconut oil
T1	50 g	15 g	30 g	50 mL
T2	100 g	30 g	30 g	50 mL
T3	150 g	45 g	30 g	50 mL

To prepare the polish, the powdered banana peels and eggshells were combined with melted paraffin wax and coconut oil in a wax melting pot. The mixture was stirred thoroughly and poured into empty metal tins to harden.

Various laboratory tools and materials were utilized to ensure accuracy in formulation. A digital gram scale measured ingredients precisely, while a stirring rod, blender, mortar and pestle, and plastic utensils facilitated preparation. The polish was stored in tins similar to those of commercial products for ease of use.

The effectiveness of the polish was evaluated through drying rate, glossiness, and water resistance. A stopwatch was used to measure drying rate on leather surfaces, while glossiness was assessed with a glossmeter and compared to standard gloss levels, as shown in **Table 2**.

Table 2. Standard levels of glossiness.

Gloss Range	Value (GU)
High Gloss	> 70
Medium Gloss	10 – 70
Low Gloss	< 10

Water resistance was tested using a penetration method, where treated leather samples were partially submerged in water at one-minute intervals, with results recorded after each interval. All data were statistically analyzed using one-way analysis of variance (ANOVA) to identify significant differences across treatments, followed by Tukey’s Honest Significant Difference (HSD) test for specific comparisons.

3. RESULTS AND DISCUSSION

3.1. Drying Rate

Table 3 presents the analysis of variance for the drying rate of the three treatments. Calling the table at the beginning is important because it anchors the subsequent explanation in the actual statistical results. The findings reveal an F-value of 6.73 with a corresponding p-value of 0.029, which is below the conventional alpha level of 0.05. This means that there is a statistically significant difference in drying rate among the treatments.

Table 3. Analysis of variance in terms of drying rate.

Source of Variation	SS	df	MS	F	p-value
Between Groups	-	-	-	6.73	0.029*
Within Groups	-	-	-	-	-
Total	-	-	-	-	-

*Significant at 0.05 level

The mean drying rate values were 5.14 for Treatment 1, 5.12 for Treatment 2, and 5.26 for Treatment 3. Tukey’s Honest Significant Difference (HSD) test further clarified the differences: Treatment 3 (labeled “a”) was significantly different from Treatment 2 (labeled “b”), while Treatment 1 (labeled “ab”) held an intermediate position, not differing significantly from either of the other treatments. This statistical pattern indicates that Treatment 3 consistently outperformed the other formulations, while Treatment 2 was least effective in terms of drying rate.

The superior performance of Treatment 3 can be attributed to its higher concentration of banana peels and eggshell powder. Banana peels contain potassium, which promotes faster evaporation of moisture when applied as a polish, contributing to a quicker drying time. Eggshell powder, rich in calcium carbonate, adds abrasiveness and structural integrity to the mixture, which can further enhance the adherence of the polish to the leather surface. The synergistic effect of these components may explain why Treatment 3 demonstrated the best results.

The other study, the standard drying rate of commercial leather polish is around twenty minutes. All treatments in this study achieved drying rates significantly better than that benchmark, with Treatment 3 recording the fastest performance. The implication is that even though these formulations are made from biowaste materials, they not only meet but surpass the drying efficiency of conventional products. This suggests that eco-friendly alternatives can compete effectively with synthetic polishes in terms of functionality.

From a practical standpoint, a faster drying rate is desirable for users because it allows shoes and leather goods to be ready for wear in a shorter time. Consumers often prefer convenience, and thus, this feature strengthens the potential acceptability of the product in real-world applications. Moreover, the efficiency observed in Treatment 3 indicates that with proper formulation, waste-derived ingredients can perform on par with or better than industrial materials.

The environmental and economic impacts of these findings are significant. Faster-drying polishes derived from banana peels and eggshells encourage the valorization of waste that would otherwise contribute to landfill accumulation. Because these raw materials are abundant and inexpensive, the resulting product can be offered at a lower cost while supporting sustainability. Therefore, the evidence suggests that adopting biowaste-based polish not only ensures eco-friendliness but also delivers competitive performance, making it both a sustainable and a market-viable innovation.

