การผลิตสบู่เหลวจากน้ำมันปรุงอาหารใช้แล้ว

แสงหอม แซ่จัง* ลภัสลดา หมีทอง ณัฏฐาพร หงส์อินทร์ และณัฐดนัย นิรุตติ์เมธีกุล

สายการเรียนวิทยาศาสตร์และคณิตศาสตร์ โรงเรียนเกษมพิทยา กรุงเทพฯ 10110

*E-mail: Sanghomsai@gmail.com

รับบทความ: 26 กันยายน 2568 แก้ไขบทความ: 25 พฤศจิกายน 2568 ยอมรับตีพิมพ์: 6 ธันวาคม 2568

บทคัดย่อ

น้ำมันพืชใช้แล้วจากครัวเรือน หากทิ้งรวมกับขยะทั่วไปหรือขยะรีไซเคิลจะส่งผลกระทบต่อสิ่งแวดล้อมหลายด้าน การศึกษานี้มีจุดประสงค์เพื่อพัฒนาสบู่เหลวจากน้ำมันปรุงอาหารใช้แล้ว และทดสอบลักษณะทั่วไปของสบู่เหลวที่พัฒนาขึ้น ได้แก่ กลิ่น ความสม่ำเสมอของสี สิ่งแปลกปลอม การเป็นเนื้อเดียวกัน และคุณลักษณะทางเคมีของความเป็นกรด–เบส โดยกรองนำน้ำมันพืชที่ใช้แล้ว ปริมาตร 100 มิลลิลิตร ใส่ในขวดรูปชมพู่ ให้ความร้อนที่อุณหภูมิ 70 องศาเซลเซียส จากนั้นเติมสารละลาย KOH ปริมาตร 30 มิลลิลิตร เท็กซาพอน® ปริมาตร 30 มิลลิลิตร และเอทานอลความเข้มข้นร้อยละ 96 ปริมาตร 40 มิลลิลิตร คนให้เข้ากันอย่างทั่วถึงเป็นเวลา 120 นาที จะได้สบู่เบสที่มีความข้นและเป็นเนื้อเดียวกัน นำสบู่เบสละลายในน้ำกลั่นปริมาตร 100 มิลลิลิตร คนต่อจนได้สบู่เหลว นำตัวอย่างสบู่เหลวมาทดสอบด้วยอาสาสมัครจำนวน 20 คน ซึ่งชักตัวอย่างแบบเจาะจง เครื่องมือที่ใช้ในการเก็บรวบรวมข้อมูลประกอบแบบสัมภาษณ์ และเครื่องวัดค่าความเป็นกรด–เบส วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนา ได้แก่ ความถี่ และร้อยละ และวิเคราะห์เนื้อหา จัดกลุ่มข้อมูล และเสนอข้อค้นพบของการวิจัย ผลการวิจัยพบว่า น้ำมันปรุงอาหารใช้แล้วสามารถนำมาใช้ผลิตสบู่ได้ โดยมีสีสม่ำเสมอ ไม่มีสิ่งแปลกปลอม และเป็นเนื้อเดียวกัน แต่ยังมีกลิ่นของน้ำมันพืชอยู่เล็กน้อยขณะใช้ และกลิ่นจางลงหลังเช็ดมือให้แห้ง สบู่เหลวมีค่าความเป็นกรด–เบสอยู่ในช่วง 8–9

