



## Application of Lime as a Natural Ingredient in Dishwashing Liquid Formulation

Timnoy SALITXAY\*<sup>1</sup>, Amphone CHANTHEEVILAYPHONE<sup>1</sup>, Khantavanh

PHOMLASABOUD<sup>1</sup>, Soulaseng BOUNVILAYSONE<sup>1</sup>, Phisouda SIVILAY<sup>2</sup>

Faculty of Agriculture and Forest Resource, Souphanouvong University, Lao PDR

### Abstract

This study aimed to evaluate the physicochemical properties, sensory acceptance, of lime-based dishwashing detergents formulated using different recipes. Completely Randomized Design (CRD) with four formulations (F1, F2, F3, F4), three replications were used. Physicochemical properties (pH value, foam retention time, and foam stability) and sensory evaluation were evaluated.

The results revealed that pH values ranged from 8.36 to 8.76, with the highest value was observed in F1 (8.76), followed by F2 (8.67), while the F4 showed the lowest pH value (8.36). Foam retention time was found as longest in F1 (50 min), followed by F4 (42.33 min). However, F3 obtained shortest foam retention time with 21 min. Foam stability was highest in F3 (100%), followed by F4 (86%), F1 (84.58%), and F2 (76.66%). Sensory evaluation was conducted with 30 panelists using 5-point hedonic scale. Most panelists were female (53.3%), aged 16-30 years (43.3%), with a monthly income of 2,000,000 – 4,000,000 LAK (50%). Among formulas, F4 received the highest sensory scores across all attributes overall liking, color, odor, viscosity, foam, cleaning efficiency, and after-washing feel with mean score ranging from 4.4 to 4.6.

Overall product acceptance and purchase intention reached 100%, indicating strong consumer acceptance and high market potential for lime-based dishwashing liquid.

**Keywords:** Lime, dishwashing liquid, cleaning agents, physicochemical properties, sensory evaluation

\*Correspondence: Timnoy

SALITXAY, Faculty of

Agriculture and Forest

Resource, Souphanouvong

University

Tel: +856 20 97575695;

E-mail: [tsalixay@su.edu.la](mailto:tsalixay@su.edu.la)

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## 1. Introduction

Lime, with botanical name: *Citrus aurantiifolia* (Christm) Swingle, a medicinal plant known which is recognized for its diverse therapeutic applications, many crucial benefits and properties for preventing and treating diseases was recorded in this plant. Among medical properties, alkaloids, flavonoids, steroids, triterpenoids, saponins, tannins and phenolics were found in lime fruit, which is considered as bacterial growth inhibitor. Various chemical compounds included citric acid, fatty resins, glycosides, minerals, vitamin B1 and essential oils were observed in Lime (Sapitri et al., 2022).

Liquid type of dishwashing soap is daily necessity, it can be dissolved quickly in water, without leaving a pungent odor on kitchen utensils thus it is more preferable compared with cream soap (Fitriany et al., 2025 as cited in Putra et al., 2025).

Dishwashing liquid are currently developed using many natural ingredients. Previous study used Bergamot as dishwashing ingredient (Bhodthipuks & Rawangwongsa, 2018). Silijanyathum & Tanthanase (2018) has also made different formulations of dishwashing liquid used lime and Bergamot as natural ingredients. Thongtan & Pongchompu (2012) studied. Business management of kaffir lime dishwashing liquid of a woman famers' group,

secondary data (Descriptive method) and primary data was collected to understand the dishwashing liquid production in the community. Other Investigation of high-efficiency. Antibacterial Liquid Dishwashing detergent by using Oregano essential oil as an antibacterial agent was reported by Dai et al., 2019.

Lime (*Citrus aurantiifolia*) and lemon (*Citrus limon*) contain natural fragrance with antibacterial properties. Thus, they are both considered as very important natural ingredient for production of dishwashing liquid in various recipes (Sugiyanto et al., 2024; Zuhlianty et al., 2025 as cited in Ningsih et al., 2025).

Sormin et al. (2023) investigated Antibacterial Activity Of Lime Peel (*Citrus Aurantifolia* (Christm.)Swingle) Ethanolic Extract Against Skin Infection Bacteria. As lime showed a strong antibacterial agent with very effective in removing grease from kitchen utensils with natural odor, this is concern able using this natural ingredient as dish washing liquid component for both household and industrial application. This approach is particularly suitable for developing countries with abundant of natural resource but limited access to appropriate technology or innovation.

