Indonesian Journal of Chemical Science and Technology (IJCST)
State University of Medan, https://jurnal.unimed.ac.id/2012/index.php/aromatika

IJCST-UNIMED 2025, Vol. 08, No. 2 Page ; 131 – 138
Received : May 7th, 2025 Accepted : Jul 18th, 2025 Web Published : Aug 26th, 2025

Sustainable Candle Production from Waste Cooking Oil and Waste Lubricating Oil

Dian Wardana[1*], Dwi Sapri Ramadhan[1], Jaman Fahmi[1], Wulan Dwi Safitri[1], Wicha Rosari Damanik[2], Astuty Evalina Simamora[2], Olivia Gina Ananta Sigalingging[2], Okto Panca Manullang[2], Zaskia Rahmadyani[2], Moondra Zubir[1], Abd Hakim S[3]

[1] *Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, 20221, Indonesia*
[2] *Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, 20221, Indonesia*
[3] *Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, 20221, Indonesia*

**Corresponding author : dianwardana@unimed.ac.id*

ABSTRACT

This study investigates the potential utilization of waste cooking oil and used lubricant oil as raw materials for candle production. These waste materials, often regarded as environmental pollutants, contain fats and hydrocarbons that can be converted into value-added products. The manufacturing process involved filtration, heating, and the incorporation of additives such as paraffin wax to enhance quality and stability, followed by molding. The resulting candles demonstrated acceptable physical properties, including melting points and burning times comparable to standard requirements. However, noticeable differences in color and odor were observed when compared to commercial candles. Despite these limitations, the valorization of waste cooking oil and used lubricant oil presents an environmentally friendly and cost-effective alternative, contributing to the development of sustainable products. Further research is recommended to optimize the blending ratios and additive compositions in order to improve the overall performance of the candles.

Keywords: Waste Cooking Oil, Waste Lubricating Oil, Candle Production, Paraffin Candle Additive

1. INTRODUCTION

Humans are among the largest contributors to global waste generation, with household activities representing a significant source. Kitchen waste, produced on a daily basis, includes packaging materials, unused food ingredients, and food residues. This type of waste poses serious environmental challenges, as improper disposal can lead to pollution, drainage blockages, and flooding. Among various kitchen by-products, used cooking oil deserves particular attention due to its widespread generation and potential health and environmental impacts.[1] Used cooking oil refers to edible oil that has undergone repeated heating during frying processes. Excessive

e-ISSN : 2622-4968, p-ISSN : 2622-1349

consumption of such degraded oil has been associated with increased health risks, including the potential development of cancer. In Indonesia, this material is commonly known as *mijel* and is generated by almost every household.

However, the majority of users dispose of used cooking oil directly into drainage systems or onto soil without prior treatment. Such practices contribute to severe environmental problems, including water pollution, degradation of aquatic ecosystems, and deterioration of soil quality, ultimately threatening the sustainability of surrounding communities.[2] Public awareness regarding the hazards of used cooking oil remains relatively low. A survey conducted by Gultom, Khairatunnisa, and Ardat (2022) reported that 31.6% of respondents demonstrated poor knowledge of the health and environmental risks associated with its use and disposal.[3] This lack of awareness highlights the urgent need for appropriate waste management strategies that not only prevent adverse impacts but also promote the valorization of used cooking oil into beneficial products. One potential pathway is its conversion into candle materials, which can simultaneously reduce pollution and provide added economic value.[4]

Lubricants, or oils, are chemical substances in liquid form that are applied between two moving surfaces to reduce friction. Hydrocarbon compounds contained in used motor oils are classified as hazardous waste (B3 waste) as a direct consequence of motor vehicle operation. Once oil can no longer be reused, it is often neglected and improperly discarded. Such disposal practices contribute substantially to environmental pollution, further aggravating the already critical state of global ecosystems.[5]

In light of these challenges, alternative strategies for managing used oil are urgently required. One potential approach is the valorization of used oil into value-added products, such as raw materials for candle production. This not only reduces the environmental burden associated with waste oil but also supports sustainable resource utilization.