คำสำคัญ: น้ำมันปรุงอาหารใช้แล้ว การผลิตสบู่ ลักษณะของสบู่

Production of Liquid Soap from Used Cooking Oil

Sanghom saijang*, **Lapatsarada Meethong,**

Nattaporn Hong–In and Natdanai Nirutmeteekul

Science and Mathematics Program, Kasem Phithaya School, Bangkok 10110, Thailand

*E-mail: Sanghomsai@gmail.com

Received: 26 September 2025 Revised: 25 November 2025 Accepted: 6 December 2025

Abstract

Disposing of used cooking oil with general or recyclable waste poses multiple environmental risks. This study aimed to develop liquid soap from used cooking oil and evaluate its physical characteristics, including odor, color, consistency, presence of foreign matter, and homogeneity as well as its chemical characteristic of pH. The method involved filtering 100 mL of used cooking oil into Erlenmeyer flask, and heating it to 70°C. Subsequently, 30 mL of potassium hydroxide (KOH), 30 mL of Texapon®, and 40 mL of 96% ethanol were added. The mixture was stirred thoroughly for 12 min to produce a thick, homogenous soap base. The soap base was then dissolved in 100 mL of distilled water and stirred until it became liquid soap. The developed soap was tested by 20 participants who were selected by purposive sampling. Data instruments included an interview form and a pH meter. Data were analyzed using descriptive statistics, including frequency and percentage, as well as content analysis by grouping data and presenting the findings. The findings indicated that used cooking oil could be successfully provided for producing liquid soap with consistent color, absence of foreign matter, and homogeneity. However, a faint cooking oil odor persisted during use, which diminished after drying hands. The liquid soap had pH range of 8–9.

Keywords: Used cooking oil, Soap production, Soap characteristics

Introduction

Palm oil remains the most prevalent vegetable oil worldwide, representing approximately 35% of global production (Downs *et al*., 2022; Taheripour *et al*., 2019). According to the United States Department of Agriculture (USDA), global consumption reached 73.87 million tons in the 2021–2022 period, with approximately 85% utilized for deep–frying purposes (May and Nesaretnam, 2014). In Thailand, ReportLinker (2023) noted that edible oil consumption reached 3.18 million tons, reflecting a compound annual growth rate (CAGR) of 1.94% over the last decade.

Deep–frying is a favored culinary technique due to its ability to produce desirable crispy textures and rich flavor profiles. However, the process typically employs oils high in unsaturated fatty acids, which are susceptible to thermal degradation (Mucti *et al*., 2021). During frying, the hydrolysis of triglycerides occurs, breaking them down into diglycerides, monoglycerides, and free fatty acids. This chemical breakdown increases the oil's acidity, reduces its smoke point, and accelerates oxidation. The resulting oxidized compounds lead to cloudiness and rancidity, compromising both the quality of the oil and the safety of the food produced.

The repeated use and improper disposal of frying oil pose significant risks to both public health and the environment (Nababan *et al*., 2024). According to Tantivivatthanaphan (Chancharoen, 2022) of the Environmental Research Institute at Chulalongkorn University, used cooking oil (UCO) becomes a severe environmental pollutant when discarded incurrectly. In many households, UCO is often disposed of in plastic bags or mixed with general municipal waste. This practice contaminates potentially recyclable materials; because oil is non–water–soluble and highly adhesive, it renders plastics and other recyclables difficult to clean and process.

Furthermore, the mechanical compression of waste during collection can cause oil containers to burst, leading to leakages on public roads. This creates unpleasant odors and hazardous, slippery surfaces. If UCO enters drainage systems, it leads to clogs and water pollution. In landfill environments, oil–contaminated waste undergoes anaerobic decomposition, releasing methane – a potent greenhouse gas with a global warming potential 23 times greater than that of carbon dioxide (Chancharoen, 2022). While institutions like Kasem Pittaya School have successfully implemented systematic waste segregation, the sustainable management of used vegetable oil remains a persistent challenge.

