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# Brew to Shine: Upcycling Spent Coffee Formulations as an Organic Alternative to Commercial Shoe Polishers

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**Abstract**

This study developed and evaluated an organic shoe polisher using upcycled spent coffee grounds (SCG), coconut oil, and beeswax as a sustainable, eco-friendly, and cost-effective shoe polish alternative to commercial shoe polishers containing harsh chemicals. With the increasing concerns about organic waste disposal and environmental sustainability, SCG seemed like a target of opportunity since it is a resource that is underutilized and releases harmful greenhouse gases when improperly discarded. Five formulations with different ratios of the ingredients were tested against critical performance values: shine level, color enhancement, durability/wearing resistance, water repellency, texture/consistency, adhesion, and odor acceptability. The study was carried out in Noveleta, Cavite, with the use of SCG collected from local households and cafes and top-grain leather as the test material and a commercial shoe polish as reference material. Findings that all formulations proved effective shoe care properties, but it was found that Trial 5 (100 mL beeswax, 20 g SCG, 100 mL coconut oil) proved to be the most superior of all. It had a high shine, a good effect of fading leather to a rich jet black color, good performance (4-hour performance), good water resistance (26, 524.60s delay absorption time), and smoothness of applying texture. good adhesion, a good smell of coffee, and it is acceptable. Other formulations had varying degrees of performance, where Trial 1 (100 mL beeswax, 15 g SCG, 150 mL coconut oil) also produced good results with a pleasing coconut smell. The findings confirmed that an efficient and sustainable shoe polisher based on a well-balanced combination of the three ingredients Spent Coffee Grounds, coconut oil, and beeswax can be produced to address environmental concerns and with similar or superior performance compared to commercial products in some key areas. This research links to the aims of transforming waste materials into a usable product and promotes the principles of green chemistry and circular economy.

**Keywords:** Spent Coffee Grounds (SCG), Beeswax Pellets, Philippines

## 1. The Problem and its Background

The world is facing a crisis of environmental sustainability. As urban populations grow, the production of organic waste increases. One example of this waste is Spent Coffee Grounds (SCG), which is an underutilized resource that is often improperly disposed of and has a large contribution to climate change. These challenges need to highlight more sustainable, eco-friendly, and innovative solutions that reduce the environmental impact.

### Background of the Study

Proper waste management and commercial waste, mostly from some cafés and households, is a critical global concern; some waste, when disposed of improperly in landfills, contributes to global warming. One major example is spent coffee grounds, commercial waste that contributes significantly to global warming when left disposed of improperly. Spent coffee grounds are a major threat to. Finding ways to upcycle spent coffee grounds to make them a high-value essential product and to reduce carbon footprint.

Coffee grounds can harm the environment because they release harmful greenhouse gases like methane and carbon dioxide. These gases are responsible for global warming (Sidlo & Latosińska, 2025). Needs for alternatives for commercial alternatives with a hint of environmental stewardship. And the need for upcycling, transforming waste into high-value products, can help

lessen the boost of global warming and support the environment.

Previous studies have proven that coffee grounds contain natural pigments and conditioners (Kim & Kim, 2022) [11]. In the past research of Arumsari *et al*. (2025) [1], coffee grounds have the ability to absorb unpleasant odours because they have active compounds such as polyphenols, caffeine, and essential oils and traps such as ammonia and hydrogen sulphide. The practical application of these properties as a primary ingredient for a DIY (Do It Yourself) shoe polisher remains underutilised by the general public. Although commercial shoe polishes are easy to find, they are often not suitable for people on a budget and those who care about the environment and practise stewardship because they are not budget-friendly and contain harmful chemicals.

By addressing this gap, a common environmental pollutant releases harmful gases like methane and carbon dioxide into a useful yet eco-friendly product. Most commercial options are expensive and use harsh, non-eco-friendly chemicals.

By developing a specific formulation that contains natural materials using coconut oil and beeswax, this product can be made in a household, which means it's accessible and easy to replicate.

Filling this gap adds value by proving that high-performance leather enhancement care improves strength and heat resistance and does not have any harsh chemical contents. This research demonstrates that this product can be both easily accessible and easy to replicate in a household setting. Formulating a shoe polisher from upcycled spent coffee grounds as an eco-friendly and cost-effective alternative to harsh commercial chemical polishers. This research aims to diminish the environmental impact of coffee waste, which releases harmful greenhouse gases like carbon dioxide and methane in landfills when improperly disposed of.

This study aims to create an eco-friendly, sustainable shoe polish using upcycled spent coffee grounds to help reduce landfills and lessen the harmful greenhouse gases by turning a harmful product into a useful product for easy accessibility of shoe polish that is natural and not harsh to the environment. The research will test a specific formulation using coconut oil and beeswax mixed with spent coffee grounds. We will observe how well this formulation works to improve the shine and strength of the leather without using harsh chemicals. We will observe how the polish reacts with other leather surfaces and how long the shine will last. We will also compare our spent coffee polish to other commercial shoe polish brands to see which is safer and more affordable to use.

Expecting that this alternative shoe polisher is a great alternative that is cheap and shows good quality and is safe for the environment. The results may show that this shoe polisher works just as well as the commercial shoe polisher products that contain chemicals. Believing that the natural oils coming from coconut oil and ground coffee will nourish the leather, making the leather water resistant and soft, if successful, this study will prove that families can save money while helping to stop global warming.

**Statement of the Problem**

This study aims to develop and evaluate an organic shoe polisher. Coming from upcycled spent coffee grinds, coconut oil, and beeswax as an eco-friendly, sustainable, and cost-effective alternative to commercial shoe polish made out of harsh chemicals, it addresses environmental concerns while aiming to create an eco-friendly, sustainable product accessible to a wide range of users in the community.

Specifically, it seeks to answer the following questions:

1. What is the most effective ratio of spent coffee grounds, coconut oil, and beeswax to achieve the ideal:
   1.1 Texture and consistency;
   1.2 Ease of application; and
   1.3 Drying and Set Time
2. How effective is the spent coffee ground formulation as a shoe polisher compared to a leading commercial brand in terms of:
   2.1 Aesthetic Quality: Level of shine and color restoration on leather;
   2.2 Deodorizing Capability: The extent to which the formulation adsorbs and neutralizes unpleasant smells or any foul odors in footwear.
   2.3 Protection: Level of Water-resistance (Hydrophobicity)
3. Is there a significant difference in the performance of 5 formulations of used coffee ground shoe polisher when differing the ratios of the spent coffee grounds, coconut oil, beeswax?

**Scope and Delimitations**

This research aims at assessing the efficiency of recycling coffee ground waste to use as an ecological resource in the production of a natural shoe shine product. The study involves the process of preparation, formulation, and application of used coffee based shoe polish in powder form that is dried and with the inclusion of coconut oil and beeswax. The study is carried out in Noveleta, Cavite and gathers UCGs in the homes and cafés.

The main criteria used to assess the performance of the developed shoe polisher on leather materials are the evaluation of the shine, the restoration of the colors and conditioning of the leather, and water resistance. It also evaluates the capacity of the product to uptake bad chemical odor, in this case, hydrogen sulfide (H2S), because of natural adsorptive characteristics of used coffee grounds. Also the paper analyses the environmental advantages of the product with respect to waste management and minimized reliance on chemical-contained commercial shoe polish and concludes whether the product has the potential to be a viable alternative to shoe care sustainably.

