

UTILIZATION OF LIME (*Citrus aurantifolia* (CHRISTM.) SWINGLE) SOLUTION FOR CLEANING FLOOR TILES BY HOUSEHOLDS IN IKWUANO LOCAL GOVERNMENT OF ABIA STATE

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ABSTRACT

This paper examined the ways households in Abia State utilize lime solution in cleaning tiles, the advantages and the challenges of using lime solution in cleaning tiles. Using survey methodology, the study adopted multistage sampling technique. The study used a 16-item questionnaire to gather information from 135 respondents drawn from two major clans in Ikwuano Local Government Area of Abia state. Findings indicated that lime solution is not only effective in cleaning tiles but also other household equipment, thereby making it a multipurpose cleanser. Again, lime solution is homemade and inexpensive, but more importantly, the study found that lime solution is environmentally safe as it contains non-toxic chemicals and also leaves tiles feeling refreshed and scented. The challenges however demonstrated that the preparation of lime solution is time consuming (81%) and it could be problematic to those who are allergic to citrus fruits (50%). The paper therefore concluded that in view of the efforts by governments, manufacturers, and relevant stakeholders to rid the environment of biochemical waste, lime solution is a viable alternative for cleaning tiles as it contains essential oil which makes it a potential cleaning composition for tiles, and further presents a better option for households who are in need of an efficient multipurpose cleaning agent. Hence, further investigation on ways to improve the solution such that it can be used on other floor types is recommended

Keywords: *Lime, tiles, cleaning, households*

INTRODUCTION

Lime (*Citrus aurantifolia* Swingle) is a small, round, green-color hybrid citrus fruit (Nagdeve, 2020) that is sought after by consumers in many countries for their unique flavour and acidity and also as a source of industrial and added-value food products (Bosquez-Molina *et al.*, 2004). There are several species of citrus fruits referred to as limes which include key lime, kaffir lime, wild lime, desert lime, and Persian lime. Lime finds its application in several products including cosmetic, cleaning and health products. Extracted from the lime's peel or skin, is the lime essential oil which is extensively used as cleaning agent, aromatherapy and perfumes. Predominantly known for its ascorbic acid reserves, lime provides 32 percent of the daily recommended intake of vitamin C (Nagdeve, 2020).

Lime is believed to have originated from South East Asia around 4000 BC and it is native to the Indo-Malayan region. It was assumed to have been carried to North Africa and the near east by the Arabs; and was taken by crusaders from Palestine to Mediterranean Europe. It was introduced to the Caribbean Island and Mexico by the Spaniards and readily became naturalized in the West Indies and Mexico (Morton, 2006). There are two groups of lime namely: low acid (sweet) and acid (sour) lime. Low acid lime (*Citrus limettoides* Tan.) cultivars such as ‘Indian sweet lime’ (also known as Palestine lime), which are popular for fresh consumption (Berry, 2003) and used for medicinal purposes; the acid (sour) cultivars including ‘West Indian’ or (‘Mexican’ or ‘Key’) lime (*C. aurantifolia* Swingle), which is small-fruited and the predominant type grown in the world, and the larger ‘Tahiti’ or ‘Persian’ lime (*C. latifolia* Tan.) (Berry, 2003). Both of these acid limes are consumed fresh and also used in food or flavour industries (Ubando-Rivera, Navarrp-Ocana, & Angeles, 2005). The juice of all acid limes provides a high-quality characteristic lime flavour and contains typical ‘lime-like’ aroma compounds, which are similar throughout most of the world. Lime has the sourest taste of all citrus fruits and is too acidic to be consumed as undiluted juice (Berry, 2003). However, lime juice is popular and is consumed in different styles such as in juice mixtures and carbonated or alcoholic beverages, or is used in salads or as a flavouring ingredient in dishes ranging from hot cooked foods to cold desserts. It is also used in pickling or with fresh fruits in syrup manufacture to protect against discolouration, and is used in medical applications (Ziena, 2000; Berry, 2003). Chaisawadi *et al.*(2003) reported that compounds from lime and its derivatives such as juice, skin and oil have a wide range of medicinal properties. They suggested that dalimonin, extracted from lime oil, has cancer-preventive and anti-carcinogenic properties. The distinctive natural lime aroma volatiles are also widely used in other industries. For example, the volatile fraction of lime oil, limonene, is used in cosmetics (e.g. perfumery ingredients) and household products such as soaps and detergents (Berry, 2003). Lime has been used to produce “homemade enzyme” solution which is very popular among housewives. It is believed to be able to act as a multipurpose cleaning agent and can be as effective as any other chemical detergent in the market. In addition, it has been used to partially substitute the household cleaning agent to do the clean up on tiles, dishes and the floor and some even use it to partially substitute facial cleanser and shampoo (Abazie, 2019). Hence this study intended to find out how households utilize lime solution in the cleaning of tiles, especially in view of the delicate nature of this sort of flooring.

