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Possibility to Implement the Usage of Plants as Coloring Agent for Hard Element

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Abstract
The creative industry is increasingly focused on extracting natural colors from plant materials, using methods like boiling, tinting, and soaking to apply color primarily to softer materials. However, these techniques are less effective for hard surfaces and often rely on toxic chemicals and unnatural processes. This research aims to investigate the potential of using raw materials from flowers, leaves, and plants as natural coloring agents for hard surface applications. The objective is to develop an effective and eco-friendly coloring process that promotes the use of natural dyes in hard surface coloring within the creative industry.

Keywords: Natural colors, Hard surface colorization, Raw properties of material

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1.0 Introduction

1.1 Use of a chemical coloring process in the hard surface materials and its effect

Hard surface materials play a crucial role in industrial settings due to their robustness, strength, and ability to withstand challenging conditions. These materials find applications across a wide range of industries and are commonly classified into categories such as metal, plastic, stone, ceramic, composite, and more. This research is particularly focused on exploring composite materials, with natural ways of coloring as a priority due to their intricate nature and importance in various industries. However, the issue of global warming has raised a significant amount of concern that force every industry to find ways to address this critical issue through various ways of sustainability effort.

The use of herbs and spice as coloring agent has been known from centuries, they are used to added elements of aesthetics to complement the basic function of food, cloths, or housewares. The way to use it is to extract the color into color pigments and implement it through boiling, soaking, paint or taint it. However, when pigment is derived from the plant's part, there will be a byproduct of the process than becomes a waste. The process of extracting itself also need the use of energy. Although this process is not as volatile as using chemical or synthetic coloring agent, it is still present as a problem nevertheless. Hence this research aimed to use the parts and

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used it as a body filler of the composite material as well, with the same principle for using wood dust as a body to form Medium Density Fibre Board (MDF) that is so commonly used in the construction nowadays.

Resins, particularly refers to a synthetic polymer, hold a prominent position as the material of choice in a wide range of products across various industries. Their significance lies in their exceptional versatility, durability, and adaptability, making them vital components in modern manufacturing processes. The utilization of resin spans across a multitude of industrial operations and applications, including coatings, adhesives, composite materials, plastics, polymers, construction projects, and the automotive sector. Undoubtedly, resin, in particular, has risen to prominence as a popular and multifaceted material within the realm of design. Its distinct attributes, such as enduring quality, transparency, and the capacity to take on diverse forms through casting, render it a highly sought-after medium for the creation of both utilitarian and artistic works.

To introduce color variations in resin materials, the common approach involves blending color pigments into the liquid resin before casting or applying surface dyes following the hardening stage. Both techniques rely on the inclusion of chemical color agents to attain the intended outcomes. While herbs and spices are items in the households, incorporating natural elements into designs is a well-established practice. Within the design field, the incorporation of herbs and spices is typically associated more with their sensory attributes, such as aroma and flavor, rather than emphasizing the distinctive visual traits they possess. For these reasons, the research will explore the ways to emphasize the distinctive characteristics and appearances of herbs and spices as key elements in the design process. By incorporating the unique textures, colors, and natural aesthetics of these materials, the research aims to create visually striking products that not only showcase the beauty of the herbs and spices themselves but also highlight their functional roles in the material accordingly.

1.2 Exploring, the possibility of reusing in-landed waste as a source of materials.

The concept of reuse, reduce, and recycle has been integrated into design industries for some time. Contemporary trends and social movements strongly emphasize environmentally friendly approaches, aligned with global Sustainable Development Goals (SDGs). To address climate change and environmental preservation, this research investigates the potential of industrial waste as a raw material for hard surface materials. Construction sites generate significant waste due to cutting and fitting processes, with MDF as a common example of a material developed to mitigate this issue. However, other waste materials, such as metal, aluminum and glass, have limited recycling options due to property degradation and complex processing requirements.

For these reasons, the research is focused on reusing raw waste materials from their original forms to create new materials. By repurposing these waste products at their initial stages, the study aims to transform what would typically be discarded into valuable resources. This approach not only reduces the environmental impact associated with waste disposal but also promotes a more sustainable cycle of material use. Ultimately, the goal is to develop new materials that align with sustainability objectives while minimizing waste and supporting environmental movement accordingly.