To address these waste management challenges, researchers have investigated various applications for oil residue, particularly those focused on sanitation and disease prevention within educational environments. Among these, the conversion of used cooking oil into soap has emerged as a highly effective method. Gusviputri *et al*. (2017) describe this transformation through a process known as saponification, a hydrolysis reaction of fats under alkaline conditions. In this reaction, triglycerides are broken down into fatty acids and glycerol using an alkaline catalyst, such as sodium hydroxide (NaOH) or potassium hydroxide (KOH). The chemical process is illustrated by Equation (1).

$$\text{Triglyceride} + 3NaOH \text{ (or } 3KOH) \longrightarrow 3\text{fatty acid salts (soap)} + \text{glycerol} \quad \text{- - - (1)}$$

When fatty acids react with these basic substances, they form soap salts–long–chain fatty acids bonded with metal ions (Na^+ or K^+) via carboxylic acid groups. The physical properties of the resulting cleansing agent depend on the metal ion used: sodium–based catalysts typically yield solid bar soap, whereas potassium–based catalysts result in liquid soap (Gusviputri *et al.*, 2017). By repurposing UCO into soap, schools can improve hygiene standards while simultaneously mitigating the environmental impact of oil waste.

Research Objectives

The primary focus of this research was the development and characterization of liquid soap derived from recycled cooking oil. The study aimed to establish an effective production protocol while simultaneously analyzing the physical quality of the output. Key parameters for evaluation included the soap's scent, color distribution, clarity regarding foreign matter, and its homogeneity, ensuring the product is both functional and aesthetically acceptable.

Scope of the Research

The scope of this study was focused on the chemical transformation and quality characterization of liquid soap synthesized from repurposed cooking oil. The research parameters were defined by the following variables and time constraints:

The independent variable in this investigation was the liquid soap formulated from used cooking oil, which serves as the primary subject of experimental development. To evaluate the success of the production process, the dependent variables encompassed a comprehensive analysis of the product's quality. This included an assessment of its general physical characteristics, e.g. odor, color uniformity, and homogeneity, as well as its chemical properties, including pH levels and cleaning efficiency. The study was conducted over a 30–day research duration, providing a focused timeframe for the synthesis, stabilization, and subsequent testing of the soap's properties.

Operational Defintions

The *liquid soap derived from used cooking oil* was operationally defined as a surfactant–based cleansing agent synthesized through the saponification of recycled triglycerides, specifically formulated for dermal application to facilitate the emulsification and removal of impurities. The *general characteristics and chemical properties* of this product referred to the standardized quality assessment metrics used to evaluate its viability. These included observable physical parameters, namely fragrance profile, chromatic consistency, the absence of insoluble particulate matter, and phase homogeneity, alongside measurable chemical indicators, such as pH stability and foaming capacity, which collectively determine the soap's compliance with hygiene and safety benchmarks.

Hypothesis

Based on the theoretical framework of saponification provided by Gusviputri *et al*. (2017), the reaction between triglycerides and alkaline catalysts in precise stoichiometric ratios yields fatty acid salts characterized by long–chain hydrocarbons bonded to metal ions via carboxylate groups. This chemical structure is fundamental to achieving a pH level suitable for dermatological applications. Furthermore, the selection of potassium hydroxide (KOH) as the primary catalyst was anticipated to produce potassium–based fatty acid salts, which exhibit superior solubility and phase stability compared to their sodium–based counterparts, thereby ensuring a more homogeneous liquid consistency with minimal separation.

These chemical principles were supported by the empirical findings of Nababan *et al*. (2024), whose formulations demonstrated that liquid soaps derived from recycled oils consistently maintain a pH range of 8.0–9.0, aligning with established safety standards. Consequently, it is hypothesized that used cooking oil can be successfully synthesized into a stable, high–quality liquid soap that meets the physical and chemical requirements for functional cleansing products.

Theoretical Framework

As defined by Nababan *et al*. (2024), soap is a primary cleansing agent essential for sanitation and disease prevention. Chemically, it consists of fatty acid salts produced through the interaction of lipids with strong alkaline bases, such as NaOH or KOH. These salts are *amphiphilic*, possessing both *hydrophobic* (water–repelling) and *hydrophilic* (water–attracting) properties. This dual nature enables soap to emulsify and dissolve non–polar substances like oil and grease, facilitating their removal from surfaces or skin.

