



Utilizing Coffee Grounds as Environmentally Friendly Odor Absorbing Camphor

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ABSTRACT

This study examines the potential of coffee grounds as an environmentally friendly odor-absorbing camphor material. Coffee grounds are known to contain active compounds such as polyphenols, caffeine, and essential oils that can absorb odors and bind gaseous compounds such as ammonia and hydrogen sulfide. Literature studies from various studies show that coffee grounds are effective for use in the deodorization process, either in the form of activated charcoal, dry powder, or used directly without activation. The use of coffee grounds as an odor absorber offers a low-cost solution and can help reduce organic waste. The study results show that the application of coffee grounds can be applied to various objects that produce odors, such as closed spaces and waste disposal areas. The potential for its use in the manufacture of environmentally friendly camphor is enormous and can be further developed into innovative products

INTRODUCTION

Coffee grounds are an abundant source of organic waste that is often underutilized. Indonesia, as one of the world's largest coffee producers and consumers, produces thousands of tons of coffee grounds annually, from households, coffee shops, and the coffee processing industry (Ministry of Plantations, 2022). This waste is generally disposed of directly without further processing, resulting in a high organic load in landfills and the potential to pollute the environment through odorous compounds released during the decomposition process.

In fact, coffee grounds contain valuable bioactive compounds such as caffeine, polyphenols, lignin, cellulose, hemicellulose, and volatile aromatic compounds. These components contribute to the grounds' ability to absorb and neutralize odors through physical and chemical adsorption mechanisms (Campos-Vega et al., 2015). Furthermore, the roasting process creates a large pore structure, increasing the adsorption capacity of odor-causing gas molecules.

Previous research by Kawasaki et al. (2006) showed that carbon material from coffee grounds has the ability to absorb ammonia gas (NH_3) is higher than commercial activated carbon. This finding confirms that coffee grounds waste has the potential to be an effective natural adsorbent. Muspa et al. (2017) also reported that coffee grounds without carbonization can reduce odor in organic waste by absorbing hydrogen sulfide gas (H_2S).



Figure 1. Coffee

Furthermore, over the past decade, various deodorizer products based on organic waste, including coffee grounds, have begun to develop. One such product is the Shoecito Patch (2024), which combines coffee grounds and orange peel to naturally combat shoe odor. This product demonstrates that utilizing coffee waste is not only relevant for research but also has real commercial value.

In line with the growing trend of green products and a circular economy, the use of coffee grounds as an odor-absorbing camphor product presents a highly promising sustainable innovation. Therefore, this study aims to develop a coffee grounds-based camphor formulation and evaluate its effectiveness in terms of organoleptic, aroma stability, and physical stability as an environmentally friendly odor-absorbing product.

LITERATURE REVIEW

The carbonization process of coffee grounds can produce porous carbon material with a higher ammonia adsorption capacity than commercial activated carbon Kawasaki et al. (2006). This high adsorption capacity is influenced by the micropore structure formed during the pyrolysis process and the presence of surface functional groups such as -OH and -COOH that can interact with ammonia molecules.

Muspa et al. (2017) provided additional evidence that even uncarbonized coffee grounds were able to reduce the odor caused by H₂S in household organic waste. This mechanism occurs primarily through physical adsorption on the surface of coffee grounds particles and the ability of phenolic compounds to neutralize odor molecules.

On the other hand, several other studies confirm that coffee grounds also have mild antibacterial activity that can help reduce odor formation caused by microbial activity. A study conducted by Ballesteros et al. (2014) reported that coffee grounds extract has the ability to inhibit the growth of certain bacteria that produce odor-causing volatile compounds.



Figure 2. Coffee Grounds

Industrial practices are also beginning to consider utilizing coffee waste as a natural deodorizer. For example, the Shoecito Patch (2024) product utilizes a combination of coffee grounds and orange peel, which work synergistically: the grounds act as an odor absorbent, while the orange peel provides a fresh scent and has natural antibacterial effects (Sari & Dewi, 2021).