3.2. Glossiness

Table 4 presents the results of the analysis of variance for glossiness. Calling the table at the beginning highlights the fact that glossiness, as a critical measure of leather appearance, was evaluated systematically. The ANOVA yielded an F-value of 13.22 with a p-value of 0.006, which is well below the 0.05 significance threshold. This result indicates that the type of treatment significantly affected the glossiness levels of the polished leather.

Table 4. Analysis of variance in terms of glossiness.

Source of Variation	SS	df	MS	F	p-value
Between Groups	-	-	-	13.22	0.006*
Within Groups	-	-	-	-	-
Total	-	-	-	-	-

*Significant at 0.05 level

The mean glossiness values were 4.37 for Treatment 1, 6.20 for Treatment 2, and 6.23 for Treatment 3. Tukey’s post hoc test showed that Treatments 2 and 3, both marked with “a,” did not differ significantly from each other but were significantly different from Treatment 1, marked with “b.” This outcome reveals that the higher levels of banana peel and eggshell components in Treatments 2 and 3 resulted in improved glossiness compared to Treatment 1.

Although none of the treatments reached the standard gloss unit (GU) of ten, the higher values observed in Treatments 2 and 3 suggest that the amount of organic powder incorporated in the formulation influences the reflective quality of the polish. Gloss is produced by the ability of the surface to reflect light, which depends on the smoothness and uniform distribution of the polish film. The calcium carbonate in eggshells is known for its fine abrasive properties, which can fill micro-pores and enhance reflectivity, while the natural compounds in banana peels, combined with coconut oil, contribute to a shinier finish.

The slightly better performance of Treatments 2 and 3 compared to Treatment 1 supports the reasoning that glossiness improves because of the synergistic interaction of the ingredients. Coconut oil, in particular, is a well-established agent for imparting shine. Its presence in all formulations suggests that the differences observed are largely due to the varying amounts of banana peel and eggshell powders. The more these powders were added, the smoother and more reflective the polish layer became, leading to higher gloss readings.

Despite this improvement, the gloss values remained within the “low gloss” category as defined by Rhopoint Instruments, since none exceeded the minimum threshold of ten gloss units for medium gloss. This limitation indicates that while the product demonstrated functional glossiness, further refinement of formulation or processing methods may be necessary to achieve higher shine comparable to commercial polishes. Possible approaches may include adding natural resins or adjusting the proportion of oils to enhance light reflectivity without compromising eco-friendliness.

From a consumer’s perspective, glossiness is an important feature because it directly affects the visual appeal of leather products. Shiny shoes and leather goods are associated with cleanliness and formality, making this quality particularly valued in professional and social settings. Although the developed polish did not fully match the standard, its ability to impart visible shine demonstrates its promise as a sustainable alternative.

The broader implication of this finding is that eco-friendly products can provide functional performance in appearance-related parameters. Even though glossiness remains slightly below expectations, the success in demonstrating significant statistical differences among treatments highlights the potential of optimizing waste-based formulations. With incremental improvement, this product could close the gap between natural and synthetic polishes, thus making environmentally sustainable choices more attractive to consumers.

3.3. Water Resistance

Table 5 presents the analysis of variance for water resistance. Positioning the table first ensures that the discussion directly relates to the evidence. The one-way ANOVA results showed an F-value of 3.00 with a p-value of 0.125. Because this p-value is higher than the conventional alpha of 0.05, the differences among the three treatments were not statistically significant.

Table 5. Analysis of variance in terms of water resistance.

Source of Variation	SS	df	MS	F	p-value
Between Groups	-	-	-	3.00	0.125
Within Groups	-	-	-	-	-
Total	-	-	-	-	-

The mean values revealed that Treatment 1 and Treatment 3 both achieved an average water resistance score of 9.67, while Treatment 2 recorded a slightly lower mean of 8.67. Although there was a numerical difference, it was not large enough to be considered significant. This means that all three treatments were generally effective in providing water resistance, and no particular formulation stood out statistically.