This study focused on evaluation of physicochemical properties of lime-based dishwashing liquid

and to conduct sensory evaluation of the Lime-based dishwashing liquid formulas.

## 2. Materials and Methods

### 2.1 Materials

- Material used : pH meter, squeezer, balance, beaker, scale, plastic container, stirring stick.

- Formulation components : Sodium Lauryl Ether Sulfate (SLES) 70% (N70), Linear Alkylbenzene Sulfonate, Sodium Salt (24%) (F24), Industrial-grade sodium chloride (Thickening agent), citric acid, salt, water, lime flavor, ash water (alkaline solution obtained from plant ash).

### 2.2 Formulation

Lime-based dishwashing liquid formulation were prepared. Formulation F1, F2, and F3 represented different formulation components according to Silijanyathum & Tanthanase, (2018) described methods. While F4 represented a commercial dishwashing liquid as control (Table 1).

### 2.3 Procedure

Fresh limes were obtained then washed, cut into four pieces, squeezed to obtain only juice, then filter through a filter net. The ingredient includes N70, F24, foaming powder, salt (thickening agent) was added into mixing container, followed by the gradual addition of the remaining supplementary ingredients. Water was then slowly poured into the mixture while stirring continuously in the same direction to ensure uniform mixing of all components. After mixing, the mixture was allowed to settle for 12 -14 hours. The resulting dishwashing liquid was stored in the container under appropriate conditions until further use in subsequent physicochemical properties analysis.

### 2.4 Physicochemical properties

#### 2.4.1 Measuring of pH value

The pH value was measured using a pH meter. A test sample (10-30 ml) was placed in a clean cup, and the pH electrode was immersed in the sample until a stable reading was obtained.

#### 2.4.2 Foam Retention Capacity

The foam retention capacity was conducted following Debnath *et al.* (2011), as cited in Ordoyo and Sepe (2019). A volume of 1 ml on each of the formulated dishwashing liquid was added to 49 ml of distilled in a 100 graduated cylinder. The graduated cylinder was covered with hand and was shaken vigorously for 10 times. The time when the foam disappeared was recorded.

#### 2.4.3 Foam Stability

The foam stability assessment followed the methodology outlined by Hembra *et al.* (2020). Dish washing liquid (10ml) was prepared and vigorously shaken for one (1) minute. The resulting foam height was measured using a ruler. The foam height was measured once more after allowing the sample to stand undisturbed

for five (5) minutes. Then The foam stability was calculated using the provided formula:

$$\text{Foam stability} = \frac{\text{Final foam height}}{\text{Initial foam height}} \times 100$$

### 2.5 Sensory evaluation

Sensory evaluation was tested with 30 panelists using 5 points Hedonic scale to measured consumer acceptability of dish washing liquid. The evaluated attributes included overall liking, color, foam, Viscosity, odor, washability, after-washing feel. Ten mL of each dish washing liquid samples were used for testing Then the mean score of all sensory attributes were calculated. The scale ranged from 1 (dislike extremely) to 5 (like extremely). Where 5: Like Extremely, 4: Like Slightly, 3: Neutral, 2: Dislike Slightly and 1: Dislike Extremely.

### 2.6 Statistical analysis

The data obtained were analyzed using Microsoft Excel and Sirichai statistic (Version 7.0). Statistical differences were evaluated at 95% confidence level ( $P < 0.05$ )

## 3. Result

### 3.1 Physicochemical properties of Lime-based dishwashing liquid

The development of hand dishwashing liquid is specifically for cleaning dishes and cutlery in households, removing a variety of food residues containing fats, starches, or proteins (The German Cosmetic, Toiletry, Perfumery and Detergent Association (IKW), Home Care Department, Frankfurt am Main, 2025).