Paraffin is a commonly used material in candle production due to its relatively high melting point, which enhances the hardness and durability of candles. Chemically, paraffin or paraffin hydrocarbons are technical terms generally used to describe alkanes. In certain contexts, however, the term specifically refers to normal alkanes, while branched alkanes are referred to as isoalkanes or isoparaffins.[6] Paraffin hydrocarbons can exist in various physical states, ranging from colorless gases and white liquids to solids with relatively low melting points. Widely known as “wax,” paraffin serves as the main component in most conventional candles. Structurally, paraffin is represented by the general formula CnH2n+2, consisting of a mixture of hydrocarbon compounds.[7] The incorporation of paraffin wax into blends of used cooking oil and waste lubricating oil is expected to improve the quality of the resulting candles. In this study, a chemical conversion process will be employed to transform used cooking oil and waste lubricating oil into wax, and the effect of paraffin addition on the properties and quality of the produced wax will be systematically evaluated.

The findings of this research are anticipated to contribute to the advancement of sustainable candle production technologies utilizing waste oils, thereby reducing the environmental burden associated with oil industry byproducts. The methodology will include chemical conversion, characterization of the physical and chemical properties of the wax, and quality evaluation of the final product. Ultimately, this study is expected to

e-ISSN : 2622-4968, p-ISSN : 2622-1349

demonstrate that high-quality candle can be produced from waste-derived feedstocks, with potential applications in daily life

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

The main materials used in this study were paraffin wax (90%), lubricating oil (Yamalube, 4.5%), and waste cooking oil (0.42%). Additional materials included cotton wicks and a lighter. The glassware employed consisted of an 800 mL measuring cup and mold cups. The analytical instrument used was a digital analytical balance (Mettler Toledo AB204-S)

2.2. Research Procedure

The experimental procedure for candle preparation was conducted as follows:

Candle Preparation with Waste Lubricating Oil

Sample 1 (1:1 ratio): 50 mL of waste lubricating oil was measured using a measuring cup, and 50 g of paraffin wax was weighed using the analytical balance. The oil was heated until boiling, after which paraffin wax was gradually added and stirred until completely dissolved. The mixture was then poured into a mold containing a pre-positioned cotton wick and left to solidify at room temperature. For sample 2 (1:2 ratio): The same procedure was followed, except that 100 g of paraffin candle was used while maintaining 50 mL of lubricating oil.

Candle Preparation with Waste Cooking Oil

Sample 3 (1:1 ratio): 50 mL of waste cooking oil was measured and mixed with 50 g of paraffin wax, following the same procedure as in Sample 1. For sample 4 (1:2 ratio): The same procedure was conducted with 50 mL of waste cooking oil and 100 g of paraffin candle.

Evaluation of Candle Performance

After solidification, all prepared candles were ignited to evaluate their burning performance. The burning power was assessed by recording the total time required for each candle to melt completely, and comparisons were made among the different formulations.

3. RESULTS AND DISCUSSION

3.1. Effect of Material Composition on the Density of Paraffin–Oil Mixtures

Density is defined as the mass of a substance per unit volume, where a higher density indicates a greater mass within the same volume.[8] According to Rahardja et al. (2019), wax produced from waste cooking oil and used lubricating oil is essentially a mixture containing solid paraffin, which functions as a hardening agent.

e-ISSN : 2622-4968, p-ISSN : 2622-1349

Variations in the type and proportion of paraffin incorporated into the mixture lead to differences in the characteristics of the resulting solid wax. An increased proportion of paraffin produces harder and denser candle, whereas a reduced proportion results in softer wax.[9]

Table 1. Mass and Volume of Paraffin and Used Cooking Oil

NO	Paraffin mass (gr)	Volume of Used Cooking Oil (m^3)	Total Volume (m^3)
1	50	50	0,0500555556
2	100	50	0,0501111

Table 2. Mass and Volume of Paraffin and Used Oil

NO	Paraffin Mass (gr)	Used Oil Volume (m^3)	Total Volume (m3)
1	50	50	0,0500555556
2	100	50	0,0501111

By incorporating paraffin into waste cooking oil and waste lubricating oil, the total volume of each mixture was obtained. Using the measured mass and the corresponding volume, the density of the candle samples derived from waste cooking oil and waste lubricating oil was calculated based on the paraffin-to-oil ratio. The resulting density values are presented in Figure 1.