This combination of scientific findings and practical evidence demonstrates that coffee grounds have broad potential as a renewable waste-based deodorizing material. Therefore, research into the development of camphor from coffee grounds is highly relevant both academically and as an opportunity for environmentally friendly product innovation.

METHODOLOGY

Tools and Materials

Tools: oven, digital scale, blender/mortar, glass container, measuring cup, strainer, spoon, small mold. Ingredients: used coffee grounds, coconut oil, tapioca flour, essential oils (lavender/lemon), water.

Research Flowchart

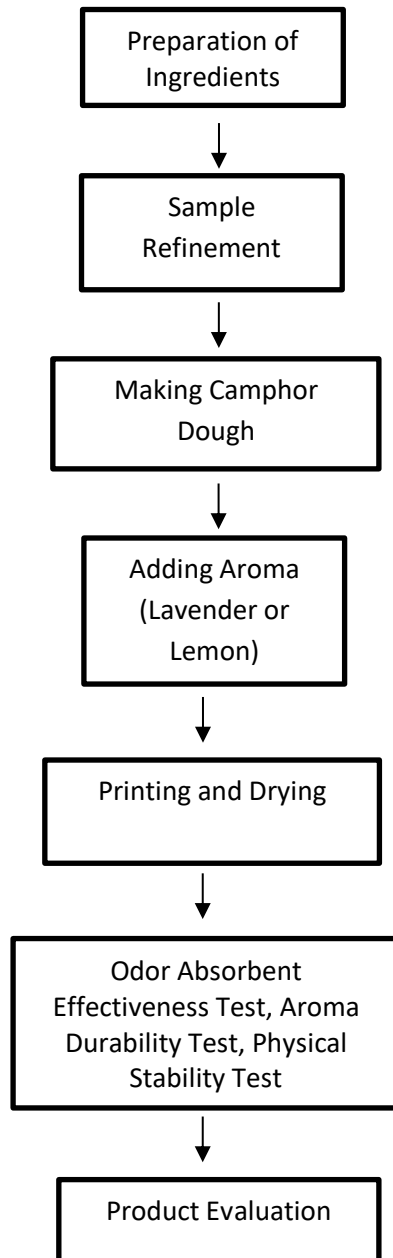


Figure 3. Research Flowchart

RESEARCH METHODS

1. **Material Preparation:** Used coffee grounds are collected, filtered from dirt, then dried using an oven at a temperature of $\pm 60-80^{\circ}\text{C}$ for 2-4 hours until the water content is reduced.
2. **Sample Refining** Dry coffee grounds are crushed using a blender or mortar until finer and more uniform particle sizes are obtained.
3. **Making Camphor Dough:** Ground coffee grounds are mixed with coconut oil as a binder, tapioca flour as an additional binder, and a little water to form a dough that is easy to shape.
4. **Aroma Addition** Essential oils (lavender or lemon) are added to the mixture to provide aroma and enhance the deodorizing function.
5. **Molding and Drying** The dough is put into small molds, then dried again using an oven until the texture hardens and forms solid camphor.
6. **Odor Absorber Effectiveness Test** Camphor products are placed in a closed container containing an odor source (e.g., sliced onions, organic waste, or ammonia solution). Observations are made on changes in odor intensity over a certain period.
7. **Product Evaluation**
Product are rated based on aroma, hardness, durability, and odor reduction ability

RESEARCH RESULT

Results of the Odor Absorber Effectiveness Test (Organoleptic Test)

At this stage, the analysis focused on the effectiveness of coffee grounds as an odor absorber after formulations with varying additions of essential oils. The testing procedure was carried out in stages, starting with sample preparation, placing the samples with the odor source, and measuring the odor intensity using an organoleptic test on a scale of 1-5.

Table 1. Results of the Odor Absorber Effectiveness Test (Organoleptic Test)

Sample	Before Treatment (Odor Score)	After 2 Hours (Odor Score)	Percentage of Odor Reduction (%)
A (Coffee grounds without essential oils)	5	3	40%
B (Coffee Grounds with Lavender 3%)	5	2	60%
C (Coffee Grounds with Lemon 3%)	5	1	80%

The organoleptic test aimed to determine the ability of each sample to reduce odor intensity after a two-hour adsorption process. Panelists assessed odor changes before and after treatment, then calculated the percentage of odor reduction to provide a quantitative overview of each formulation's effectiveness.