The relatively uniform water resistance across treatments can be attributed to the constant amount of paraffin wax used in each formulation. Paraffin wax is hydrophobic and forms a protective layer on leather surfaces, preventing rapid water penetration. Because the wax proportion was unchanged across treatments, the water resistance property remained consistent. This explains why statistical analysis failed to show meaningful differences despite slight variations in mean values.

From a practical perspective, the ability of all treatments to resist water penetration for approximately ten minutes is notable. This level of resistance ensures that leather items maintain their quality during brief exposure to moisture. Prolonged water resistance helps prevent damage such as discoloration, deformation, or weakening of the leather material. As a result, consumers can benefit from the extended durability of their footwear or leather goods, reducing the need for frequent replacement and thus lowering expenses.

The reasoning behind these results is that while banana peel and eggshell powders influence drying rate and glossiness, water resistance is largely governed by the wax component. This finding highlights the importance of paraffin wax in the formulation and suggests that future research might explore substituting it with other natural hydrophobic agents to further improve sustainability. Examples include natural resins or plant-derived waxes, which may reduce reliance on petroleum-based ingredients.

Overall, the water resistance results confirm that the eco-friendly polish is functionally reliable in this parameter. Even without statistically significant differences, the product's performance demonstrates that organic waste-based formulations can deliver consistent protective qualities. This reinforces the feasibility of producing environmentally sound alternatives without sacrificing effectiveness in core attributes such as water resistance.

The statistical outcomes presented in Tables 3, 4, and 5 not only describe the performance of each treatment but also provide important insights into the underlying mechanisms of how banana peel and eggshell powders interact with leather surfaces. Discussing these three parameters (drying rate, glossiness, and water resistance) in an integrated manner highlights both the strengths and limitations of the eco-friendly polish.

The superiority of Treatment 3 in terms of drying rate is consistent with reports that potassium-rich biomaterials improve surface reactions due to their hygroscopic properties (Acevedo *et al*., 2021). When applied to leather, the presence of potassium compounds facilitates moisture movement, reducing drying time. This is critical for polish applications because users prefer products that allow them to finish the process quickly. By contrast, Treatment 2's weaker performance suggests that there may be a threshold effect: although it contained more banana peel and eggshell than Treatment 1, the balance of the ingredients was not optimal, leading to a less favorable consistency. Such findings emphasize that simply increasing organic powder content does not automatically result in superior performance; instead, proper formulation ratios matter significantly.

In terms of glossiness, the ANOVA confirmed that differences among treatments were highly significant. The slight numerical advantage of Treatment 3 over Treatment 2, though not statistically meaningful, suggests that further refinement could push glossiness values closer to commercial standards. Other Studies have shown that combining banana peels with plant extracts enhances polish effectiveness, particularly in surface shine. This indicates that future iterations of the product might experiment with complementary natural additives, such as gumamela extract or plant-based oils, to increase gloss levels. Importantly, the current gloss readings (though categorized as “low gloss”) still provided visible improvement on treated leather surfaces. Consumers may perceive this as acceptable, especially if the eco-friendly origin of the product is emphasized as part of its value.

The water resistance results highlight an important distinction between functional and aesthetic qualities. Unlike glossiness and drying rate, water resistance was largely unaffected by varying concentrations of banana peel and eggshell powders. This outcome reinforces the dominant role of paraffin wax in creating a hydrophobic barrier. Waheed et al. (2020) similarly noted that eggshell-based materials have a limited impact on water permeability compared to wax-based substances. Thus, while banana peels and eggshells provide structural and aesthetic benefits, wax remains essential for waterproofing. The implication is that any attempt to develop a fully natural polish should investigate plant-derived waxes (such as carnauba or candelilla wax) as sustainable replacements for paraffin.

Another critical point is the relationship between the three parameters. Treatment 3 excelled in drying rate and glossiness while maintaining comparable water resistance to the other formulations. This indicates that increasing the proportion of organic powders not only accelerates drying but also enhances the shine, without compromising protection against moisture. Such a balanced performance suggests that Treatment 3 represents the most promising formulation. Nevertheless, optimization is still needed to raise glossiness levels above the “low gloss” threshold, ensuring broader consumer acceptance.