2.0 Literature Review

In this chapter, we define and discuss similar previous studies that were performed related to our study**.** For thousands of years herbs and spices has begun playing an essential role in human life either used for flavoring, preservation and coloring agent in food, medicine, cosmetics and others like painting, textile and various houseware. Being safe to be consumed by men, herbs and spices-based coloring becomes a preferable healthy and sustainable choice (Elizabeth, J., 2017) Mostly originate from Europe, Africa and Asian countries, spices and herbs are obtained from non-woody and flowering plants. Spices are obtained from the dry part of the plant like rootstalk, twigs, nuts, flower, seeds and outermost layers of stems and roots. Herbs are always obtained from the leaves (Farhana, et. all., 2021)

Herbs and spices also always regarded as a source of natural colors. Human has perfecting ways to derive color pigments and used them not only for food, or cosmetics but also for textile and various housewares by ways of dip, paint or taint. In a research conducted in India regarding staining capability of spices in Indian food turmeric is regarded the most capable in staining resin-based material (Usha, C, 2018). In several cases herbs and spices can provide not only coloring benefit but antibacterial properties at the same time like being shown in a research regarding the use of turmeric to dye silk fabric, where it also increases the anti-bacterial properties of the material (Ghoereishian, S., 2013) The same effort use in wood industry to more natural antibacterial by impregnating it into the wood, although the capabilities differ amongst different kind of wood (Peker H., 2021).

The common way to derived color in industry scale from herbs and spices is to extract it by chemical process, use heat or using fungi by biotechnology process resulting in what is called Monascus pigment. (Pintea A.,2008) More traditional way is by boiling the herbs and spices with resulted in colored water which is then used to boil or dip the intended material to be colored (Tresnawati, N., 2020) Other way is to transfer the color essence directly from herbs and spices to the material it is intended too, like in the process of eco-printing (Haylamaz, et all. 2023). However, the byproducts of herbs and spice industry becomes its own problem, as they are regarded as a waste (Shams, R., 2023). Only successful effort of utilizing and enhancing this by-product can, in the end, support the agricultural overall sectors sustainability. Several utilizing efforts for example by turning it into higher-value goods, which in turn creating new jobs that help local community prosper economically (Nair, et al., 2022). Therefore, it is the aim of this research to use the spice as a whole, not only for the coloring properties and leaving waste which becomes another environmental issue, but as a composite element to produce hard surface for furniture or interior benefit.

3.0 Methodology

3.1 Exploration of herb and spices colors

In the resin coloration, two predominant techniques have been practical in practice including: the integration of pigments directly into the liquid resin pre-casting and the application of dyes onto the solidified surface post-casting. Both methodologies have relied heavily on chemical colorants to achieve specific shades, color tones and hues. However, in a recent experiment process, the studies explore the potential substitute methods to replace these chemical colorants with the naturally occurring pigments found within the bodies of various herbs and spices. This exploration aimed to not only diversify the color palette available in resin production but also to potentially introduce a more sustainable and environmentally friendly approach to resin coloring. The research, focused on a meticulous process by selecting primary colors derived from natural materials as the focal points for preliminary testing subjects within the experiment. Each color was meticulously selected to showcase the distinct hues found in various organic sources: red from grounded dried red chili, green from grounded dried green chili, yellow from turmeric, light brown from curry powder, and dark brown from ground coffee beans. At the outset of this innovative experiment, the research strategically combined these selected natural materials into the adhesive liquid in varying ratios. This deliberate approach aimed to explore a spectrum of ingredient proportions to discern their impact on the final color outcomes. By systematically balance the ratios of these primary colors within the adhesive mixture, the researchers sought to contribute the visual aesthetics of the hardened surface material. This methodical exploration set the groundwork for an understanding of how each natural pigment influenced the overall color palette and characteristics of the adhesive product, setting the stage for further exploration and refinement as shown in Fig. 1.

Fig. 1: The image of selected herbs and spices mixing with adhesive experiment results
(Source:) The authors

3.2 Exploration on in-landed waste

The primary objective of this research was to provide alternative color solutions for the coloration process in hard surface materials while focusing the area of studies beyond conventional natural products. This initiative aims to expand the potential for reusing waste materials in the production process without compromising the integrity of the original resources. In other words, the research strives to harness waste to create new materials while emphasizing minimal energy consumption throughout the process. When considering the unique properties of glass, it becomes evident that it stands apart from other materials. One of the key challenges associated with glass is that once it breaks, it becomes exceedingly difficult to regenerate or reproduce in its solid form. To return glass to a liquid state for reshaping and repurposing into desired products, it must be subjected to extremely high temperatures. This requirement for significant energy input poses a challenge for recycling efforts, as the energy-intensive nature of melting glass limits the feasibility of its regeneration.