The table shows that all samples were able to reduce odor intensity, but their effectiveness varied. Sample C, which contained lemon essential oil, had the greatest odor reduction, namely 80%, followed by sample B (60%) and sample A (40%). This shows that the addition of essential oils can increase the ability of coffee grounds to adsorb odors, especially essential oils with high volatility and antibacterial activity, such as lemon.

Aroma Durability Test Results

An aroma persistence test was conducted to determine how long each sample's aroma could persist during open storage. Observations were made over 14 days, and aroma levels were assessed using an organoleptic scale of 0–5, with 5 indicating a very strong aroma and 0 indicating no aroma.

Table 2. Aroma Resistance Test Results

Observation Day	Sample A (Coffee grounds without essential oil)	Sample B (Coffee Grounds with Lavender)	Sample C (Coffee Grounds with Lemon)
Day 0	Strong aroma (5)	Strong aroma (5)	Strong aroma (5)
Day 3	4	4	5
Day 6	3	4	4
Day 9	2	3	4
Day 12	No scent (0)	3	3
Day 14	No scent (0)	2	3

Overall, the addition of essential oils to the coffee grounds formulation had a positive effect on aroma durability. The sample with lemon essential oil showed the best durability, followed by lavender, while the sample without essential oils quickly lost its aroma in less than 10 days.

Physical Stability Test Results of Coffee Grounds Deodorant Samples

Physical stability tests were conducted to observe changes in color, texture, and odor in the three samples over 14 days of storage. These results are crucial for determining the product's durability and suitability as a natural coffee grounds-based deodorant.

Table 3. Physical Stability Test Results

Day	Parameter	Sample A	Sample B	Sample C
0	Color	Dark chocolate	Dark chocolate	Dark chocolate
0	Texture	Solid hard	Solid hard	Solid hard
0	Smell	Neutral	Strong lavender	Strong lemon
7	Color	Faded brown	Faded brown	Faded brown
7	Texture	Solid hard	Solid hard	Solid hard
7	Smell	Neutral	Weakened → scale 3	Weakened → scale 4

14	Color	Dull brown	Stable brown	Stable brown
14	Texture	A little fragile	Stable	Stable
14	Smell	Neutral	Weakened → scale 2	Weakened → scale 3

Sample C (lemon essential oil) showed the best physical and aroma stability up to day 14. Sample B (lavender) came in second with good color and texture stability, but the aroma weakened more quickly than lemon. Sample A had the lowest stability due to the absence of essential oils that function as aroma binders and physical stabilizers.

DISCUSSION

Discussion of Organoleptic Test of Odor Absorbers

Based on the organoleptic test results, the three samples showed the ability to absorb odors with different effectiveness. Sample A (coffee grounds without essential oils) showed a 40% odor reduction, while Sample B (with lavender essential oil) reached 60%, and Sample C (with lemon essential oil) showed the highest effectiveness at 80%. These findings indicate that coffee grounds do have natural abilities as odor adsorbents, as explained by Kawasaki et al. (2006) who stated that carbonization and porosity of coffee grounds can increase the absorption capacity of ammonia and other volatile compounds.

Essential oils provide a significant additional effect. Lemon and lavender have antibacterial properties and contain volatile aromatic compounds that can inhibit the growth of odor-causing bacteria. Lemon oil, in particular, contains limonene, a highly volatile and strongly scented oil, enhancing the product's overall deodorizing ability. The combination of natural aromatic compounds and the porous structure of coffee grounds synergistically enhances odor absorption, resulting in samples with essential oils performing better than those without.