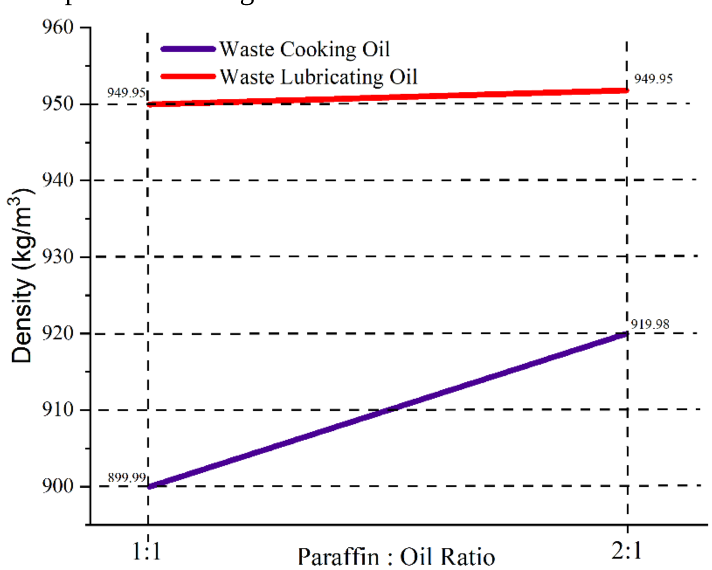

Figure 1. Variation of density in candle mixtures derived from waste cooking oil and used lubricating oil

The comparison between paraffin and waste oils resulted in the formation of waste cooking oil wax and used lubricating oil wax with varying densities. For the mixture of paraffin and waste cooking oil at a ratio of 50 g:50 mL, the density obtained was 899.99 kg/m³, while at a ratio of 100 g:50 mL, the density increased to

e-ISSN : 2622-4968, p-ISSN : 2622-1349

919.98 kg/m³. In contrast, the mixture of paraffin and used lubricating oil at a ratio of 50 g:50 mL produced a density of 949.95 kg/m³, and at a ratio of 100 g:50 mL the density slightly increased to 951.79 kg/m³.

3.2. Effect of Material Composition on Wax Formation Time

Measurement of wax formation time was conducted to determine the duration required for the wax to achieve complete solidification. According to Rusdi and Kurniawan (2021), the hardening of wax typically requires approximately one hour. After this period, the wax becomes fully solidified and can be safely removed from the mold[10] . A comparison of wax hardening times obtained in this study with previous literature is presented in Figure 2, further highlighting the influence of material ratios and oil types on the solidification process.