Focusing on the waste generated from the metal industries, it becomes clear that metal scrap and shavings undergo similar recycling methods. The recycling process requires exposure to high temperatures to convert the materials back into a liquid state, making them able to reproduction and reforming. Metals, particularly aluminum, are known for their weatherproof characteristics, durability, and long lifespan, making them a top choice in construction and manufacturing process. However, the cutting or division of aluminum materials often results in the creation of shavings and scraps that are challenging to repurpose or reform into new products. These fragments can pose a significant challenge within the recycling industry, as their irregular shapes and sizes complicate the recycling process. Recognizing this issue, the research team identified a valuable opportunity to utilize these metal shavings and scraps in an innovative way beside their traditional recycling processes. By exploring alternative applications for repurpose the use of scrap and shred materials, the research seeks to maximize resource efficiency and reduce waste, ultimately contributing to more sustainable practices within the metal industry. This approach not only addresses the challenges presented by metal waste but also provided new possibilities for integrating these materials into diverse applications, thereby promoting a circular economy, respectively.

The experiment combined these selected waste materials into the adhesive liquid using different ratios to explore the effects on texture, and overall appearance of the final output, as shown in Fig.2.

Fig. 2: The image of selected industrial toxic waste mixing with adhesive experiment results
(Source:) The authors

4.0 Findings

4.1 The exploration of alternative options for coloring hard material products

This study, presents a fascinating avenue for innovation, particularly through the implementation of herbs, spices, and even industrial toxic waste. This approach not only aims to diversify the color palette available for various applications but also seeks to promote sustainability and environmental responsibility in the manufacturing process. In addition, the potential to incorporate industrial toxic waste into the coloring process opens up an intriguing dialogue regarding waste reuse and resource efficiency. While the term "toxic waste" typically carries negative connotations, with the right processing and treatment, certain by-products from industrial activities could be transformed into functional pigments or colorants. The possibility of combining natural and industrial waste materials in the coloring of hard products can lead to a more sustainable and responsible approach to manufacturing respectively.

4.2 Possibility to provide substitution of colors pigment in hard surface materials.

The issue of potential chemical waste is predominantly present within the realm of synthetic color pigment production. The creation of these synthetic pigments involved a chemical process that can result in the generation of byproducts and residues. If not handled and disposed of in a proper manner, this issue undoubtedly poses a significant harm to the environment. In the event of their release into the surrounding environment directly effects ecological consequences. Among the various aspects of the production process, the wastewater produced stands out as a particularly critical concern associated with synthetic coloring methods. When toxic waste materials are collected and repurposed, they can be transformed into new products or incorporated into existing materials, thus keeping them out of landfills and preventing their harmful components from leaching into the soil.

4.3 Providing the alternative natural colors options

Throughout history, herbs and spices have served as a veritable treasure trove of natural colors, finding diverse applications spanning from culinary endeavors to textile dyeing. Offering a sustainable and aesthetically pleasing alternative to synthetic dyes, these botanical sources contribute a rich and varied palette of hues. The colors derived from natural sources often exhibit a more subdued or earthy quality, contrasting with the bold and vivid tones achievable through synthetic pigments. While certain natural pigments may manifest in an opaque form, many showcase a translucent nature. This transparency lends itself to the creation of intricate layering effects, resulting in visually captivating outcomes. As exemplified by the blend of turmeric, calcium and metal shred depicted in Image Fig.3., the interplay of natural pigments not only offers a nuanced color spectrum but also opens avenues for artistic exploration and creativity. In the realm of pigments, a notable distinction often arises between natural and synthetic variants in terms of particle size. Natural pigments tend to exhibit larger particle sizes compared to their synthetic counterparts, a factor that can significantly influence both the intensity of coloration and the overall texture of the end product. This characteristic difference in particle size not only influences the aesthetic appeal of the pigments but also contributes to the distinctive visual effects they achieve in various applications respectively.

In this research, the focus on alternative coloration methods seeks to address these challenges by exploring the utilization of waste materials, not only to create vibrant colors but also to contribute to a more sustainable approach in the production and reuse of hard

surface materials, including glass and metal scrap and metal shred. By investigating innovative solutions and strategies, the research aims to promote a circular economy that values resource efficiency and minimizes environmental impact respectively.

Fig. 3: The image Turmeric, Calcium and Metal layering experiment results
(Source:) The authors

5.0 Discussion

5.1 Exploring the potential utilization of herbs and spices on hard surface materials represents a promising frontier with a multitude of possibilities.