Discussion of Organoleptic Test of Odor Absorbers

The 14-day aroma persistence test showed variations in the level of aroma stability in each sample. From day 0 to day 9, Sample B (lavender) and Sample C (lemon) still maintained their aroma, although its intensity gradually decreased. Sample C showed better aroma persistence than Sample B, as the lemon scent remained at a medium level until day 14. This is in line with the characteristics of lemon essential oil, which has high volatility but still leaves a stable after-scent thanks to the presence of monoterpene compounds such as citronellal and limonene.

In contrast, Sample A remained neutral because it contained no essential oils. These results confirm that while coffee grounds can absorb odors, additional aromatic components are needed to provide added value in the form of a longer-lasting scent. A study by Shoecito Patch (2024) also showed that combining coffee grounds with natural scented ingredients can extend the scent's longevity while improving the comfort of use in deodorizing products.

Discussion of Physical Stability Test

Physical stability tests were conducted to observe changes in color, texture, and odor stability over 14 days. In terms of color, all samples experienced color fading on the 7th day, but the most drastic change occurred in Sample A, which

turned a dull brown on the 14th day. This was due to the absence of oil components that could inhibit oxidation. Samples B and C showed better color stability because essential oils contain natural antioxidants that function to slow down pigment degradation.

In terms of texture, Sample A showed a slight change, becoming slightly brittle on day 14. This occurs because coffee grounds without a binder tend to lose moisture more quickly. In contrast, Samples B and C remained stable and dense, indicating that the essential oils also act as a natural softener or binder, maintaining the product's physical structure.

In terms of odor, samples B and C showed a decrease in intensity but retained their basic aroma until day 14. Sample A remained neutral with no significant changes. The odor stability of samples containing essential oils indicates that the volatile components in the oils persisted despite a decrease in intensity.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This research successfully demonstrated that coffee grounds have significant potential as a base ingredient for making natural deodorants or environmentally friendly odor-absorbing camphor. Based on the results of organoleptic tests, aroma persistence tests, and physical stability tests, several important conclusions can be drawn:

1. Coffee grounds are effective as an odor absorber. Samples without essential oils were able to reduce odor intensity by up to 40%, while samples with essential oils (lavender and lemon) showed an increase in effectiveness of up to 60–80%. This indicates that the combination of coffee grounds and essential oils provides a synergistic effect in absorbing and masking odors.
2. Aroma durability was better in samples with essential oils. Sample C (lemon) showed the most stable aroma durability for 14 days, followed by sample B (lavender). This indicates that essential oils act as aroma-enhancing elements in coffee grounds-based deodorant formulations.
3. The physical stability of the product was relatively good, especially in the sample containing essential oils. The color and texture of Samples B and C were more stable than those of Sample A. This is due to the essential oils' natural antioxidant properties and their ability to maintain moisture in the product.
4. The best formulation was found in sample C (coffee grounds + 3% lemon essential oil). This sample had the highest odor-absorbing effectiveness, the most stable aroma, and the best physical form after 14 days of storage.

Overall, this research proves that coffee grounds have the potential to be developed into a natural deodorant product that is economical, easy to make, and environmentally friendly.

Recommendation

Coffee grounds products can be used as a natural camphor alternative for wardrobes, shoe cabinets, small enclosed spaces, and household trash cans. The addition of essential oils is highly recommended, as they not only increase the odor-absorbing effectiveness but also provide physical stability.

Lemon is the most effective essential oil, making it a priority for product formulation on both a laboratory and commercial scale. A simple oven drying process is sufficient, making this research suitable for educational laboratories with limited facilities. The product can be developed into various variants, such as solid camphor, deodorizing sachets for shoes, multi-purpose deodorizing tablets, and natural fresheners for kitchen or bathroom shelves.

FURTHER RESEARCH

This research has not yet been tested on a wider range of odors, such as ammonia, cigarettes, or shoes, so its adsorption capacity is not yet fully understood. Future research could expand the testing to various odor characteristics and test its application in conditions such as cupboards, closed rooms, or shoe racks. Furthermore, measuring gas levels before and after the adsorption process could provide more accurate data. Developing camphor forms and formulations, such as adding essential oils or reducing the particle size of coffee grounds, could also be a promising research direction.

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