The result of physicochemical properties showed that, all treatments have statically difference at 95% confidence level ( $P < 0.05$ ) in pH value. F1 exhibited the highest pH (8.76), followed by F2 (8.67), While the lowest pH was observed in F4 (8.36). Foam Retention Capacity also showed a significant at 95% confidence level. The longest Foam Retention Capacity was recorded in F1 (50 min), followed by F4 (42.33 min), and F2 (28 min). Whereas F3 showed the shortest Foam Retention Capacity (21min). Foam stability differed significantly among formulas ( $P < 0.05$ ). The highest value for foam stability was observed in F3 (100%), Followed by F4 (86%). While the lowest value was found in F2 (76.66%) (Table 2).

### 3.1 Sensory evaluation of Lime-based dishwashing liquid formulas

#### 3.1.1 Demographic information

A total of 30 panelists participated in the sensory evaluation of the Lime-based dishwashing liquid. Among the respondents, 53.3% were female. The age distribution was as follows: 16-30 years (43.3%), 31-45 years (33.3%), and 40-50 years (23.4%). Monthly income levels were 500,000-1,000,000 LAK (23.3%), 2,000,000- 4,000,000 LAK (50%), 4,000,000-6,000,000 LAK (20%), and above 6,000,000 LAK (6.7%). (Table 03)

### 3.1.2 Sensory Evaluation of Lime-based dishwashing liquid formulas

The sensory evaluation was performed with 30 panelists. Significant differences ( $P < 0.05$ ) were observed among the treatments for all evaluated attributes, including overall liking, color, odor, viscosity, foam, cleaning ability, and after-wash feel. Treatment F4 consistently received the highest sensory scores across all evaluated attributes (Table 05)

Overall liking ranged from 2.4 to 4.6, with F4 scoring the highest (4.5) and F3 the lowest (3.1). Color preference was highest for F4 (4.6) and lowest for F3 (2.5). Odor scored highest in F4 (4.4) and lowest in F3 (2.2). Viscosity was rated highest for F4 (4.6) and lowest for F1 (2.8). Foam quality was highest in F4 (4.5) and lowest in F1 (3.3). Cleaning ability was rated highest in F4 (4.6) and lowest in F1 and F3 (3.4). After-wash feel was highest in F4 (4.5) and lowest in F3 (3.5). All respondents (100%) indicated willingness to accept and purchase the Lime-based dishwashing liquid (Graph No: 01). The findings suggested that the Lime-based dishwashing liquid would be well accepted by consumers and have strong market potential.

## 4. Discussion

The physicochemical analysis of four lime-based dishwashing liquid formulations showed significant differences in pH values among the treatments ( $P < 0.05$ ). The Formula F1 being the highest (8.76), followed by F2 (8.67), F3 (8.46), and F4 (8.36). Ordoyo & Sepe (2019), produce liquid hand soap using Piper aduncum leaf extract, the pH ranged between 8.4 to 9.7 of tested samples. While The pH values of the formulated liquid hand must be in an acceptable limit pH range of 8.5-10.5. Our finding the pH ranged from 8.36 to 8.76. This may acceptable according to the previous mention.

Foam retention capacity tests also revealed significant differences ( $P < 0.05$ ). F1 maintained foam for the longest duration (50 min), followed by F4 (42.33 min), F2 (28 min), and F3 (21 min). Foam retention and volume were consistent with previous studies (Christian, 2023), indicating that lime-based formulations can achieve effective foaming suitable for cleaning.

Foam stability measurements showed F3 had the highest value (100% relative scale), followed by F4 (86%), F1 (84.58%), and F2 (76.66%). Foam volume evaluation revealed F4 and F3 had the highest foam formation ( $96.12 \pm 0.44\%$  and  $97.08 \pm 1.42\%$ , respectively), demonstrating good foam stability and cleaning efficiency. Christian (2023) emphasized that foam formation and stability are crucial for effective detergent performance.

Nurrohimi et al. (2025) studied Formulation and Evaluation of Dishwashing Soap Based on Eichhornia crassipes Activated Carbon as an Environmentally Friendly Cleanser, reported that pH of tested sample was 9.78, foam stability (90%). This study was compared to

Product Evaluation based on Indonesian National Standards (SNI), where pH (8-11) standard foam stability (60-100%) are acceptable. Our study contained higher Foam stability in comparison with Nurrohimi et al., 2025.

