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VALORIZATION OF USED COOKING OIL FOR INSECT-REPELLING CANDLE PRODUCTION ENRICHED WITH LEMONGRASS

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ABSTRACT

Improper disposal of used cooking oil contributes to environmental issues such as water pollution, clogged drains, and fire hazards. This study presents a sustainable solution by formulating an insect-repellent candle using recycled cooking oil and lemongrass extract. The candle was produced by blending filtered used oil with soy wax, crayon for colouring, and lemongrass essence. The mixture was poured into containers and allowed to cool at room temperature. Fourier Transform Infrared (FTIR) spectroscopy was employed to analyse the chemical composition of the final product. The FTIR spectrum revealed absorption peaks at 2914.3 cm^{-1} and 2847.3 cm^{-1}, indicating the presence of saturated fatty acids from both soy wax and cooking oil. A distinct peak at 1697.8 cm^{-1} confirmed the presence of C=O stretching vibrations, associated with ester and aldehyde functional groups, validating the successful incorporation of lemongrass oil and oxidation products. The candle not only retained the aromatic properties of lemongrass but also met safety and functionality expectations. The findings support the viability of transforming household waste into value-added products, offering an eco-friendly alternative to chemical insect repellents while promoting environmental sustainability.

Keywords: waste oil, insect repellent insect, lemongrass extract, sustainable, waste valorization

1. INTRODUCTION

The improper disposal of used cooking oil is a growing environmental and public health concern. Common practices such as pouring used oil down drains or into the open environment contribute to water pollution, clog sewage systems, and encourage the formation grease masses that obstruct wastewater infrastructure. These consequences not only place significant strain on urban drainage systems but also foster microbial growth and attract pests, increasing health risks (Kumar et al. 2025; Merman et al. 2023)

Despite being considered waste, used cooking oil contains valuable organic compounds, particularly saturated and unsaturated fatty acids that can be repurposed for beneficial applications such as biodiesel, soap, and candles (Awogbemi et al. 2021). In recent years, attention has shifted toward utilizing such waste in eco-friendly products to promote sustainability and reduce dependence on synthetic materials. One promising application is the production of insect-repellent candles using recycled oil, which offers an alternative to conventional paraffin-based products often associated with volatile organic compounds (VOCs) and harmful residues (Irawan et al. 2024; Martinelli and Da Silva 2024). This study builds upon recent international efforts that explore the repurposing of household waste into functional products (Boonpracha et al. 2024; Siddique et al. 2024), and aligns with global interest in integrating green chemistry and sustainable consumer practices (Sharma and Sharma 2022; Wattanakit et al. 2024).

This study introduces a natural insect-repellent candle made from used cooking oil and lemongrass extract, a plant known for its effective bioactive compounds like citral and geraniol (Salsabila, Hutahaen, and Basith 2023; Sari, Gafur, and Sari 2023). These natural agents are known to interfere with insect receptors and are widely used in aromatherapy and repellents (Faruki 2024).

The purpose of this research is to formulate and characterize a candle using recycled cooking oil, soy wax, crayon, and lemongrass extract, with a focus on chemical validation through Fourier Transform Infrared (FTIR) spectroscopy. The contribution of this paper lies in demonstrating a practical waste-to-product innovation that combines environmental sustainability with public health benefits.

2. METHODOLOGY

2.1 Material

The main materials used in this study were used cooking oil, lemongrass, soy wax, and crayons for coloring. The used cooking oil was collected from domestic kitchens and filtered prior to use. Fresh lemongrass stalks were purchased from a local market. Soy wax flakes were sourced from a commercial supplier. Crayons of various colors were used to enhance the visual appeal of the candles.

2.2 Preparation of Lemongrass Extract

Fresh lemongrass was rinsed under tap water and cut into small pieces. Approximately 100 grams of lemongrass were blended with 200 mL of distilled water using a household blender to extract the juice. The resulting mixture was filtered using a muslin cloth to obtain a clear lemongrass extract, which was collected in a clean glass beaker and stored at room temperature until use.

2.3 Filtration and Heating of Used Cooking Oil

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Collected used cooking oil was passed through a fine mesh strainer followed by muslin cloth to remove food residues and impurities. The filtered oil was poured into a pot and heated on a stove at low to medium heat (70–80°C) for 10–15 minutes to ensure its in fluid condition. The oil was stirred occasionally during heating.