The synthesis of soap occurs via *saponification*, a chemical reaction where triglycerides, the primary components of fats and oils, react with an alkali. This process results in the cleavage of the ester bonds in triglycerides, yielding glycerol as a by–product and fatty acid salts as the functional soap molecules. The transformation is the cornerstone of converting waste lipids into value–added hygiene products (Nababan *et al*., 2024).

Utilizing used cooking oil (UCO) for soap production requires specific pre–treatment and concentration controls to ensure product safety and efficacy. Hartini *et al*. (2021) observed that heating UCO at approximately 45°C for 40 min, followed by a purification step using a 15% NaOH concentration, is a viable method for preparation. Their research further indicated that while increasing NaOH concentration to 40% can significantly reduce impurities and improve initial quality, excessive alkalinity must be avoided. An over–saturation of alkaline catalysts can result in a product with a pH level too high for safe dermal application, thereby compromising the final soap's integrity.

Regarding the production of liquid variants, the concentration of the alkali catalyst plays a pivotal role in determining physical stability. Dalimunthe (2009) successfully synthesized soap from UCO using KOH concentrations of 25%, 30% and 35%. The study concluded that a 25% KOH concentration yielded the most favorable results, producing a pH value of 10.3 and a moisture content of 0.0847%. These parameters align with standard quality benchmarks, suggesting that lower alkaline concentrations may be more effective in balancing cleaning power with user safety.

Research Methodology

This study employed a true–experimental research design to investigate the synthesis of liquid soap from repurposed lipids. The primary materials utilized included used cooking oil sourced from the Kasem Pittaya School cafeteria, distilled water, NaOH, KOH, 96% ethanol, and Texapon®. The experimental procedure was adapted from Nababan *et al*. (2024). Initially, 100 mL of used vegetable oil was filtered to remove particulate matter, transferred to an Erlenmeyer flask, and heated to a constant temperature of 70°C. Subsequently, 30 mL of KOH, 30 mL of Texapon®, and 40 mL of 96% ethanol were added into the heated oil. The mixture was subjected to continuous mechanical stirring for 120 min until the saponification process yielded a dense, homogeneous soap base. Finally, this concentrated base was diluted with 100 mL of distilled water and stirred until a uniform liquid consistency was achieved (Figure 1).

Figure 1 Soup production from used cooking oil

Research participants: 20 participants from the school community were selected by a purposive sampling method with the sample size determined by the principle of data saturation. Participants were included based on their voluntary informed consent. Conversely, individuals were excluded if they expressed unwillingness to participate, possessed known allergies to the soap's chemical constituents (KOH, Texapon®, ethanol, or vegetable oil), or presented with pre–existing skin sensitivities and dermatological conditions.

Research instrument: Data collection was facilitated through two primary instruments: 1) Semi–structured interview form organized into sections covering demographic profiles and qualitative evaluations of the soap's physical properties, including aromatic profile, color uniformity, phase stability and the presence of impurities. 2) pH meter was used to measure the soap's acidity or alkalinity levels.

Data analysis: Quantitative data were processed using descriptive statistics, including frequencies and percentages. Qualitative insights from interviews underwent content analysis to identify emerging themes and categorize findings, ensuring a comprehensive evaluation of the research objectives.

Results and Discussion

Regarding the first research objective, the synthesis of liquid soap from repurposed cooking oil was successfully achieved, resulting in a stable liquid formulation as depicted in Figure 2. In addressing the second objective, evaluating the product's physical and chemical properties, the findings indicated high levels of quality and consistency across all parameters. Sensory evaluation revealed that a majority of participants (55%, n=11) noted a faint residual scent of cooking oil during application, which dissipated completely upon rinsing, rendering the soap suitable for regular use. In terms of aesthetic and structural integrity, there was a unanimous consensus (100%, n=20) that the product exhibited perfect color uniformity, was entirely free of foreign particulate matter, and maintained complete phase homogeneity without signs of separation. Furthermore, chemical analysis confirmed that the soap possessed a pH range of 8.0–9.0, align with findings of Nababan *et al*. (2024). The pH range is consistent with established safety standards for cleansing agents, ensuring that the repurposed product is both chemically stable and dermatologically viable for hand hygiene (Dalimunthe, 2009; Nababan *et al*., 2004).