The experiment only uses used coffee grounds found in households located in Noveleta, Cavite and it does not extend to coffee grounds found in other places or areas which may have different brewing styles or coffee varieties. The results can also be restricted to the type and degree of roast of coffee grounds used because different degrees of roast darkness could cause the slight difference in color and polishing performance of the product. The study concentrates on one formulation and method of preparation and fails to delve into alternative ingredients, methods of processing and large scale production techniques.

The research is only an assessment of the immediate or short-term impact of the shoe polisher on leather surfaces only and the results are not evaluated about the long-term performance, storage stability and long-lasting durability of the treated material. Other issues like market viability, customer acceptability, and business viability are also outside the limits of the present research.

The study assumes that the quantity of used coffee in Noveleta, Cavite is easily accessible and is fairly uniform in quality as well as does not take into consideration the variance which may be caused by the different pastures of preparing coffee at home. Outlining these limitations, the study is expected to give a narrow and controlled breakdown of the viability of used coffee grounds as an environmentally friendly shoe polishing solution.

**Significance of the Study**

This study holds important value as it addresses that utilizing spent coffee grounds, which most households and commercial structures use and leave disposed in the landfills to release strong chemical-effect greenhouse gases, this research offers a solution that mitigates the carbon footprints. It also challenges the reliance on using commercial shoe polish and petroleum-based chemicals. The successful formulation of eco-friendly and sustainable shoe polish leads to a balance between environmental stewardship and everyday use. The outcome of this research will be highly beneficial to:

**Schools**, this research serves as a foundation for building greener and can show that the school cares about the environment and supports the students' sustainable inventions. The results may serve as an inspiration for other students to create their own sustainable, eco-friendly inventions. Also serve as a practical guide for the school to turn waste into something useful and safe, helping the entire school help reduce or mitigate the carbon footprint.

**Students** will directly benefit from this research it helps them to become more creative yet mindful when reusing or upcycling items that should be thrown away it also makes them aware of how their actions affect the planet, this study shows how to lessen of cost of commercial shoe polisher by making their own sustainable and eco-friendly shoe polisher, may also help them to save allowance and helps lessen the impact of coffee waste while keeping their shoes shiny and neat looking.

**Teachers** can use the results and integrate utilizing an item that diminishes the contribution to global warming into their teaching practices. And may serve as a reference for their lesson plans and activities that connect classroom learning for students to real-life applications, particularly promoting upcycling and environmental stewardship.

**Parents** will find this study highly significant, as this study provides practical solutions to reduce household expenses instead of relying on commercial shoe polisher brands. Parents can use this study to create a cost-effective shoe polisher using common household ingredients. It benefits them by using safer ingredients and an alternative chemical-free content shoe polisher and ensuring that their children are not exposed to harsh chemicals or toxic substances.

**Local Community**, this study will help inspire local environmental change by showing the community that waste can turn into something useful and also can contribute to mitigating global warming. For local coffee shops and businesses that handle coffee grinds, this research offers a way to manage their spent coffee grounds, reducing the amount of trash that ends up in local landfills. By turning waste into a useful product that will end up in a circular economy.

**Future Researchers**, this study will serve them as a valuable reference or a baseline of their study for those who are interested in sustainable science. It provides them specific ingredients that can make other research tests improve or adapt for different materials that help them explore how different types of food waste can be turned into eco-friendly and sustainable products.

**School Administrators** can use the results of this study to create new waste management programs, sustainability projects. This research provides evidence based ideas for innovation and implementing green related policies in schools fostering environmental stewardship.

**Theoretical Framework**

The theoretical framework of this study, entitled "Brew to Shine: Upcycling Spent Coffee Formulations as an Organic Alternative to Commercial Shoe Polisher.," the underpinning theories applied are aligned with how to organically produce a shoe polish product using waste materials. This work is about reusing commonly thrown away coffee grounds as household and café waste to make a green and effective shoe polisher. The study rests on three main theories: the theory of waste exploitation, eco-design theory and material recovery theory all of which focus on sustainability, resource management and environment protection.

K. T. N. M. P. Senanayake has proposed waste exploitation theory which can be applicant in waste management showing the processes of making waste things back to useful things that improving the resource utilization, economic profitability and environment compatibility (Sidło & Latosińska, 2025). Spent coffee grounds are the waste product that is usually thrown in the trash or used as landfill which causes harm to the environment and air pollution. Based on this concept, the present work reveals that used coffee grounds can be recycled as a shoe polisher, extending the concept of recycling organic waste to the generation of a viable household item rather than simply allowing it to become an environmental liability. This practice enables sustainable waste management, making use of waste material to produce valuable items.

Jean--Louis Bruneau's eco-acoustic design and the concept of resource efficiency in environmental product design illustrate that products should have minimal environmental impact and maximized resource efficiency in the entire product life cycle. This relates in concept to the fact that this natural shoe polisher is made with very simple ingredients that includes widely available and natural elements like dried coffee grounds and coconut oil. By reducing our reliance on chemical laden commercial shoe polishes, the product reduces health risks and environmental damage. The process of turning coffee waste into a natural product for shoe care demonstrates eco-design concepts such as waste reduction, decreased use of chemicals, and the development of a sustainable product.

According to Michael P. Van Winkle was the first to introduce the notion of material recovery in his material recovery theory built on the premise of the recovery of useful material properties from discarded materials and the reintegration of these materials into functional products. The natural pigments, oils and tannins found in used coffee grounds are good for treating leather. Coffee has natural colouring and conditioning effects" (Kim and Kim 2022) [11]. Tannins present in coffee grounds also increases the strength, durability and heat resistance of leather (Nasr *et al.* 2023) [15] These results highlight the potential for extracting high-value compounds from spent coffee grounds, and for

their use as a natural substitute for the synthetic shoe polishes.

The theories can be applied to the objectives of the research as they explain positive functionalities and environmentally healthy features of using waste coffee grounds as a shoe polishing product. The colour restoration derives out of the natural pigments whereas the tannins and oils help in conditioning and increasing the durability of the leather. Moisture, storage and other variables should be considered since the compounds may spoil or be rendered ineffective in case they are not stored under the necessary conditions. By addressing these difficulties, the green shoe polisher will be able to operate efficiently and also maintain sustainability and safety.

**Definition of Terms**

**Absorption** – Ability of the leather to absorb the shoe polisher.

**Beeswax** – Natural preservative that enhances the feel, uniformity, and resistance to water of the polish.

**Carbon Footprint** – Greenhouse gas emissions reduced by repurposing spent coffee grounds.

**Color Enhancement** – Improvement of color after being applied to a surface or leather.

**Commercial Shoe Polisher** – Factory-made shoe polish used for comparison in terms of performance, cost, and environmental impact.

**Coconut Oil** – Naturally occurring substance used by manufacturers to keep leather shine.

**Durability** – Length of time that the polish remains shiny.

**Eco-Friendly** – Natural ingredients should typically limit harm and waste to the environment.

**Formulation** – Measured combination of SCGs, coconut oil, and beeswax used to produce the shoe polisher.

**Heat resistance** – Ability of leather to protect itself against the heat.

**Leather Shine** – Visible gloss and improved appearance of leather after polish application.

**Organic Shoe Polisher** – Natural shoe-care product which is made up of spent coffee grounds, coconut oil, and beeswax.

**Spent Coffee Grounds (SCGs)** – Used and dried-up coffee grounds collected from different homes and cafés in Noveleta, Cavite which is the main component of shoe polisher.

**Upcycling** – Process of taking waste materials and making high value products. It signifies the usage of SCGs as a shoe polisher.

