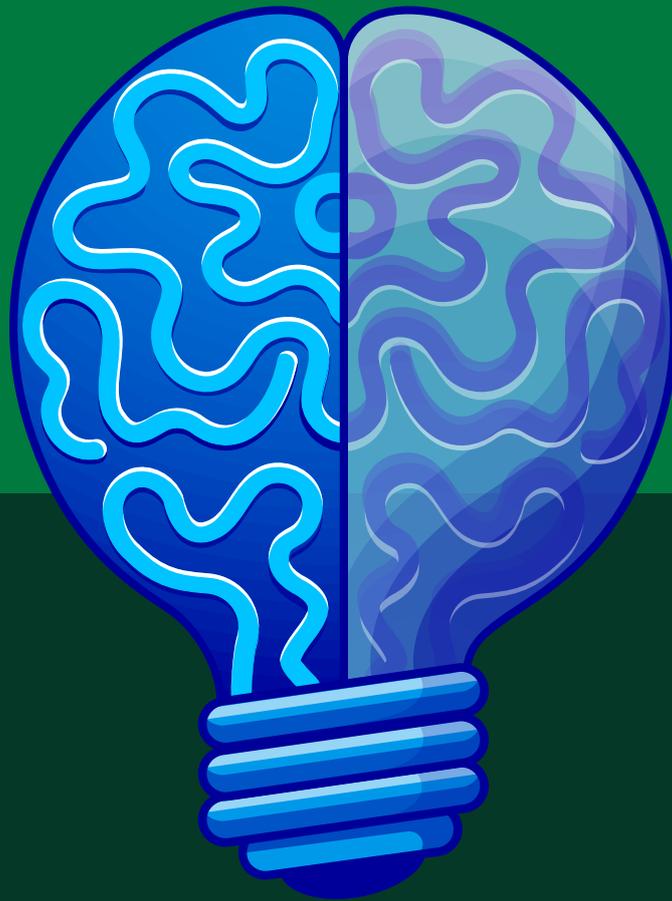


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PERAK BRANCH

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Preface

The Scientific Project Colloquium offers a platform for publishing Diploma Science final year projects (FYP). The objective is to effectively distribute research findings throughout all scientific disciplines. The primary objective of including final year projects into the course curriculum is to encourage students to put their theoretical knowledge into practical applications.

We would like to express our gratitude to our primary establishment, the Faculty of Applied Sciences and Universiti Teknologi MARA, Perak Branch, for their invaluable assistance.

Lastly, we would like to express our gratitude to all of the authors for the tremendous help in preparing the articles, without which this undertaking would not have been completed.

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FORMULATION AND CHARACTERIZATION OF BAR, PASTE, AND LIQUID SOAPS USING RECYCLED COOKING OIL

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Abstract: This research focuses on the development of soaps formulated from the recycled cooking oil as the primary raw material. The objective was to produce soaps capable of effectively reducing bacterial presence, suitable for all skin types, and available in three distinct forms: solid, paste, and liquid. The formulations were prepared by combining sodium hydroxide, distilled water, and repurposed cooking oil, with lime juice incorporated for its antibacterial properties. The physicochemical evaluations were conducted to examine parameters such as pH stability, foaming capacity, allergenic potential, and colour. The results show the potential of upcycling waste materials into consumer-friendly soap products.

Keywords: *Paste soap, Liquid soap, Solid soap, Saponification, Used cooking oil*

INTRODUCTION

The increasing global focus on sustainability and consumer demand for multifunctional personal care products has driven innovation in soap production (Martins, 2020; WHO, 2020). While conventional soaps are typically produced using fresh oils and fats, recycled cooking oil has emerged as a sustainable and cost-effective alternative that reduces environmental waste (Okpo & Edafiaadhe, 2024). Soap remains one of the most essential hygiene products due to its ability to emulsify oils, dirt, and microbes through the saponification process, where triglycerides are converted into soap and glycerol using alkalis such as sodium hydroxide (Benedict, 2024). Beyond its cleansing properties, soap also plays a historical and cultural role in daily hygiene, underlining its universal relevance (Zahran, 2023)

Research demonstrates that incorporating renewable, biodegradable, and non-toxic ingredients results in environmentally safe soaps with desirable physicochemical properties. Comparative studies further reveal that antibacterial soaps do not always outperform regular soaps in reducing bacteria, reinforcing the effectiveness of simple, well-formulated natural soaps (Kanyama, 2025).

In this study, recycled cooking oil was employed as the primary base material, combined with sodium hydroxide as the alkali, lime juice for antibacterial enhancement, and lavender fragrance for the aroma. Soaps were prepared in solid, paste, and liquid forms and tested for pH stability, foaming capacity, colour, and allergenicity. The results demonstrated that soaps made from recycled cooking oil exhibited antibacterial properties, stable pH levels, enhanced foaming ability, and safety for human use, highlighting their potential as sustainable, biodegradable, and consumer-friendly hygiene products.