Akpolome et al. (2025) evaluated the formula of Natural Cleaning Agent from Citrus Lemon Peel Extract, Eggshell, and Coconut Shell. The findings underscore the potential of agro-waste-based formulations as sustainable, non-toxic alternatives to conventional cleaners. The cleaning performance of hand dishwashing detergents is assessed by measuring the number of **scrubbing strokes** required to completely remove polymerized grease-based soil from stainless-steel plates using a standardized scrub tester (The German Cosmetic, Toiletry, Perfumery and Detergent Association (IKW) Home Care Department, 2025).

Sensory evaluation using 30 panelists showed that F4 consistently scored highest across attributes including overall preference, color, odor, viscosity, foam, cleaning ability, and after-wash feel ( $P < 0.05$ ). This suggests F4 is the most preferred formulation among all tested samples. Overall, F4 exhibited the most favorable combination of pH, foam stability, viscosity, cleaning performance, and consumer acceptance, indicating its potential as an effective, environmentally friendly lime-based dishwashing liquid suitable for household use. Based on observations from the market, where industrial-scale lime-based dishwashing detergents are produced using chemical ingredients as the main components. In addition to consumer needs, we are prioritizing the development of eco-friendly dishwashing liquid to ensure long-term sustainability (De Moura & Da Silva, 2024). This study revealed that the consumer acceptance and purchase decision were high. All examined formulas achieved 100% acceptance, indicating that consumers recognize and approve of this lime-based dishwashing liquid. Additionally, the purchase decision also reached 100%, demonstrating that if this product were available on the market, it would likely attract a high number of buyers.

## 5. Conclusion

The study showed that lime-based dish washing liquid has favorable Physicochemical properties (pH, foam stability, and form retention time) and is widely accepted by users, with 100% willing to purchase. Among the tested formulations, F2 and F3 had maintaining high quality and aroma similar to commercial products (F4), making them suitable for household use and potential market production. Proper adjustment of lime content can further improve cost efficiency and product appeal. Further study on antibacterial activity and additional parameters for evaluating cleaning efficiency and safety are recommended.

## 6. Conflict of Interest

The authors declare no conflict of interest and accept full responsibility for the integrity of the submitted work.

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**Table 1.** Formulation of Lime-based dishwashing liquid

Formula components	Formula			
	F1	F2	F3	F4 (Commercial product)
Sodium Lauryl Ether Sulfate (SLES) 70%, N 70	500 g	1 kg	1 kg	Sodium Alkylbenzene Sulfonate), Sodium Laureth

Linear Alkylbenzene Sulfonate, Sodium Salt (24%), F24	500 g	1 kg	1 kg	Sulfate, Cocamidopropyl Betaine, Magnesium sulfate, Hydroxypropyl Methylcellulose), Tetrasodium, Hydantoin, Methylchloro isothiazolinone, Water, Lime flavor
Sodium chloride (Thickening agent)	150 g		800 g	
Lime (freshly Squeezed Juice)	100 mL	1 L		
Sodium Lauryl Sulfate (Emal)	100 g	200 g	200 g	
Ash water		10 L		
Salt		800 g		
Citric acid			7.5 g	
lime flavor			25 g	
Water			5 L	

**Table 2.** Physicochemical properties of Lime-based dishwashing liquid

No	Measurement	Formulas				p-value
		F1	F2	F3	F4	
1	pH	8.76 <sup>a</sup> ±0.18	8.67 <sup>a</sup> ±0.13	8.46 <sup>b</sup> ±0.1	8.36 <sup>b</sup> ±0.09	0.003
2	Foam Retention Capacity (min)	50 <sup>a</sup> ±1.63	28 <sup>c</sup> ±2.16	21 <sup>d</sup> ±1.63	42.33 <sup>b</sup> ±2.49	0
3	Foam stability (%)	84.58 <sup>ab</sup> ±2.93	76.66 <sup>b</sup> ±4.5	100 <sup>a</sup> ±0	86 <sup>ab</sup> ±6.75	0.045

Note: Means followed by different letters (a, b, c) within the same row are significantly different ( $P < 0.05$ ) as determined by ANOVA using Sirichai Statistics software.