Figure 2 Liquid soap from used cooking oil

Conclusion and Recommendations

The findings of this study successfully demonstrate the feasibility of repurposing used cooking oil from both household and institutional sources into a functional liquid soap via the saponification process. The resulting product exhibits high physical quality, characterized by total phase homogeneity, complete color uniformity, and the absence of foreign particulate matter. While a faint residual odor of cooking oil may be detected during initial application, it dissipates effectively upon rinsing, ensuring the soap's suitability for routine hygiene.

Based on these results, it is recommended that educational institutions integrate this innovation into their waste management policies and environmental curricula. Schools can utilize these findings as a framework for policy–making, while educators can design hands–on learning activities that allow students to collaborate with parents and teachers in sustainable practice. By promoting the conversion of used lipids into hygiene products, schools can foster a culture of environmental stewardship. For future research, it is suggested that the formulation be enhanced by incorporating natural aromatic agents to neutralize residual scents and by optimizing the concentration of surfactants to improve foam stability and volume, thereby increasing consumer satisfaction and product performance.

References

Chancharoen, K. (2022). **Chula's Potassium Liquid Soap from Used Cooking Oil for a Greener Environment and Circular Economy**. Retrieved from https://www.chula.ac.th/en/highlight/89894/, July 17, 2025.

Dalimunthe, N. A. (2009). **Pemanfaatan Minyak Goreng Bekas Menjadi Sabun Nandi Padat** (Unpublished Master's thesis). Universitas Sumatera Utara, Jurusan Teknik Kimia. (in Indonesian)

Downs, S. M., Nicholas, K., Linn, K. K., and Fanzo, J. (2022). Examining the trade–offs of palm oil 4 production and consumption from a sustainable diets' perspective: Lessons learned 5 from Myanmar. **Public Health Nutrition** 25(5): 964–976.

Gusviputri, A., Njoo Meliana, P. S., Aylianawati, and Indraswati, N. (2017). Pembuatan sabun dengan lidah buaya (*Aloe vera*) sebagai Antiseptik alami. **Widya Teknik** 12: 11–21. (in Indonesian)

Hartini, S., Widharto, Y., Indarto, S. R., and Murdikaningrum, G. (2021). Eco–efficiency analysis of waste cooking oil recycling into liquid dish soap using life cycle assessment. **IOP Conference Series: Earth and Environmental Science** 896(1): 012066.

May, C. Y., and Nesaretnam, K. (2014). Research advancements in palm oil nutrition. **European Journal of Lipid Science and Technology** 116(10): 1301–1315.

Mucti, S., Purwasih, R., and Destiana, I. D. (2023). Analisis mutu minyak goreng yang dipakai oleh pedagang gorengan di pasar pujasera Subang. **EDUFORTECH** 8(2): 1–10. (in Indonesian)

Nababan, B. P., Mulmeyda, R., and Insyani, N. P. (2024). Utilization of used cooking oil in making liquid soap with the addition of water hyacinth (*Eichhornia crassipes*) leaf extract as an antibacterial. **Chemistry and Materials** 3(2): 64–70.

ReportLinker. (2023, March 15). Edible oil market in Thailand: Analysis and forecast to 2025. Retrieved from https://www.reportlinker.com/p06234567/Edible-Oil-Market-in-Thailand.html, July 17, 2025.

Taheripour, F., Hertel, T. W., and Ramankutty,

N. (2019). Market–mediated responses confound policies to limit deforestation from oil palm expansion in Malaysia and Indonesia. **Proceedings of the National Academy of Sciences** 116(38): 19193–19199.