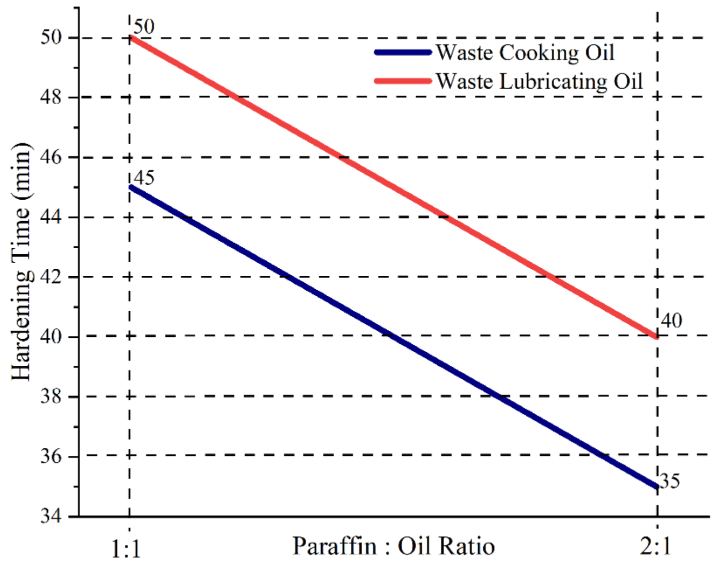

Figure 2. Effect of Paraffin–Oil Composition on Wax Hardening Time

Based on the findings of this study, it was observed that at a paraffin-to-used oil ratio of 1:1, the hardening time was 45 minutes, whereas at a 2:1 ratio (with a higher proportion of paraffin), the hardening time decreased to 35 minutes. A similar trend was identified in the paraffin–used cooking oil mixture, where a 1:1 ratio required 50 minutes to harden, while a 2:1 ratio shortened the hardening time to 40 minutes. These results indicate that a higher proportion of paraffin in the mixture tends to accelerate the wax hardening process. Furthermore, the comparison also demonstrates that mixtures with used cooking oil exhibited faster hardening times than those with used lubricating oil at the same ratios, suggesting that the type of oil significantly influences the wax hardening behavior. This observation is consistent with the findings reported by Rahardja et al. (2019), which state that an increased proportion of paraffin results in a denser and more solid wax structure, whereas a lower paraffin content leads to a softer wax texture.[9]

3.3. *Influence of Ingredient Composition on Candle Color and Odor Characteristics*

Wax derived from used cooking oil and used lubricating oil exhibited clear differences in both color and aroma. The wax obtained from used cooking oil solidified into a yellow material, which is consistent with Delta

e-ISSN : 2622-4968, p-ISSN : 2622-1349

(2019), who reported that wax produced from used cooking oil typically displays a yellowish-white appearance.[11] In contrast, wax derived from used lubricating oil showed a blackish-green coloration. These variations are attributed to differences in the physical properties and dissolved substances present in the two waste oils, such as pigments, degradation by-products, and residual hydrocarbons. The comparison of wax colors obtained from different raw materials is presented in Figure 3.

Figure 3. Color Variation of Wax Derived from Used Cooking Oil and Used Lubricating Oil

In terms of aroma, wax produced from used cooking oil was relatively neutral but retained a slight food-like odor. Such characteristics are influenced by oil degradation indicators, including changes in color, increased free fatty acid content, viscosity, iodine value, and peroxide value resulting from repeated heating.[12] Conversely, wax obtained from used lubricating oil emitted a more pungent and unpleasant odor, which can be attributed to the presence of heavy metals and oxidized carbon compounds. As noted by Basuki and Prihanto (2023), used lubricating oil contains significant amounts of hydrocarbon species, including aromatic and polycyclic hydrocarbons, which contribute to its distinctive odor profile.[13]

3.4 Influence of Composition Variation on Candle Combustion Performance

Burning time refers to the duration that reflects the quality of a candle's endurance when combusted until it is completely consumed. This parameter is determined from the initial ignition of the candle until the wick is entirely burned out or the flame extinguishes.[14] The longevity of a candle flame is strongly influenced by the composition of its raw materials.[15] A higher paraffin content generally results in a slower and more stable combustion process, thereby prolonging the burning duration. Conversely, a higher proportion of waste oil leads to faster and less stable combustion, which shortens the overall burning time.

Experimental results demonstrated that the burning duration increased with a higher proportion of paraffin in the formulation, both in candles produced from used cooking oil and from used lubricating oil. In the case of candles prepared with paraffin and used cooking oil, the burning time was recorded at 11.06 minutes for a 1:1 ratio and increased to 14.44 minutes for a 2:1 ratio. This trend indicates that increasing the paraffin fraction significantly enhances the combustion performance of the candle. Moreover, the resulting candles exhibited a dense, rigid, and crystalline structure, which prevented rapid melting.[16] Similarly, candles formulated with paraffin and used lubricating oil showed a burning time of 11.22 minutes at a 1:1 ratio, which increased to

e-ISSN : 2622-4968, p-ISSN : 2622-1349

14.11 minutes at a 2:1 ratio. Although this increase was evident, the burning duration was slightly shorter than that of candles with paraffin–used cooking oil mixtures at the same ratio. This phenomenon is likely attributable to the physicochemical properties of used lubricating oil, which tends to be more viscous and possesses a higher flash point, thereby influencing the combustion process. A comparison of the combustion performance of candles is presented in Figure 4.