**Water Resistance** – Ability of polished leather to repel water.

## 2. Review of Related Literature and Studies

This chapter presents a comprehensive review of related literature and studies that establish a scientific framework for reusing organic waste to create an eco-friendly and sustainable consumer product and examines the potential of Spent Coffee Grinds (SCG) as a sustainable shoe polisher alternative to commercial shoe polishers that contain harsh chemicals; upcycling helps mitigate the environmental impact of traditional petroleum-based shoe polishes.

**Conceptual Framework**

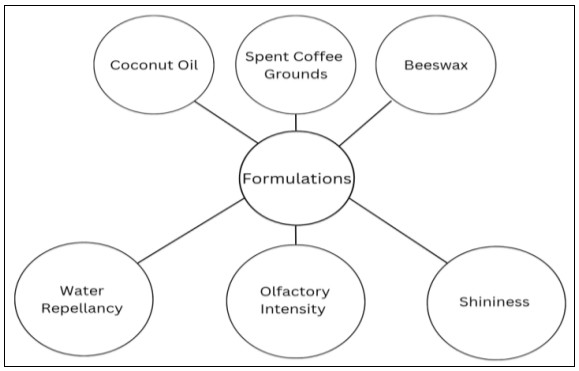


**Fig 1:** Conceptual Framework

Figure 1 outlines the conceptual framework of this study, which follows a structured flow to show how natural ingredients transform into an eco-friendly, sustainable and functional shoe polisher. It begins with the independent variables, which are the raw materials used: coconut oil, spent coffee grounds and beeswax. These materials are chosen because of their specific properties that could make a long-lasting shoe polisher: coconut oil for conditioning, beeswax for protection and texture and coffee grounds for odour neutralisation and pigment.

The bottom outlines are the dependent variables, which represent the measurable results of the study: the water repellency, olfactory intensity or fragrance concentration and lastly the shininess. The bottom variables will determine if the eco-friendly organic polish can perform as well as commercial shoe polish brands.

The bridge acting between the ingredients and the results is the formulation, which means it represents the different mixing ratios and the process where the organic ingredients go through formulations. This is the testing phase: how varying the amount of coffee or conditioning affects the quality of the polish.

Through combining the independent variable and dependent variable, the final product would be the sustainable spent coffee grounds. The purpose of this product is to mitigate carbon footprints and replace commercial shoe polisher products that are mostly petroleum-based chemicals with natural alternatives and to reduce environmental waste to reduce the contribution to climate change.

This outline illustrates the concept of upcycled spent coffee grounds as an alternative to commercial shoe polishers.

**Foreign Literature**

**The Global Crisis of Organic Waste in Landfills**

The global literature, including this study, shows an increasing tension related to the amount of organic waste in landfills, and coffee waste is one of the most recognizable waste part. Pongsiriyakul *et al*. (2024) [17] Spent coffee grounds are generated in millions of tons every year due to the popularity of coffee worldwide, and a significant portion is discarded in landfills. In the absence of oxygen, coffee waste produces the greenhouse gas methane, which does far more harm than carbon dioxide.

La Scalia *et al*. (2022) considered the environmental impact

of coffee biowaste disposal, related to climate change and soil pollution. Global environmental reviews often recommend waste valorisation as solution to the problem. This is indicative of the growing need to find a way to convert coffee waste into value-added products (for example eco-friendly shoe polish, rather than simply throwing the waste into landfills and producing greenhouse gases).

**Advancements in Green Chemistry for Consumer Products**

The green chemistry literature reflects a global trend toward employing non-toxic and petroleum-derived materials in guest consumer experience goods. Lourith et al. (2022) [12] stated that the principles of green chemistry favor the utilization of renewable raw materials and green procedures in product development. They were able to show that coffee waste can replace synthetic surfactants and chemical solvents in consumer products.

Pongsiriyakul *et al*. (2024) [17] also noted that circular economy systems are encouraging the redesign of products made from biodegradable materials derived from waste. Plant-based waxes and oils are increasingly being promoted by international organizations as replacements for paraffin wax and other petrochemical products. This current of change further endorses organic shoe polishers as a sustainable alternative along with the global green chemistry movement.

**Benefits of polyphenols and Caffeine in Surface Maintenance**

Functional effects of polyphenols and caffeine present in the coffee waste, spent coffee grounds (SCG), have been broadly acknowledged in the international literature. Bevilacqua *et al*. (2023) [6] stated that polyphenols are powerful antioxidant agents, which prevent oxidative deterioration and browning. They also impart natural coloring to the treated surfaces.

Lourith *et al*. (2022) [12] added that caffeine and polyphenols protect the skin against UV damage to some extent as they absorb some UVR, thereby minimizing surface degradation. Theoretical papers propose that such chemicals may be used to enhance the durability and aesthetic quality of surfaces, without the addition of synthetic dyes or UV stabilizers. These are positive results for the use of SCGs in shoe polishes, where accentuating color and protecting the surface are also key attributes.

**Local Literature**

**Adsorption Capability of Spent Coffee Grounds**

The demand for coffee grounds is rising, which also doubles the amount of spent coffee grounds, and this waste is dangerous if not properly disposed of, according to a study conducted by Mangussad *et al*. (2023). Explores how (SGCs) can be applied as an adsorbent, a way to reduce the amount of trash in landfills. They use systematic mapping.

They are focusing on four questions about the research trend, the types of pollutants that coffee can trap, and how the coffee performs during the cleaning process or holds particles. The findings are relevant because coffee is identified as a scientific solution for bad odor, as they use systematic mapping looking for the best process, like drying and activation, affecting the coffee's ability. On holding particles as they were finally shown in their study, they developed a porous structure.

Concluding that spent coffee grounds (SGCs) are an effective raw material for trapping unwanted substances, the study has not yet tested the effectiveness of beeswax and oil to create a semi-solid polish regarding the application of spent coffee grounds for leather care. The findings of this study proved that spent coffee grounds (SGCs) are not just ineffective; they have that porous structure that can trap bad odor and certain dirt. While the study of Arumsari *et al*. (2025) [1], their study on "Odor Absorbing Camphor," proves that it can also absorb or attract gaseous compounds, specifically ammonia and hydrogen sulfide, primary chemicals for foul footwear odors, it proves that it doesn't mask the smell with the coffee aroma; it physically detaches them from the air. To transition this from a deodorizer into a leather polish, the material needs to be mixed into a stable base. in the study of Astudillo and Beley (2024) found out that natural waste combined with natural binders can have the same quality of performance as with the commercial waxes They also explained that the characterization of a specific organic polish highlights the effectiveness of organic polish; it depends on the characteristics of the waste. The reviewed literature establishes the strengths of coffee as an adsorbent and absorbent and oils as conditioners for leather. The studies lack literature that tests the effectiveness of lipid-based medium mixed with coffee grounds, especially for leather foot care. This study seeks to determine whether oils block the pores of the coffee and reduce its odor-absorbing ability. It also seeks the best ratio that provides deodorizing effect and shoe shine, creating a 2-in-1 solution that has not been explored by the local shoe polish studies.

**Performance of Organic Agricultural Waste as Leather Polish**

Agricultural waste as a leather care agent is mostly reviewed based on its chemical composition rather than the color. The study of Biñas *et al*. (2024) [5], investigates the use of banana skin and eggshells as an innovative eco-friendly leather polish. The study found out that agricultural waste that is rich in potassium promotes faster drying and evaporation, while materials containing calcium carbonate provide the structural grit that fills in the scratches in leathers. While the study of Pabular (2024) on bio floor wax and leather care confirms that phytochemicals, waxes, and oils create glossy coatings that are similar to the commercial shoe polisher products. According to the study of Jacob (2021) [9], the performance of organic polisher when mixed with a purified lipid medium like coconut oil and cooking oil ensures that the polisher stays glutinous yet shiny rather than becoming brittle.