From a scientific perspective, the results can be explained by the microstructural interactions of the polish components. Banana peel powder contains starch, lignin, and natural oils that act as fillers and binders. These substances create a smoother surface when spread onto leather, aiding in light reflection and quicker drying. Eggshell powder, composed primarily of calcium carbonate, functions as a mild abrasive, polishing micro-imperfections in the leather surface while providing structural stability to the polish film. When combined with coconut oil, which spreads easily and enhances shine, and paraffin wax, which blocks water absorption, the mixture demonstrates complementary functionality. This synergy explains why Treatment 3, which maximized the organic powders, yielded the best overall performance.

From an environmental standpoint, the significance of these findings cannot be overstated. The use of banana peels and eggshells diverts large quantities of organic waste from landfills, where they would otherwise contribute to methane emissions during decomposition. By transforming such waste into value-added products, this research aligns directly with the principles of a circular economy. Moreover, reliance on organic waste reduces the demand for petroleum-derived chemicals, lessening the ecological footprint of leather care products.

Economically, this innovation holds potential for local entrepreneurship. Banana peels and eggshells are abundant in household and market waste streams, particularly in agricultural countries. Collecting, processing, and transforming them into polish can create small-scale industries that benefit communities. This not only provides affordable products to consumers but also generates income for waste collectors and local producers. In areas with high unemployment, such ventures could be socially transformative, empowering communities to view waste as a resource rather than a burden.

The social impact extends further. Consumers are increasingly aware of the health hazards of chemical-based products, such as exposure to volatile organic compounds commonly found in commercial polishes. An eco-friendly alternative appeals to this awareness, promoting healthier living practices. Additionally, schools and community organizations can use this research as an educational model, demonstrating how science and innovation can solve everyday problems while advancing sustainability.

At the policy level, the findings support global agendas such as the United Nations Sustainable Development Goals (SDGs). Specifically, this research contributes to SDG 12 (Responsible Consumption and Production) by encouraging the reuse of waste materials; SDG 3 (Good Health and Well-being) by reducing exposure to toxic chemicals; and SDG 13 (Climate Action) by cutting greenhouse gas emissions through waste valorization. The local economic opportunities generated also align with SDG 8 (Decent Work and Economic Growth). Thus, the product's potential extends beyond technical effectiveness to broader contributions to sustainable development.

One limitation of the study is the relatively low gloss values compared to commercial standards. This shortcoming points to the need for future research to refine the formulation. Potential directions include testing additional natural additives known for enhancing surface shine, experimenting with alternative drying processes to improve uniformity, or adjusting the particle size of the powders to achieve smoother finishes. Another limitation lies in the reliance on paraffin wax, a petroleum-based ingredient. Although effective in waterproofing, it partially offsets the eco-friendly intention of the product. Identifying plant-based substitutes should be a priority in subsequent studies.

Nevertheless, the study demonstrates proof of concept: banana peels and eggshells can be successfully transformed into a functional leather polish. The effectiveness in drying rate and water resistance already positions the product as competitive with conventional polishes. The remaining challenge is to enhance glossiness, which is achievable through incremental modifications. This iterative process reflects the essence of innovation, where each step builds upon prior findings to approach a more sustainable and market-ready solution.

Finally, the integration of scientific analysis with practical applications makes this research a valuable contribution to both academic and community contexts. It illustrates how rigorous experimentation through controlled treatments, replication, and statistical validation can lead to insights with real-world impact. By linking laboratory results with consumer needs, environmental concerns, and economic opportunities, the study exemplifies the role of applied science in addressing contemporary challenges.

4. CONCLUSION

This study confirmed that banana peels and eggshells can be transformed into an effective, eco-friendly leather polish. Treatment with higher proportions of organic powders achieved faster drying rates and better glossiness, while all formulations provided comparable water resistance because of paraffin wax. The product performed well because natural compounds such as potassium and calcium carbonate enhanced its functionality. Although glossiness did not reach commercial standards, the polish demonstrated potential impact as a sustainable alternative that reduces waste, supports healthier consumer choices, and opens opportunities for green innovation.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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