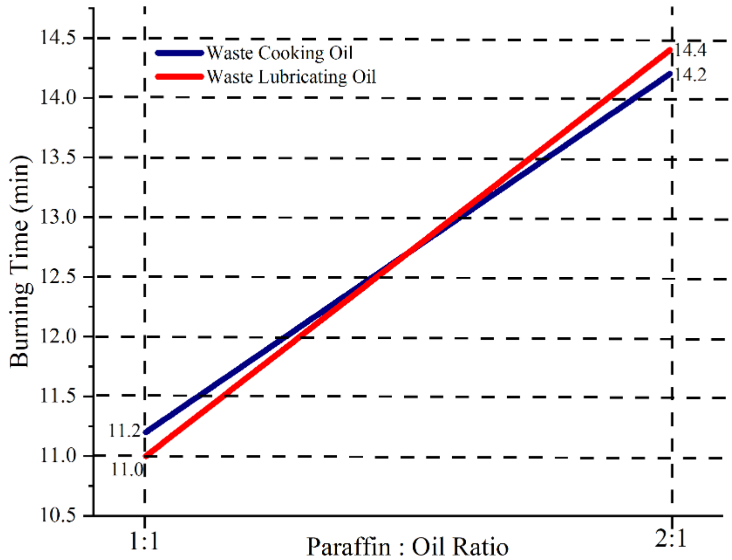

Figure 4. Candle Burning Time

Overall, candles with higher paraffin content exhibited longer burning times, regardless of the type of additive used. However, the paraffin–used cooking oil mixture at a 2:1 ratio produced candles with the longest burning duration. Candles prepared from filtered used lubricating oil combined with paraffin and selected essential oils also displayed relatively stable combustion performance, although they were consumed slightly faster than commercial candles formulated solely from pure paraffin.[17] In addition to compositional factors, burning duration is also affected by wick size and placement. Larger wicks or those positioned closer to the candle's edge accelerate the combustion process and reduce overall burning time.[18]

4. CONCLUSION

Based on the findings of this study, both used cooking oil and used lubricating oil can be utilized as raw materials for candle production. Both types of waste oils are capable of producing functional candles; however, the paraffin–used cooking oil mixture at a 2:1 ratio demonstrated the longest burning duration of 14.44 minutes. This result suggests that used cooking oil is more suitable as a blending component for candle manufacturing compared to used lubricating oil.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the Department of Chemistry and the Department of Biology, Universitas Negeri Medan, for their valuable support in the completion of this research.