These studies proved that organic agricultural waste is a scientifically feasible alternative to commercial shoe polish containing harsh chemicals. The results suggest that it's in the performance of the organic polisher; it's not just about the color but the synergy with the binding agent and agricultural wastes. The study of Jacob (2021) [9] confirms that using a lipid medium is the key to great performance of shoe polish. They tested for glossiness, drying time, and rub resistance. There is no local research that measures the performance in terms of shininess and odor removal.

**Efficiency of Fruit Seed Waste as an Alternative Lather Care Agent**

The use of fruit based on local research has expanded from

fruit skins to seeds. The great example of a study is the study by Acosta *et al*. (2025) [3] titled 'Avocado Seed as Alternative Shoe Polish', using avocado seeds with natural binders such as olive oil and beeswax. the findings shows that avocado seeds has natural fats in it and tannins which help improve the leather's durability, the color retention, water repellency and the drying time the study tested different formulas and found that a balance mixture produce the best results the goal of this research is to reduce the health risk linked to harmful chemicals found in commercial shoe polishers such as naphtha and turpentine like coffee grounds avocado seed powder has a rough texture that helps fill small scratches in leather however this study only focused on leather protection and shine it doesn't examine the odor control leaving the gap in while organic waste like banana peels and avocado seeds are effective polishing materials there still limited studies on how the ratio of oils to porous materials such as coffee grounds affecting both shine and odor absorption.

**Foreign Studies**

**Physicochemical Analysis of Spent Coffee Grounds**

Physicochemical properties of used coffee grounds have been investigated by various foreign researchers with a keen emphasis on the fact that they contain high carbon levels, are composed of nitrogenous compounds and possess porous microstructure. Naganbishi and Khorasani (2025) assert that SCGs are composed of lignocellulosic biomass as well as carbon-based functional groups that are highly adsorptive. Their experimental study established that SCGs could accept sulfur compounds in the wastewater treatment process and this implied that they could accept unpleasant odors that are an outcome of volatile sulfur compounds. To a large extent, this adsorption ability can be attributed to the fact that there are functional groups containing nitrogen and with high surface area and which contribute to chemical attachments.

Laboratory tests of Lourith *et al*. (2022) [12] revealed the presence of organic acids, caffeine residues, and nitrogenous substances in coffee waste. These were found to be the source of deodorizing and cleansing effects of the (SCGs). As has been pointed out in the paper, coffee wastes have odor-retaining applications because they possess fine particles that can trap volatile compounds that make coffee smell. The presence of these physicochemical characteristics can explain why SCGs can be included in shoe care products; odor absorption and freshness are the most important key performance indicators of this sector.

As Pongsiriyakul *et al*. (2024) [17] have emphasized, two methods of optimization of adsorption behavior and, in turn, its interaction with gases are the drying and particle-size adjustments of SCGs. When integrated, these scientific studies determine that the nitrogen and the carbon composition of spent coffee grounds qualifies them as effective in the absorption of sulfur to impose their suitability in application as natural odor-cancelling materials in environmentally-friendly development.

**Comparative Analysis of Bio-waxes vs. Paraffin-based Polishes**

Comparisons of bio-based and conventional paraffin-based polishes in terms of protecting surfaces, durability, and environmental performance have been extensively made in the world of international research. Papadaki *et al*. (2024) quantified the generation of the wax esters by spent coffee grounds oil and found that the bio-waxes had comparable hardness, gloss retention as well as coating stability with petroleum-derived waxy products. Their studies have revealed that bio-waxes can be used to create homogenous protective coating on surfaces and inhibit moisture and mechanical degradation and they are also biodegradable and not toxic.

Polishes made out of paraffins are fossil-fuel products and most of them contain artificial additives that might be damaging to the environment and health. As Lourith *et al*. (2022) [12] pointed out, natural waxes and plant-based oils were employed effectively as the surface-conditioning agent as they did not leave any harmful residues. They emphasized in their works that bio-waxes provide a long-lasting shine and protection and are in line with the sustainability agenda.

Coffee-based materials can be utilized in construction, La Scalia *et al*. (2022) elaborated on the fact that when applied to construction, coffee-based materials can be applied as mechanical performance and could be used to enhance the durability of the surface. Although the mortar production was the topic of the study, the findings confirm that coffee-based waxes and oils can be used to improve the surface integrity. This kind of international comparison points out that bio-waxes not only perform well when compared to the paraffin-based polishes but also when it comes to environmental sustainability where the bio-waxes can be used in the production of organic shoe polish.

**Desiccant Capabilities of Dried Coffee in Humid Environments**

The dried spent coffee ground properties have been investigated even in various literature around the globe where it has been noted that the properties of Moorish are porous and hygroscopic. As Naganbishi and Khorasani (2025) have mentioned, the micro- and mesoporous structure of processed SCGs is capable of holding the water molecules. According to their experimental findings, coffee ground but dried and used as a desiccating material is a good moisture absorbing substance and thus can be used as a natural desiccant.

La Scalia *et al*. (2022) also explained that SCGs are employed to regulate the humidity in case of its integration into building material, which could eliminate condensation and the proliferation of molds. The paper has noted that moisture is a requirement in the need to ensure that there is no microbial degradation and this can be transferred to consumer items such as shoes and leather items stored.

According to Pongsiriyakul and colleagues (2024) [17], people have been interested in the use of the dried coffee grounds in the storage and packaging process since they absorb the excess moisture. These findings imply that dried SCGs can be used in two folds of the shoe care products i.e. keeping the shoes damp and hindering the development of molds that serve to extend the life of the shoe care products and safeguard the quality of the products.

**Local Studies**

**Synergistics Effects of Carbon-Rich Waste and Essential Oils**

Beyond fruit peels and seeds, carbonised agricultural waste is being explored for its ability to provide deep coloration and mild odour management. In the study of Libatan *et al*. (2024) on the shoe polishing properties of banana peels and

charcoal, they integrated charcoal and lemon extract into a liquid polish base. The findings revealed that charcoal serves as an effective natural pigment that mimics the black pigment of commercial dyes, while lemon extract acts as a natural preservative and mould deodoriser.

It highlights how adding a carbon-rich component can improve the coating quality of the polish by filling in micro scratches on the leather's surface. It shows that carbon-rich additives are essential for achieving a high-quality finish for the leather and suggests that mixing a rougher organic material with a lipid base creates a superior structural grit for repair. The results successfully created a natural dye-based polish, noting the grit of the charcoal for colour; they did not investigate the specific adsorption capacity of the material in a solid-state polish.

**Performance of Leafy Vegetable Extracts in Lipid Bases**

Testing of organic binders also involved the testing of leafy vegetable wastes and specialized plant waxes. In the study of Adovia *et al*. (2024), the shoe polish is mainly radish combined with a mix of leaf extract with coconut oil, soy wax, and calamansi. The study emphasises the phytochemicals in radish leaves, which, when infused in a lipid medium like coconut oil, create the glutinous texture preventing the leather from becoming brittle. Their results showed that the addition of calamansi helped stabilize the pH level of the mixture, ensuring that it does not damage the leather fibres over time while maintaining a dust-resistant finish. The study effectively measured glossiness and dust resistance; it did not specifically address the dual action of odour removal and shine that is central to the use of spent coffee grounds.