**Table 3.** Demographic information of panelists

Information	Category	Frequency	Percentage (%)
Gender	Female	16	53.3
	Male	14	46.7
Age	Lower 15 years	0	0
	15 - 30 years	13	43.3
	31 - 45 yeas	10	33.3
	46-60 years	7	23.4
	Over 60 years	0	0
Monthly Income (LAK)	Lower 500,000	0	0
	500,000 - 1,000,000	7	23.3
	2,000,000 - 4,000,000	15	50
	4,000,000 - 6,000,000	6	20
	Over 6,000,000	2	6.7

**Table 4.** Formula Acceptability and Purchase decision

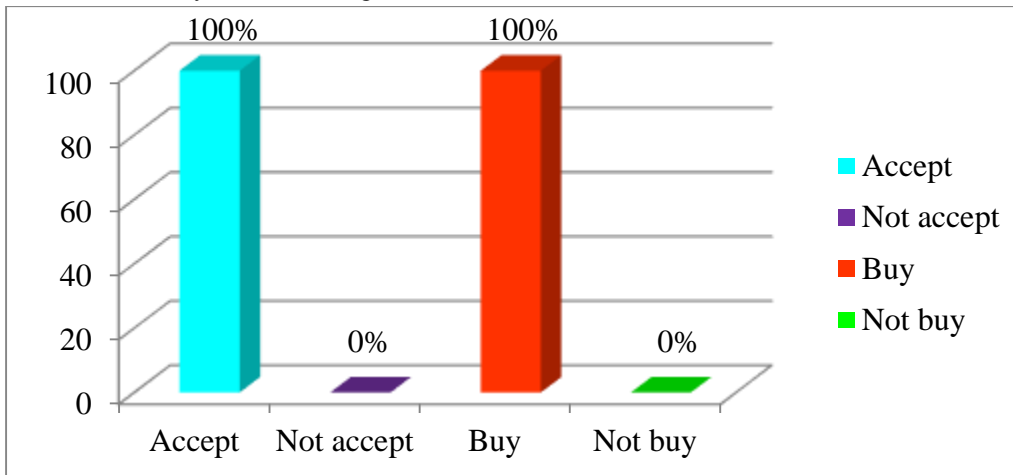
Attributes	Category	Frequency	Percentage (%)
Acceptability	Accepted	30	100
	Not accepted	0	0
Purchase decision	willingness to purchase	30	100
	Unwillingness to purchase	0	0

**Table 5.** Sensory Evaluation Scores of All Lime-based dishwashing liquid formulas

No	Attribute	Formulation	P-value
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		F1	F2	F3	F4	
1	Overall preference	3.6 <sup>b</sup> ±1.15	3.8 <sup>b</sup> ±0.81	3.1 <sup>c</sup> ±0.78	4.5 <sup>a</sup> ±0.94	0.00
2	Color	3.8 <sup>b</sup> ±0.87	3.5 <sup>b</sup> ±0.89	2.5 <sup>c</sup> ±1.33	4.6 <sup>a</sup> ±0.76	0.000
3	Odor	2.4 <sup>bc</sup> ±0.94	2.7 <sup>b</sup> ±0.73	2.2 <sup>c</sup> ±0.89	4.4 <sup>a</sup> ±1.04	0.000
4	Viscosity	2.8 <sup>c</sup> ±1.21	3.4 <sup>b</sup> ±0.86	3.3 <sup>b</sup> ±0.96	4.6 <sup>a</sup> ±0.93	0.000
5	Foam	3.3 <sup>b</sup> ±0.96	3.6 <sup>b</sup> ±1.04	3.4 <sup>b</sup> ±0.97	4.5 <sup>a</sup> ±0.97	0.000
6	Cleaning ability	3.4 <sup>b</sup> ±0.68	3.5 <sup>b</sup> ±0.73	3.4 <sup>b</sup> ±0.93	4.6 <sup>a</sup> ±0.89	0.000
7	After-wash Feel	3.6 <sup>b</sup> ±0.89	3.9 <sup>b</sup> ±0.94	3.5 <sup>c</sup> ±0.93	4.5 <sup>a</sup> ±0.81	0.000

Note: Means followed by different letters (a, b, c) within the same row are significantly different ( $P < 0.05$ ) as determined by ANOVA using Sirichai Statistics software.



**Graph 01:** Formula Acceptability and Purchasing decision