Previous research has examined the influence of different oils on soap properties, with findings showing that solid soaps provide greater hardness and durability, while liquid soaps excel in lathering and moisturizing qualities (Arasaretnam & Venujah, 2019). From an environmental perspective, the use of recycled cooking oil in soap production significantly reduces carbon footprint and waste generation compared to conventional. Research is still limited on the effects of soap ingredients on skin conditions, particularly for consumers seeking antibacterial formulations that support skin health, such as eczema treatment.

There is also a lack of standardized methods to ensure consistency across different batches of soap made from recycled cooking oil. Furthermore, little is known about the long-term performance and shelf life of such products in terms of consumer satisfaction and stability. This study contributes to addressing these gaps by demonstrating the potential of recycled cooking oil in producing safe, effective, and eco-friendly soaps, thereby supporting sustainable waste management practices and offering viable alternatives to conventional soap manufacturing.

METHODOLOGY

Preparation of the Soap

Soaps were produced in three forms: solid, paste, and liquid. For solid soap, 24 grams of sodium hydroxide

(NaOH) were weighed and dissolved in distilled water. The solution was handled carefully, as it became hot during the reaction. Then, 300 grams of cooking oil were slowly added while the mixture was blended using a hand blender until it formed a homogeneous solution. Approximately 15 ml of lime juice were added to enhance the antibacterial properties and aroma of the soap. The mixture was then poured into molds and left at room temperature for one week to harden. For paste and liquid soaps, from the same mixture, it was dissolved in hot distilled water to diluted. The mixture was stirred until a gel-like paste formed. One portion was retained as paste soap, while the other was diluted with additional distilled water to produce a liquid form. Lavender fragrance was added to improve the scent of the soap. The soaps were then left to cured for four weeks.

pH Testing

The pH of the soaps was measured using a pH meter. Samples were taken during production to confirm complete saponification and to prevent excessive alkalinity or acidity.

Physicochemical Testing

Physicochemical properties have been evaluated including colour, foaming ability, pH stability, and potential allergenicity. Feedback was also collected from student users to assess the performance and safety of the soaps.

FINDINGS

Three soap forms were successfully produced using the waste cooking oil is feasible, with three distinct forms liquid, paste, and solid. It's been produced through the saponification process. Figure 1 illustrates the soap products made from waste cooking oil, namely: S.B (Soap Bar), S.P (Soap Paste), and S.L (Soap Liquid). The pH level was identified as a crucial parameter for evaluating soap quality, cleaning effectiveness, and compatibility with human skin. Since natural soaps typically have a pH between 9–10, which balances cleansing with skin comfort (Anantharaman et al., 2018; Tarun et al., 2020), the measured values of 12.18 for liquid soap, 11.54 for paste soap, and 11.50 for solid soap indicate higher alkalinity.

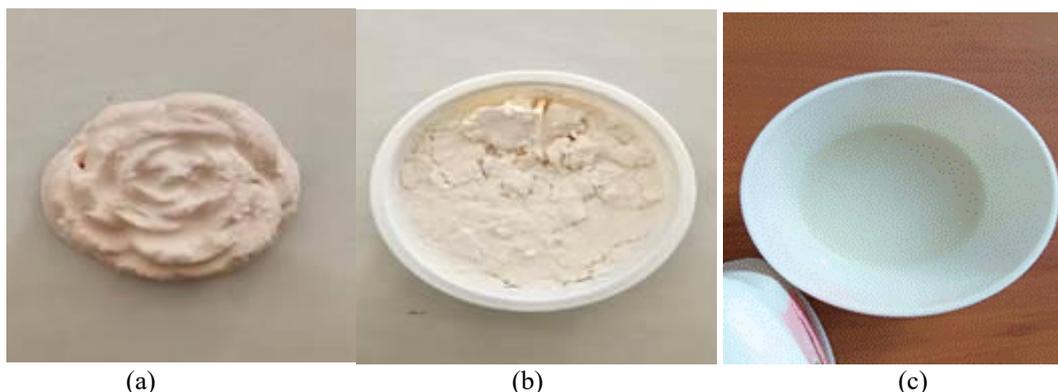


Figure 1 Illustrates the soap products: (a) S.B – Soap Bar, (b) S.P – Soap Paste, and (c) S.L – Soap Liquid

This survey was conducted to gather valuable feedback on the performance and quality of soaps made from used cooking oil in three forms: liquid, paste, and solid. A physicochemical testing form was used to evaluate parameters such as texture, effectiveness, scent, and overall user experience. This feedback was critical in identifying areas for improvement in the formulations, with the goal of developing soaps that are safe for skin, effective in cleaning, and acceptable to consumers. The study successfully demonstrated that soap production from used cooking oil through saponification with sodium hydroxide is feasible, yielding three distinct product types.