**Efficiency of Carbonized Agricultural Waste as a Blackening and Shining Agent**

Investigating the framework of chemical bonding existing between purified lipids and carbonized coconut shells with the aim of duplicating a deep black pigment existing in commercial brand shoe polishers, the analysis of Jacob (2021) [9] reveals that there is a distinct iodine number existing for coconut shells, signifying a high level of carbon activity that could aid in terms of shining capability. The finding of this research is to establish that recycled oils can indeed provide a low cost for organic polishes if properly deodorized through charcoal filtration. This study focused more on its aesthetic qualities and less on its functional qualities of odor removal. This study does not examine odor removal.

**Synthesis**

The reviewed foreign and local literature all underline the piqued interest in the problem of organic waste landfilling, in the form of the spent coffee ground (SCGs), and their prospects of becoming a sustainable consumer product. International studies have always indicated that coffee waste has contributed greatly to landfills due to the high rate of coffee consumption in the world. Poorly treated SCGs release methane gas under an anaerobic condition that leads to climate change and environmental degradation (Pongsiriyakul *et al*., 2024 [17]; La Scalia *et al*., 2022). The expanding world environmental literature in response suggests the waste valorization as an answer to a sustainable solution-value creation of an environment friendly product out of organic waste.

Consistent with this direction, the foreign literature on green chemistry has emphasized on the world halting the consumption of petroleum materials and beginning to use non-toxic renewable materials. The study has indicated that the coffee waste has utility compounds, which can replace synthetic chemicals in the consumer products, including surfactants, solvents, and pigments (Lourith *et al*., 2022) [12]. The principles of the circular economy also support the redesign of the waste-based product-based polish to the biodegradable polish, positioning the organic shoe polish as the alternative to the traditional polishes that are founded on the chemicals (Pongsiriyakul *et al*., 2024) [17].

In practice, the research conducted internationally identifies the effectiveness of polyphenols and caffeine that are available in SCGs. They include antioxidant compounds, UV-absorbing compounds, and natural colorants that help to prevent oxidation, discoloration and degradation on the surface (Bevilacqua *et al*., 2023; Lourith *et al*., 2022) [6, 12]. These are some of the significant properties of shoe polish compounds that the protection of the surface, the formation of color and durability are the key performance index. Physicochemical studies also confirm that SCGs contain high amounts of carbon and nitrogen and have porous microstructure that allows it to adsorb the contents of foul odor-causing sulfur-based volatile compounds (Naganbishi and Khorasani, 2025). This capacity of adsorption is also enhanced by drying and optimization of particle size that increases their effectiveness as a natural deodorizing agent.

In a complementary study to foreign literature comparing bio-waxes and plant-based oils to paraffin-based polishes, it was discovered that bio-waxes possess the same retention of gloss, hardness and coating stability and are biodegradable and non-poisonous (Papadaki *et al*., 2024; Lourith *et al*., 2022 [12]). The findings are in favor of the environmental and functional advantages of bio-based polish compositions over the fossil based products.

These global results are supported by domestic literature that indicate SCGs to be adsorbed to odor and trap pollutants. Optimal processing of SCGs contributes to the creation of porous structures that are capable of taking in gaseous substances such as ammonia and hydrogen sulfide that are plausible causes of footwear odor (Mangussad *et al*., 2023; Arumsari *et al*., 2025 [1]). However, these studies primarily focus on the deodorization and do not extend the use of SCGs in the system with the use of lipids as the care of leather.

Other local research of agricultural waste-based leather polish also indicates that material synergy is important. Natural oils and waxes have also been found to enhance the gloss, time spent drying, scratch fill and conditioning leather when combined with eggshells, fruit seeds, leafy vegetable extracts and banana peels (Binas, 2024 [5]; Pabular, 2024; Jacob, 2021 [9]; Acosta *et al*., 2025 [3]). To make it more pigmented and surface-healing, waste products with high carbon content, such as charcoal, are added, but to provide it with the desired elasticity, glossiness, and stickiness, lipid media, such as coconut oil and beeswax, are included (Libatan *et al*., 2024; Jacob, 2021 [9]). Despite these kinds of improvements, as far as the local research studies are concerned, most studies either involve the performance of polishing or the aesthetic improvement but little regarding the odor-control mechanism.

Research gaps can be found in the foreign as well as in the local literature. Despite well-known deodorizing effect of

SCGs, moisture-absorbing and adsorptive properties, oils and waxes are already known as good leather conditioners, little studies have been performed to identify the synergistic effect of SCGs and lipid-based binders in the semi-solid form of shoe polish. More precisely, no local study is conducted systematically to test whether the oils prevent the porous structure of coffee ground, and reduce their odor-absorbing power, or what the ideal ratio is that would allow compromising between deodorization and shine.

The gap is addressed with the current paper by taking into consideration used coffee grounds to be added to a lipid-based media to create a dual purpose organic shoe polish that serves not only as an odor control agent but also in giving a shine to the surface. By doing so, the proposed study will contribute to the fact that the process of waste utilization will become more sustainable, further the overall principles of green chemistry and enlarge the local literature on the usage of multifunctional and environmentally friendly leather care products.

## 3. Research Methodology

This chapter provides an overview of the research design, the procedures for data collection, the population and sampling, and the methods for analyzing the gathered information. Each component is carefully detailed to ensure the validity, reliability, and accuracy of the findings, contributing to the successful achievement of the study's objectives.

### Research Design

The research design was a mixed-method sequential explanatory approach, as the proposed research aims to create (5) different ratios of spent coffee grounds (SCGs), coconut oil, and beeswax to create an organic shoe polish. A mixed-methods approach was suitable. characterised by a two-phase process. The study used quantitative data analysis to be collected and analysed first, to be followed by the qualitative data that explores in-depth explanations of initial results. The paper focuses on comparing (5) different formulations employing the quantitative data analysis techniques to evaluate performance parameters that include the water repellency, shininess, and olfactory intensity, durability. The (5) ratios were carefully tabulated and interpreted and explained the results documenting the observable and physical changes of the leather samples before and after applying the shoe polish. Researchers combine these techniques to yield a more detailed analysis of the efficiency and viability of the created organic shoe polish (Creswell & Creswell, 2022) [8].

The quantitative aspect of the research was some controlled performance testing of the organic shoe polish formula. A number of experimental treatments were made, where the main pigment was spent on coffee grounds (SCGs) that are mixed with mild abrasives, natural waxes, and plant-based oils, which provide shine, odorless aroma, surface protection, and conditioning of leather. The control treatment was a commercially packaged shoe polish. All the formulations were used on leather samples under controlled conditions through uniform procedures. Objective testing methods were employed in measuring performance indicators like level of shine, ease of application, odorlessness, and water resistance so as to come up with numerical data that could be analyzed statistically.

The qualitative aspect was used to supplement the quantitative results through the recording of descriptive observations throughout the formulation and implementation stages. Qualitative data entailed observations in texture, consistency, spreadability, absorption, and general workability of shoe polish to leather surfaces. These observations were used to give contextual descriptions of the quantitative results and gave insight into better informing the behaviour of the formulation and user-related properties. Once the best formulation was found, it went to the qualitative phase. The sequential approach ensures the study is self-explanatory; the qualitative findings explain the 'why' behind the quantitative 'what', which shows the products' viability and why the products work as a sustainable alternative.

Spent coffee grounds were chosen to be the primary raw material because of their availability as one of the wastes generated during the coffee brewing process and their potential sustainability in reuse in several areas of the industrial sector. It has already been proven that spent coffee grounds can be used to make valuable compounds and repurposed into environmentally friendly and value-added products (Andrade *et al*., 2022 [2]; Sidlo and Latosinska, 2025). The use of natural waxes and vegetable oils also aided in the development of green products since these substances have been used throughout the history of leather and shoe care products as a conditioner and waterproofer without relying on synthetic compounds (Brands, 2025) [7].