2.4 Candle Formulation Procedure

The insect-repellent candles were formulated using a volumetric ratio of 2:3 for used cooking oil to lemongrass extract. To begin the process, the filtered used cooking oil was heated in a pot over a moderate flame. Once the oil reached a consistent temperature, approximately 20 grams of soy wax flakes were gradually added into the pot. The mixture was stirred continuously using a wooden stick until the wax was fully melted and formed a homogenous solution. Separately, crayon pieces of any desired color were melted using the same heating setup, and around 10 mL of this liquefied crayon was added to the oil-wax mixture to impart color to the final candle product. After the crayon was fully dissolved, 75 mL of freshly prepared lemongrass extract was introduced slowly into the hot mixture while stirring gently to ensure even distribution of all components.

Once the blend was well mixed, waxed cotton candle wicks were positioned upright at the center of each 100 mL glass jar. To maintain the wick's position during pouring and setting, simple wooden sticks placed across the jar opening were used. The hot candle mixture was then carefully poured into the prepared jars, ensuring the wick remained centered and undisturbed. The candles were left at room temperature to cool and solidify naturally over a period of 24 to 48 hours. After complete solidification, each batch was labeled and stored in a clean, dry environment in preparation for testing and analysis.

2.5 FTIR Spectroscopy Analysis

Fourier Transform Infrared (FTIR) spectroscopy was conducted to analyze the chemical composition of the formulated candle. A small sample of the solidified candle was scraped and tested using a FTIR spectrometer. The measurement was taken in the wavenumber range of 4000–400 cm^{-1}. The peaks were interpreted based on standard infra-red absorption bands to identify functional groups originating from the cooking oil, soy wax, and lemongrass components.

3. RESULT AND DISCUSSION

The development of insect-repellent candles using used cooking oil and lemongrass was successfully achieved through a straightforward blending and casting process. The final candle product exhibited favorable physical characteristics, including uniform texture, solidified structure, and a pleasant lemongrass aroma. Solidification occurred consistently within 24 to 48 hours at ambient temperature, with no evidence of phase separation or oil leakage, suggesting excellent compatibility among the used cooking oil, soy wax, and lemongrass extract. To preliminarily assess short-term storage stability, the candles were kept at room temperature (approximately 25–28°C) for four weeks. No visible changes in physical integrity, scent, or component separation were observed during this period. These observations support short-term shelf stability, though further studies are required to evaluate long-term storage performance.

The formulation employed a 2:3 volumetric ratio of used cooking oil to lemongrass extract, which was found to be effective in maintaining structural integrity while enhancing aromatic potency. The addition of soy wax provided necessary rigidity to the final product, while the inclusion of melted crayon improved its aesthetic appeal. The candle burned steadily for more than three hours and released a persistent fragrance throughout, suggesting its potential as a viable alternative to commercial paraffin-based insect repellent candles.

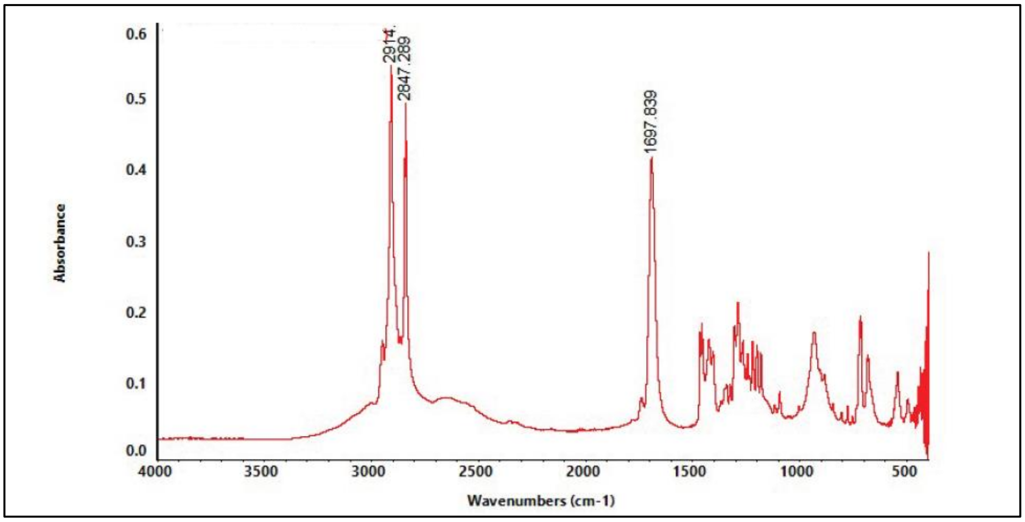

Figure 1.0: Data of FTIR for candle sample

Table 1.0: FTIR absorption peaks for formulated candle sample

Wavenumber (cm^{-1})	Functional Group	Assignment	Source Material
2914.3	C–H stretching (asymmetric)	Aliphatic hydrocarbon chains	Used cooking oil
2847.3	C–H stretching (symmetric)	Methylene groups (CH_2)	Fatty acids in oil and wax
1697.8	C=O stretching	Carbonyl groups (ester, aldehyde)	Lemongrass extract