Table 1 shows the physicochemical testing for the Soap Bar (S.B), Soap Paste (S.P), and Soap Liquid (S.L).

Type of cooking oil soap	Physical test			
	Color	Foam test	Allergic test	pH
Soap Bar (S.B)	Milky white	Low	negative	11.50
Soap Paste (S.P)	Milky White	High	negative	11.54
Soap Liquid (S.L).	Milky white	Medium	negative	12.18

Table 1 show the physicochemical testing for the Soap Bar (S.B), Soap Paste (S.P), and Soap Liquid (S.L). The results indicated that pH level is an essential factor in assessing soap quality, cleansing efficiency, and skin

compatibility. Typically, natural soaps fall within the pH range of 9–10, balancing cleaning effectiveness with skin comfort. In this study, however, all three soaps showed higher alkalinity, with recorded pH values of 12.18 for liquid soap, 11.54 for paste soap, and 11.50 for solid soap. These values exceeded the standard range, suggesting potential challenges for safe skin application.

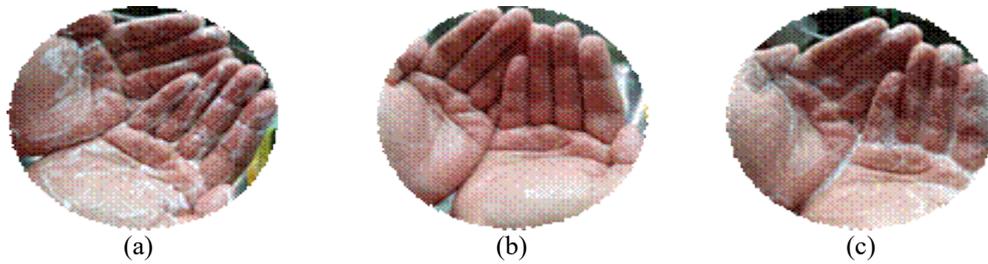


Figure 2 The level of soapiness on hands for the three soap types: (a) S.B – Soap Bar, (b) S.P – Soap Paste, and (c) S.L – Soap Liquid.

The liquid soap, formulated with lavender fragrance, had the highest pH (12.18), making it the most alkaline of the three. While this high alkalinity enhanced its cleaning strength, it also raised concerns regarding possible skin irritation. This elevated pH could be due to incomplete neutralization of sodium hydroxide or insufficient dilution during the saponification process. Additionally, the type of oil used influenced foam production. Oils high in unsaturated fatty acids, such as palm oil, generally produce less foam than oils with higher saturated fatty acid content, such as coconut oil (Arasaretnam & Venujah, 2019).

The paste soap had a slightly lower pH of 11.54 but remained strongly alkaline. Its thick and concentrated texture made it effective for cleaning tough grease and dirt. However, it tended to leave sticky residues on the skin due to its low solubility. The high surfactant content and low water level helped generate stable foam, but also increased the risk of skin dryness or irritation. The solid soap, which included lime juice, showed the lowest pH at 11.50. The lime juice slightly reduced the alkalinity, making it gentler on the skin compared to the other types.



Figure 3 Cleaning effectiveness of S.B (Soap Bar), S.P (Soap Paste), and S.L (Soap Liquid) on plates before, during, and after washing

Figure 3 illustrates the cleaning effectiveness of the three soap types—S.B (Soap Bar), S.P (Soap Paste), and S.L (Soap Liquid)—showing the condition of a dirty plate before washing, during cleaning, and after cleaning, where all three soaps produced comparable results. The findings confirmed that soaps produced from used cooking oil are effective cleaning agents and represent a sustainable alternative to conventional formulations. However, the elevated pH values observed across all types highlighted limitations in skin compatibility.

CONCLUSIONS

This study confirms that the saponification of used cooking oil provides a sustainable method for producing soaps in liquid, paste, and solid forms, demonstrating both environmental and economic value by transforming waste into useful hygiene products. Future improvements should be done to focus on refining the neutralization process, adjusting dilution ratios, and incorporating buffering agents or natural additives to achieve a milder pH. These modifications will enhance consumer safety and comfort, ensuring that the soaps remain both environmentally sustainable and user-friendly.

COMPLIANCE OF ETHICAL STANDARDS

Not applicable.

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Surat kami : 700-KPK (PRP.UP.1/20/1)

Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
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Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan amanah,

Setuju.

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