The combination of quantitative data in the performance and qualitative observation allowed for a holistic evaluation of the organic shoe polish formulations. The statistical procedures were done to establish that there was any significant difference between the experimental treatments and the commercial control, and the qualitative findings were to support and analyze the numerical results. The proposed mixed-methods research design allowed the study to measure the efficacy and sustainability of used coffee grounds as a green shoe polish using a mixed-method research design.

### Data Gathering

This study will apply experimentation as the primary method of data gathering, as it produces reproducible and valid findings. In simple terms, It is a systematic and scientific method. Where in manipulating one or more variables to observe the effect on other variables, helping establish clear cause-and-effect relationships, Paperpal (2025) [18]. Through experimentation, the performance of the Spent Coffee Shoe Polisher can be assessed by comparing (5) different ratios and examining their effects on shine test, color enhancement test, Durability / wear Test, water resistance test, texture and consistency test, adhesion test, odor test. By conducting these procedures you can help determine which is the successful product or most effective shoe polisher properties, while considering sustainability. Qualitative and quantitative measurements collected during experimentation.

The student researchers have used a step-by-step systematic plan to collect the data across (5) ratios to accomplish the goals of the study. The tools used in the collection, measurement, and analysis of data were mainly experimentation and controlled testing. Wang and Bai (2022) [21] note that experimental testing plays a crucial role in terms of determining the viability and sustainability of alternative materials since objective testing under controlled

conditions becomes possible. By applying the controlled test targeting the water repellency, shininess, and scent to ensure the student researchers that the results of three ratios are precise and replicable and free from unwanted factors of the product.

**Experimental Ratios of Coffee-Based Shoe Polish**

| Trial | Melted Beeswax (mL) | Spent Coffee Grounds (grams) | Coconut Oil (mL) |
|---|---|---|---|
| 1 | 100mL | 15g | 150mL |
| 2 | 100mL | 20g | 50mL |
| 3 | 100mL | 35g | 75mL |
| 4 | 100mL | 10g | 75mL |
| 5 | 100mL | 20g | 100mL |

**Collection of Materials and Equipment**

| | |
|---|---|
|  | **Used Coffee Grounds** Collected From a Local Café/Coffee Shop, air dried to reduce moisture content to avoid early spoilage of the product. |
|  | **Beeswax Pellets** Beeswax Pellets used as natural binding for the shoe polish and hydrophobic material. |
|  | **Coconut Oil** Purchased from a local store and used as a hydrophobic agent. |

All the materials and equipment needed in the experiment were collected by the student researchers. The used coffee grounds were gathered in local cafes, whereas such other materials as coconut oil and beeswax were sourced locally. The equipment needed was weighing scale, heating equipment, mixing containers, mixing tools and leather samples used in the tests.

**Preparation of Materials**

The spent coffee grounds were collected, washed well to remove the impurities and then dried in the air and even in the oven to dry off the remaining moisture. The coffee grounds after drying were then ground into a fine state and packed in a container. The amounts of the coconut oil and beeswax were addressed in line with the necessary composition percentages. The materials were to be properly prepared in order to maintain consistency and reliability of the experimental process.

**Formulation of the Organic Shoe Polisher**

The certain portions of the coffee grounds used, coconut oil, and beeswax were placed together and heated continuously with stirring until a fine mixture was made. A number of formulations which had different proportions were also made so as to act as experimental treatments.

**Testing of the Experiment**

The ratios under treatment were then rated according to pre-set performance metrics, that is, shine, application and water-resistance. This stage had to be carefully observed, measured and recorded so as to have precise outcomes.

**Interpretation of the Collected Data**

Every observation and measurement will be structured and tabulated. To determine which of the trials/ or formulations shows best water repellency, odour, finest shine for a natural shoe polisher.

**Validation of Experimental Results**

To give validity and reliability, the results of the experiment were checked and approved by a specific research adviser or subject specialist. This move assisted in ensuring that the research procedures, measurements, and methods of evaluation were suitable in the study and that the research results were valid and reliable.

**Data Recording and Analysis**

All quantitative and qualitative data from experimentation will be organized and analyzed to determine which shoe polish formulation is most effective between Test 1-5.

**Data Analysis**

Student researchers will use quantitative data analysis techniques to assess the efficacy of the organic shoe polish made from spent coffee grounds (SCG), coconut oil, and beeswax. Experiments were conducted to assess critical parameters such aesthetic appeal, deodorizing property, water repellent property, and relative efficacy compared to other commercially available products.

After the completion of all experimental work, the data regarding intensity, shininess, and repellency were carefully tabulated and interpreted. Results were shown using the descriptive statistical methods such as mean, standard deviation, and observed value for every ratio of spent coffee ground, coconut oil, and beeswax Siedlecki (2020) [20]. Charts and figures were used to present the study results. To determine if the differences between the three ratios and the control (if applicable) are statistically significant, the researchers may employ a one-way Analysis of Variance (ANOVA).

**4. Results & Discussion**

This chapter presents the performance analyses of the UCGs shoe polish. The results are presented according to the different aspects: shine, colour, durability, water resistance, texture, adhesion, smell and shelf life. The results from each test are compiled into tables for convenience and clarity of interpretation.

In this chapter, the results are discussed and the performance of the shoe polish in relation to the expected outcomes. The analysis has revealed some trends, positive and negative, and the outcome is a measure of how the developed shoe polish performs and if, and where, it can be improved. Lastly, to clarify the following terms, here is their detailed meaning:

- SCG - Spent Coffee Grounds
- CO - Coconut Oil
- BW – Beeswax

**Performance Testing Results of Used Coffee Grounds Shoe Polish**

**Table 1:** Shine test

| Trial no. | Type of Shoe Leather | Amount of Polish Applied | Buffing Time (minutes) | Shine Level (Low/Moderate/High) | Observations |
|---|---|---|---|---|---|
| 1 | Top-Grain Leather | BW - 100mL<br>CO - 150mL<br>SGC - 15g | 1:08.46s | High | It is a paste-like polish and has a rich and long-lasting shine, and the leather looks deeper or more saturated and has a pleasant smell of coconut oil. |
| 2 | Top-Grain Leather | BW - 100mL<br>CO - 50mL<br>SGC - 20g | 1:16:20s | Low | It is a thick polish and has a fog over the shine, making it blurry and not shining, and not even shining, and it is uneven; some parts of the shoe are shinier than others. |
| 3 | Top-Grain Leather | BW - 100mL<br>CO - 75mL<br>SGC - 35g | 1:08.59s | Moderate | It is a thick polish and has a slight fog over the shine, making it slightly blurry and not shining, and not even shining, and it is uneven; some parts of the shoe are shinier than others. And has a strong smell of coffee. |
| 4 | Top-Grain Leather | BW - 100mL<br>CO - 75mL<br>SGC - 10g | 1:07.96s | Moderate | It is a thick polish and has a slight fog over the shine, it is even shining and has a strong smell of coffee. |
| 5 | Top-Grain Leather | BW - 100mL<br>CO - 100mL<br>SGC - 20g | 1:34.61s | High | It is a slightly thick polish, the leather color looks deeper, it is even, and has a strong coffee smell. |

In performing, applying spent coffee polisher in each shoe based on the observed buffing time, shine level, Sample 5 (BW-100 mL, CO-100 mL, SGC-20 g) is the most effective in terms of buffing time and shine level, followed by Sample 1 and Sample 4, Sample 2, Sample 3.