REFERENCES

1. Mulyaningsih M, Hermawati H (**2023**) Sosialisasi Dampak Limbah Minyak Jelantah Bahaya Bagi Kesehatan dan Lingkungan. Jurnal Penelitian dan Pengabdian Kepada Masyarakat UNSIQ 10, 61–65.
2. Yuniati A, Roisnahadi DT, Irawan D, Erggi Irawan S, Andreanto L, Dwi Cahya S, Fepdiyani C, Tika Roisnahadi D (**2022**) Pembuatan Sabun dari Minyak Jelantah dan Eco Enzime. Buguh: Jurnal Pengabdian Kepada Masyarakat 2, 24–30.
3. Br Gultom N, Khairatunnisa K, Ardat A (**2022**) Hubungan Pengetahuan dan Sikap dengan Penggunaan Minyak Jelantah pada Penjual Gorengan di Kecamatan Rahuning Kabupaten Asahan Tahun 2021. JUMANTIK (Jurnal Ilmiah Penelitian Kesehatan) 7, 86.
4. Inayati NI, Dhanti KR (**2021**) Pemanfaatan Minyak Jelantah sebagai Bahan Dasar Pembuatan Lilin Aromaterapi sebagai Alternatif Tambahan Penghasilan pada Anggota Aisyiyah Desa Kebanggan Kec Sumbang. BUDIMAS : Jurnal Pengabdian Masyarakat. https://doi.org/10.29040/budimas.v3i1.2217
5. Ijaz Malik MA, Kalam MA, Mujtaba MA, Almomani F (**2023**) A review of recent advances in the synthesis of environmentally friendly, sustainable, and nontoxic bio-lubricants: Recommendations for the future implementations. Environ Technol Innov 32, 103366.
6. Ilmi N, Novawanda O (**2020**) Pelatihan Pembuatan Lilin sebagai Peluang Usaha di Dusun Pendem. Jurnal Sains Teknologi dalam Pemberdayaan Masyarakat 1, 69–74.
7. Ginting Z, Clarita S, Dewi R (**2022**) Pemanfaatan Minyak Nilam (Pogostemon Cablin Benth) dalam Pembuatan Lilin Aromaterapi. Jurnal Teknologi Kimia Unimal 11, 157–167.
8. Putri IA, Fatimura M, Husnah H, Bakrie M (**2021**) Pembuatan Minyak Atsiri Kemangi (Ocimum Basilicum L.) dengan Menggunakan Metode Distilasi Uap Langsung. Jurnal Redoks 6, 149–156.
9. Budhi Rahardja I, Nugroho Kristono S, Mahfud A, Dermawan Y, Basyir Rantawi A, Lestari I, Leksi Siregar A, Ilmar Ramadhan A (**2019**) Pelatihan Pembuatan Lilin Untuk Penerangan Rumah Tangga Menggunakan Bahan Dasar Crude Palm Oil (CPO). Prosiding Seminar Nasional Pengabdian Masyarakat LPPM UMJ 1–4.
10. Rusdi R, Kurniawan D (**2021**) Pelatihan Pengolahan Minyak Jelantah Menjadi Lilin Aroma Daun Jeruk Untuk Ibu-Ibu PKK Kelurahan Sungai Pinang Luar Samarinda. Selaparang Jurnal Pengabdian Masyarakat Berkemajuan 4, 557.
11. Delta (**2019**) Pemanfaatan Minyak Jelantah (Waste Cooking Oil) dalam Pembuatan Lilin Aroma Terapi. Jurnal Kesehatan Luwu Raya 7, 37–42.
12. Sutomo S, Viogenta Pratika, Normaidah N (**2023**) Pelatihan Penjernihan dan Pemanfaatan Minyak Jelantah Menjadi Lilin Aroma Terapi di Guntung Paikat, Banjarbaru Selatan, Kalimantan Selatan. Jurnal Pengabdian Inovasi Lahan Basah Unggul 2, 452257.
13. Wasis B, Prihanto D (**2023**) Pertumbuhan Semai Salam (Syzygium polyanthum) Terhadap Pemberian Pupuk Kandang Sapi dan Arang Sekam pada Tanah Tercemar Oli Bekas. Journal of Tropical Silviculture 14, 47–55.
14. Taufiq Thahir M, Fitriani I (**2023**) Making Aromatherapy Candles From Patchouli Oil Extract (Pogostemon Cablin Benth.) And Crude Glycerol From Used Cooking Oil. Jurnal Sains dan Teknik Terapan 1, 18–26.
15. Rinanto Y, Apriliana C, Yulianto RLH, Naufal WM, Dewi AVC, Resnanti RA, Isnaeni KA, Ananda RF, Supomo VAHA (**2024**) Pemanfaatan Minyak Jelantah Menjadi Lilin Aromaterapi di Desa Karanglo, Karanganyar. SWARNA: Jurnal Pengabdian Kepada Masyarakat 3, 302–308.
16. Aisyah S, Effendi Z, Nur Hawalis S (**2020**) Optimasi Pembuatan Lilin Aromaterapi Berbasis Stearic Acid Dengan Penambahan Minyak Atsiri Cengkeh (Syzygium Aromaticum). Jurnal Hexagro. https://doi.org/10.36423/hexagro.v4i1.362
17. Fatkhurrohman F, Nuraeni L, Fioni A, Adiyanti RC, Lutfi MR (**2025**) Pemanfaatan Limbah Minyak Jelantah sebagai Bahan Baku Lilin Aromaterapi di Desa Tlogo, Tretep, Kabupaten Temanggung. Jurnal SOLMA 14, 2912–2920.
18. Hilmarni H, Fauzana S, Ranova R (**2021**) Formulasi Sediaan Lilin Aromaterapi Dari Ekstrak Kecombrang (Etlingera Elatior), Sereh Wangi (Cymbopogon Nardus L.),Dan Cengkeh (Syzygium Aromaticum). JOPS (Journal Of Pharmacy and Science) 4, 29–36.

e-ISSN : 2622-4968, p-ISSN : 2622-1349