Incorporating these natural elements into hard surface materials opens avenues for innovation and creativity, offering a departure from conventional synthetic additives. The application of herbs and spices on hard surfaces presents a range of advantages. These natural ingredients bring with them not only their inherent color properties but also their unique textures. Furthermore, the prospective use of herbs and spices on hard surfaces aligns with the growing demand for sustainable and eco-friendly practices in various industries. By opting for natural additives, stakeholders can reduce their reliance on synthetic chemicals and contribute to a more environmentally conscious approach to material production. Overall, exploring the incorporation of herbs and spices into hard surface materials represents a harmonious blend of nature-inspired design, sensory stimulation, and sustainable innovation, paving the way for a more vibrant and environmentally friendly aesthetic in diverse applications accordingly.

5.2 Possibility to equip the natural materials agents in adhesive process.

By considering the incorporation of these organic elements into adhesives, a new frontier emerges in the realm of bonding techniques, offering a departure from traditional synthetic formulations. The exploration of natural materials as agents in adhesive processes holds significant promise for various applications. These natural ingredients bring forth a range of unique properties, including biodegradability, sustainability, and potentially enhanced adhesive qualities. By harnessing the inherent characteristics of natural materials, such as plant extracts or mineral derivatives, in adhesive formulations, manufacturers and researchers can potentially unlock novel solutions that cater to eco-conscious consumers and industries. Embracing natural additives not only diversifies the range of available resources but also contributes to reducing the environmental footprint associated with adhesive production and application. In conclusion, exploring the feasibility of incorporating natural materials as agents in adhesive processes represents a dynamic convergence of sustainability, innovation, and performance enhancement, opening doors to a more ecologically harmonious and technologically advanced adhesive respectively.

5.3 Limitation of materials properties

Achieving the liquefaction of adhesive materials necessitates the application of specific temperature thresholds to facilitate the mixing process effectively. In the context of resin materials, for instance, a temperature range of 43-70 degrees Celsius is commonly prescribed to achieve the desired state of fluidity during the blending phase. In a targeted approach towards integrating grounded natural material sources for pigmentation, the focus lies on leveraging green-leaf powder and flower petal powder as key additives.

The outcomes of the experimental undertaking revealed intriguing results, indicating a transformation in color from the initial blend to the hardened state of the material. Specifically, the incorporation of green-leaf powder and flower petal powder led to the development of rich, dark brown hues upon the completion of the hardening process. An important consideration in working with natural materials is the challenge of preserving the exact finishing colors throughout production. Given the dynamic nature of plant and mineral pigments, achieving consistent color outcomes can be a formidable task. During the mixing phase where temperatures are elevated, a noteworthy

phenomenon emerges in the form of small air bubbles being released from the color pigment agents as the materials blend together. This occurrence is influenced by the fluctuation of temperatures throughout the adhesive preparation process, particularly during the subsequent curing and hardening stages where temperatures decrease. This purging of air bubbles is a critical aspect of ensuring the integrity and quality of the final adhesive product, as the presence of bubbles can compromise the structural integrity and visual appeal of the hardened material. The synthetic nature of artificial pigments may result in variations in how they interact with temperature fluctuations during the mixing, curing, and hardening processes. Understanding and managing these distinct characteristics of natural and artificial pigment agents play a pivotal role in achieving desired outcomes in adhesive formulation and application.

Fig. 4: The results of herbs, spices and waste materials colorize in hard-surface experiments
(Source:) The authors

6.0 Conclusion & Recommendations

6.1 Future work

The study purpose was to investigate the colorization in hard surface material. The results of this research indicated the possibilities to implement natural color pigments from natural resource directly into the body of materials, creating new colors palette for the design industrials as shown in Fig.4. On the process of experimental procedure, this research discovered an alternative option of a color in material by added aluminum dust and glass bits into body of adhesive materials on mixing process. The study results and significant findings have provided valuable data, leading to greater in-depth understanding of the way to involved raw material into the hard-surface materials for product design respectively.

6.2 The use of new materials

The findings from this research indicate the exciting possibility of reusing raw materials to create new, functional products. Looking ahead, the research team plans to expand the application of these newly colorized hard surface materials for larger-scale industrial purposes. A primary focus of future efforts will be on transforming glass shards into panels that can serve as valuable resources in the construction industry. Additionally, the team believes there is significant potential in repurposing aluminum shavings and scraps. By utilizing these aluminum shreds, it may be possible to develop aluminum panels that could serve as an alternative to traditional aluminum sheets. Much like medium-density fiberboard (MDF), recycled aluminum panels could offer a comparable option, providing the same durable and versatile qualities for various applications. The research aims to showcase the viability of utilizing waste materials to create innovative products that meet industry standards, thereby promoting practices across industries respectively.

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