Sample 3 and 4 were moderately effective; these trials were noted as having a "slight fog'' over the shine, making the reflection matte. Sample 2 was the least effective, as its formulation created a thick polish resulting in a matte finish, leaving an uneven and heavy fog, resulting in a low shine level despite a buffing time of (1:16:20s). The formulation of Sample 1 and 5 marks it as the most effective polishing formulation that provides a high-gloss finish and pleasant aroma. The volume of the coconut oil contributes to enhancing the polish's performance. In Sample 1 the spreadability and clarity of the shine were improved, In Trial 2 the coconut oil was reduced and the formulation became too thick, which provided the matte finish, preventing a clear, even reflection.

**Table 2:** Color Enhancement Test

| Trial no. | Leather Color (Before) | Color After Application | Uniformity (Even/Uneven) | Visible Improvement (Yes/No) | Remarks |
|---|---|---|---|---|---|
| 1 | Fading Gray | Jet Black | Even | Yes | Deepest color saturation, Successfully restored to rich black finish with a strong coconut oil scent. |
| 2 | Fading Gray | Dull Black | Uneven | No | Weak color enhancement with a finishing matte/fog and lacked a clear, polished shine. |
| 3 | Fading Gray | Dull Black | Uneven | No | Moderate color enhancement with a slight "fog" and lacked a clear shine. |
| 4 | Fading Gray | Jet Black | Even | Yes | Stronger color enhancement, successfully restored the rich black finish with a strong coffee scent |
| 5 | Fading Gray | Jet Black | Even | Yes | Deepest color saturation, Successfully restored to rich black finish with a strong coffee scent. |

In performing the color enhancement test, the student researcher found that Sample 2 and 3 achieved a "Dull Black" color after the application; they were ineffective and had uneven uniformity. The observation noted a fog over shine and thick polish, which makes the leather appear matte/blurry rather than polished.

The Samples 1, 4, and 5 were the most effective in terms of achieving the "Jet Black" with even uniformity. Trial 5 provided the "Deepest Color Saturation" that masked all of the grey areas. In conclusion, Sample 5 (BW-100 mL, CO-100 mL, SGC-20 g) is highly effective for maintaining the color of black shoes providing a polished appearance and a strong coffee smell that contributes to color staining.

**Table 3:** Durability / Wear Test

| Trial no. | Duration of Use (Hours) | Activity Performed (Walking/Standing) | Shine Retention (Low/Moderate/High) | Visible Fading (Yes/No) | Observations |
|---|---|---|---|---|---|
| 1 | 4h | Walking/Standing | High | No | Maintains shine and deep black color well |
| 2 | 4h | Walking/Standing | Low | No | The shine removes over time |
| 3 | 4h | Walking/Standing | Moderate | No | Durable for regular use |
| 4 | 4h | Walking/Standing | High | No | Maintains shine and deep black color well |
| 5 | 4h | Walking/Standing | High | No | Maintains shine and black color well |

For the durability and wear testing, the student researchers evaluated the longevity of the polish formulations by using the shoe leathers for 4 straight hours by walking and standing. Based on the shine retention and visible fading, it was noted that Samples 1, 4, and 5 were most effective, as they all maintained the shine and the black color well.

The results from Sample 2 noted that it has a low shine retention level; the shine removes over time. It indicates that it has a lack of bond between the thick polish and the leather surface. While on Sample 3, it shows a moderate shine that is considered durable enough for regular use.

In conclusion, none of the samples showed visible fading of the base color. The most superior formulation is Sample 5 (BW-100 mL, CO-100 mL, SGC-20 g), as it balances the shine retention and also has the ability to maintain the deep black color through physical activities.

**Table 4:** Water Resistance Test

| Trial no. | Water Amount Applied (Drops/ml) | Absorption Time (Seconds) | Water Repelled (Yes/No) | Leather Condition After Test | Remarks | Ranking |
|---|---|---|---|---|---|---|
| 1 | 5 mL | 18, 317.84s | Yes | Excellent | Strong surface wetting | 3 |
| 2 | 5 mL | 15, 080.73s | Yes | Excellent | Water beads on surface | 4 |
| 3 | 5 mL | 14, 733.62s | Yes | Excellent | Water beads on surface | 5 |
| 4 | 5 mL | 24, 503.04s | Yes | Excellent | Slight water resistance | 2 |
| 5 | 5 mL | 26,524.60s | Yes | Excellent | Strong Water Resistance | 1 |

Performing the water resistance test, student researchers observed how each sample repelled the water drops and measured the time it took the moisture to be absorbed in the leather condition. Samples 5 and 4 were the most effective in this test; they both showed an absorption time of (26,524.60s) and (24, 503.04s) and kept the leather in excellent condition.

Samples 1 and 3 show protective properties with absorption with their time mark at 18, 317.84s and 14, 733.62s, respectively. Sample 2 shows the least effective of the group and fastest absorption time of 15, 080.73s. These trials were effective because they caused the water to form beads on the surface, preventing immediate soaking into the leather. However, Sample 5 (BW-100 mL, CO-100 mL, SGC-20 g) remains the most superior formulation; this formulation combines the longest absorption delay with the strongest water resistance, effectively protecting the top-grain leather from moisture.

**Table 5:** Texture and Consistency Test

| Trial no. | Texture Description (Smooth/Grainy/Hard/Soft) | Ease of Application (Easy/Moderate/Difficult) | Spreadability (Good/Fair/Poor) | Remarks |
|---|---|---|---|---|
| 1 | Grainy | Easy | Good | Light texture, easy to apply |
| 2 | Hard | Hard | Poor | Thick but manageable |
| 3 | Hard | Hard | Poor | Medium thickness, spreads evenly |
| 4 | Smooth | Moderate | Fair | Slightly thicker, smooth application |
| 5 | Smooth | Easy | Good | Light texture, easy to apply |

In performing the texture and consistency test, the student researcher assessed the feel, application ease, and spreadability of different mixtures based on Samples 1 and 5, which were most effective; both featured a texture that was easy to apply with good spreadability. While Sample 1 has a grainy texture, Sample 5 is noted as smooth, providing a light texture that simplifies the polishing process.

Samples 2 and 3 were the least effective in this test. These formulations are described as hard with poor spreadability, making the application step more difficult for researchers. Sample 2 was noted as being thick, while sample 3 maintained a medium thickness that spread evenly despite the hardness. Sample 4 fell in the middle, showing moderate ease of application and fair spreadability with a smooth, slightly thicker consistency.

Sample 5 (BW-100 mL, CO-100 mL, SGC-20 g) remains the superior formulation across all tests; it combines smooth, light texture and easy application with the excellent shine and water resistance results seen in previous trials.

**Table 6:** Adhesion Test

| Trial no. | Drying Time (minutes) | Rubbing Method (Cloth/Finger) | Polish Removal (Low/Moderate/High) | Adhesion Quality (Good/Fair/Poor) | Observations |
|---|---|---|---|---|---|
| 1 | 15 | Cloth | Low | Good | Stays on leather well |
| 2 | 5 | Cloth | Low | Good | Excellent adhesion |
| 3 | 7 | Cloth | Low | Good | Maintains polish after rubbing |
| 4 | 13 | Cloth | Low | Good | Maintains polish after rubbing |
| 5 | 20 | Cloth | Low | Good | Thick layer, excellent adhesion |

In performing the adhesion test, the student researcher measured the drying time for each sample and then used a cloth for the rubbing method for checking the polish removal. All the samples demonstrated good adhesion quality; they showed low polish removal after rubbing. Sample 5 has the longest drying time at 20 minutes. It was shown that providing a thick layer with excellent adhesion, Sample 1 had a drying time of 15 minutes and was observed to stay on the leather very well.