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To assess the chemical composition of the formulated candle, Fourier Transform Infrared (FTIR) spectroscopy was performed. The FTIR spectrum identified three primary absorption peaks, as summarized in Table 1.0 (extracted from Figure 1.0). A strong peak at 2914.3 cm^{-1} was attributed to asymmetric C–H stretching, indicating the presence of long-chain aliphatic hydrocarbons typical of saturated fatty acids found in used cooking oil and soy wax. Another prominent peak at 2847.3 cm^{-1}, corresponding to symmetric C–H stretching, confirmed the abundance of methylene groups ($–CH_2–$), further validating the fatty acid backbone within the candle matrix.

Significantly, a peak at 1697.8 cm^{-1} was assigned to C=O stretching vibrations, which are commonly associated with carbonyl groups found in esters and aldehydes. This band provides chemical evidence for the presence of oxidized triglyceride derivatives from the used cooking oil and aromatic aldehydes such as citral and geraniol from the lemongrass extract (Liang et al. 2024). These functional groups are known for their bioactivity and contribute to the candle's mosquito-repelling properties. The integration of these compounds also suggests that the heating and blending process did not degrade the essential chemical characteristics of the raw materials (Dewi and Lusiyana 2020).

Overall, the FTIR analysis validates the successful incorporation of both natural ingredients into the final candle product. The detection of expected functional groups including aliphatic hydrocarbons and carbonyl compounds confirms the formulation's chemical consistency and supports its intended function as a plant-based insect repellent. Furthermore, no additional peaks indicative of undesirable chemical reactions was observed, demonstrating the chemical stability and safety of the formulation process. However, it is important to note that this study did not include quantitative insect-repellent testing, as its scope was limited to the formulation process and chemical characterization using FTIR spectroscopy. Future research could incorporate bioassay evaluations or standardized insect exposure trials to directly assess the efficacy of the formulated candle.

This investigation demonstrates not only the effectiveness of the insect-repellent candle but also its alignment with sustainable product development. By repurposing used cooking oil—a common household waste—and enhancing it with natural lemongrass extract, the study contributes to waste valorization and environmental conservation. The absence of synthetic chemicals aligns with consumer trends toward eco-friendly and health-conscious alternatives for household insect control (Ramadani and Kusumaningrum 2024).

In conclusion, the results affirm that candles formulated with used cooking oil and lemograss' are structurally stable, chemically verified, and functionally effective as insect-repelling agents. The FTIR findings play a crucial role in confirming material integration and reinforce the product's viability for broader application in sustainable household innovations. In terms of practical relevance, the formulation process developed in this study requires only low-cost materials and simple tools, making it feasible for small-scale or home-based production. Although detailed economic or market feasibility analysis was not conducted, the potential for community-level application exists. This may be particularly relevant for sustainability-oriented programs or local entrepreneurship initiatives.

4. CONCLUSION

This study successfully demonstrated the formulation of an insect-repellent candle using used cooking oil and lemongrass extract as a sustainable and eco-friendly alternative to commercial paraffin-based products. The use of simple, low-cost materials and methods makes the process suitable for household or small-scale production. The optimal 2:3 ratio of used oil to lemongrass extract resulted in candles with uniform consistency, a pleasant aroma, and effective burning duration. Fourier Transform Infrared (FTIR) spectroscopy confirmed the presence of key functional groups of aliphatic C–H and carbonyl (C=O), verifying successful integration of all ingredients without unwanted by-products. By transforming a common household waste into a functional, plant-based insect repellent, this product aligns with broader goals in sustainable waste management, green chemistry, and environmentally conscious consumer practices. The findings support the potential for waste valorization in developing safe and practical household solutions. Future research could further explore improvements in burn efficiency, storage stability, or the addition of other natural repellents to enhance performance.

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