The Samples 2 and 3 were the fastest to dry at approximately 5 and 7 minutes, respectively. However, even at a faster drying time, the two samples remained with excellent adhesion, wherein it stayed on the surface after rubbing. Sample 4 falls into the middle category with 13 minutes of drying time, effectively holding the polish on leather throughout the test.

All the formulations showed good bonds with top-grain leather, which ensures the product does not easily rub off after application. However, Sample 5, BW-100 mL, CO-100 mL, SGC-20 g, remains the best formulation throughout this entire study. Although it requires longer drying time, it produces a thick, durable layer that complements the high shine and deep color restoration observed in previous tests.

**Table 7:** Odor Test

| Trial no. | Initial Odor Strength (Weak/Moderate/Strong) | Odor After Drying | User Acceptability (Acceptable/Not Acceptable) | Remarks |
|---|---|---|---|---|
| 1 | Strong | Coconut Oil Scent | Acceptable | Pleasant aroma, Coconut Oil Scent is noticeable and Coffee Scent fades away. |
| 2 | Weak | Faint Coffee | Acceptable | Pleasant aroma, Coconut Oil Scent is slightly noticeable and Coffee Scent fades away. |
| 3 | Moderate | Mild coffee | Acceptable | Soft coffee smell |
| 4 | Moderate | Mild coffee | Acceptable | Soft coffee smell |
| 5 | Strong | Strong Coffee Scent | Acceptable | Strong Coffee Scent |

In the odor test, the student researcher had to evaluate the intensity of the odor and how long the appeal lasts to determine the acceptability of the user. On the basis of the odor test, Samples 1 and 5 were the most distinctive scent experiences, as they lasted from the beginning with a Strong initial odor strength. Sample 1 had a noticeable Coconut oil smell as the coffee odor diminished, and Sample 5 had a Strong Coffee Scent even after drying, which were both acceptable by the user as the aromas were pleasing.

Samples 3 and 4 were moderately effective based on their scent, as they gave an initial Moderate strength that reduced to a mild coffee smell as they dried. However, it was also established that samples 3 and 4 were acceptable, as they gave a mild coffee smell, unlike sample 5. The least impactful scent profile belonged to Sample 2, which gave an initial Weak strength and reduced to barely a coffee smell as the coconut smell began to emerge slightly.

In conclusion, all the five formulations were able to attain the level of User Acceptability, thus ensuring that the natural ingredients such as coconut oil and spent green coffee offer a nice alternative to chemically active polishes. Sample 5 (BW 100 mL, CO 100 mL, SGC 20g) remains the best for those who prefer a strong, professional scent as it is the only formula that remains intact throughout the application and drying process without losing the coffee smell.

## 5. Summary, Conclusions, and Recommendations

The chapter gives the summary of findings, conclusions and recommendations of the study Brew to Shine: Upcycling Spent Coffee Formulations as an Organic Alternative to Commercial Shoe Polishers. The polish was developed by utilizing waste materials, that is, used coffee grounds (SCG), coconut oil and beeswax. The five coated leather samples (Trials 1-5) with different formulations were tested by determining several performance parameters, and compared with the commercial shoe polish products.

### Summary of Findings

The evaluation of performance was done in shine level, color enhancement, durability/wear, water resistance, texture/consistency, adhesion, and odor. Findings indicated that all of the treated leather samples had effective shoe care properties and most of the formulations did well or even better than the commercial alternative in certain aspects.

Among the tested samples, Trial 5 (100mL beeswax, 20g spent coffee grounds, 100mL coconut oil) proved to be the most performing on the whole. It attained a high level of shine, even application, delivered the greatest level of color saturation in restoring faded leather to a rich jet black, a high level of shine and color was maintained after 4 hours of use, it had a smooth and easy to apply texture, it adhered well with a strong layer of adhesion which stayed in place, and had an appealing strong coffee smell that was very well accepted by users. Lastly, it shows the longest absorption delay in a time of (26,524.60s).

Trial 1 (100mL beeswax, 15g spent coffee grounds, 150mL coconut oil) provided a high level of performance; it was very shiny, deeply colored, provided a good degree of durability and water resistance, and the coconut oil smell was pleasant. With a time of delayed water absorption with a time of (18, 317.84s) Trials 3 and 4 had moderate results

and slight degrees of fog over shine and satisfactory overall performance. Trial 2 (100mL beeswax, 20g spent coffee grounds, 50mL coconut oil) was the least successful one resulting in a thick polish, which lacked shine and had a matte quality of application, although it had good water resistance and adhesion.

Overall, the research results support the idea that a well-balanced blend of spent coffee grounds, coconut oil, and beeswax will create an efficient, sustainable shoe polish that would give the shoe aesthetic, protective, and sensual qualities and minimize the waste produced by organics.

## Conclusion

In accordance with the outcomes of the study, the following conclusions can be made:

1. The ground coffee, coconut oil, and beeswax make an organic shoe polisher that can be successfully developed, having a positive impact on the environment by substituting the products that include commercial chemicals.
2. Every developed sample showed good to excellent performance in all testing parameters, which proves the fact that used coffee grounds that have been upcycled can be successfully used as the active ingredient in the shoe care items.
3. The proportion and balance of the components of the polish determines the effectiveness of the polish, greatly signifying that ratio of the formulation is critical when it comes to identifying performance characteristics like shine, texture, and water resistance.
4. Trial 5 is the most effective formulation in terms of overall performance as it has been reported to give the same and consistent results in all tests undertaken.
5. Trial one was very well performing with a good coconut smell and thus it is a good substitute to those who want less intense aromas.
6. The performance of Trial 3 and 4 was average and the limitation of the trials was probably caused by the inappropriate proportions of used coffee ground and coconut oil which influenced the clarity and the texture of the shine.
7. Although Trial 2 demonstrated good levels of water resistance and adhesion, it performed worse in terms of shine and uniformity of color because of the lack of coconut oil that resulted in too thick consistency.
8. It is made with the usage of spent coffee grounds, which will offer natural pigmentation, odor control, and possible leather conditioning qualities, and coconut oil and beeswax that help to add shine, protection, and text.
9. The innovative shoe polish is considered sustainable, affordable and environmentally friendly as an alternative to the traditional synthetic shoe polishers which can contribute to the reduction of organic waste and exposure to harsh chemicals.

## Recommendations

In accordance with the results and conclusions made in the study, the following recommendations are offered:

1. Subsequent research can be used to test the performance and the shelf life of prepared polish in the long run and how it is able to withstand different conditions of storage and how it is able to resist degradation with time.
2. Due methods of standardized testing of shoe care products including those developed by the industry organizations are suggested to further prove the performance and safety of the devised polish.
3. Future studies can be dedicated to the size optimization of the spent coffee particles, other natural additives and alternative methods of application to enhance the overall performance and usability. non-leather materials, as well as to determine how the deodorizing property of the formulation can be improved to suit particular footwear Odors.

## 6. Acknowledgment

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With hearts full of gratitude, the researchers dedicate this success to everyone who has, in one way or another, shared their time, knowledge, and kindness to make this academic endeavor meaningful and successful.

## 7. Dedication

This research is lovingly dedicated to the families of the researchers, whose unconditional love, unwavering support, and countless sacrifices have been their greatest source of inspiration. Their encouragement, patience, and faith provided the motivation to persevere through challenges and academic success.

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Above all, this research is humbly offered to Almighty God, the ultimate source of wisdom, strength, and guidance. His divine light has illuminated every step of this journey, granting the researchers the courage and determination to complete their work with faith and gratitude. All glory and honor belong to Him.

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