The tiles industry is labour-intensive and contributes 0.95% to manufacturing gross domestic product (GDP) and 1.6% to manufacturing employment, giving it the potential to play an important role in economic development and job creation (Department of Trade and Industry, 2013 cited in Abazie, 2019). Tiles can last a very long time if taken care of properly; but, while it can last for centuries, it can etch and stain if not cared for, just as most other materials do. Tiles are a timeless choice for floors, kitchens, bathrooms, and more, and nothing ages a home prematurely like the look of cracked and worn tiles or grungy, discolored tile and grout; similarly, routine upkeep of tile grout is a great way to minimize health risks within the home. Scrubbing the grout destroys harmful bacteria living in the floor; hence, cleaning is important in preserving the beauty and condition of tiles. Like many aspects of homeownership, if neglected, the dust, dirt, and other

contaminants that stain tiles and grout can weaken the integrity of tile floors. This will make them to begin to discolor, fade, crack, lose their luster and shine, and generally wear down much more quickly than they would if they are cleaned properly. For cleaning tiles, acid cleaners are not suitable because they can damage enamel finishes (Firman, 2019). More suitable however, are general-purpose cleaners or scouring powders. Special tub and tile cleaners offer extra ingredients to aid in the removal of soap, and fatty deposits. Typical are a "combination of surfactants, complex chelating agents, solvents (ethanol, isopropanol, or glycol ethers), fragrances, and antimicrobial additives. The use of lime solution as a major cleaning agent for tiles cannot be over emphasized because, in recent time, manufacturers are concerned with the ability to produce products that are cost effective, efficient as well as environmentally safe. Manufacturers are preoccupied with the production of tile cleaning agents with non-toxic chemicals especially as tiles have become a popular household flooring material. Consequently, this study intended to ascertain the utilization of lime solution as a cleaning agent for tiles in Abia state.

OBJECTIVES OF THE STUDY

- i. To ascertain the ways by which households use lime solution in cleaning tiles
- ii. To identify the advantages and challenges of using lime solutions to clean tiles by households in the study area

RESEARCH QUESTIONS

- i. In what ways do households use lime solution in cleaning tiles?
- ii. What are the advantages of using lime solutions to clean tiles by households?
- iii. What are the challenges of using lime solutions to clean tiles by households?

LITERATURE REVIEW

Lime (*Citrus aurantifolia* Swingle) as a Cleaning Agent

According to Nagdeve (2020), lime as a cleansing agent easily increases the cleansing properties of any facial cleanser or shampoo by merely adding two to three drops of its juice. Lime is also used in cosmetic products like body oil, hair oil, toothpaste, beauty soap, disinfectant, mouthwash, and deodorant. Because of their antibacterial, antiseptic, and disinfectant properties, the peel, oil, and juice of the fruit have medicinal uses. Lime essential oils which are obtained from the peels are also a component for the pharmaceutical industry for the preparation of drugs, soaps, perfumes, hair cream, body oil and other cosmetics as well as for home cleaning products (Ferguson, 1990). *C. aurantifolia* juice and sometimes fruit peels are combined with vinegar to produce disinfectant; it is combined with salt to clean copper pot. It is used to polish brass, aluminum and copper. It is combined with peroxide or used alone to bleach cloth, remove ink, rusty and mineral stains from cloths; whitening tannin shoe and soften fabrics (Ferguson, 1990). Furthermore, *C. aurantifolia* fruit peels have been found very useful domestically. In a study by Li-Yun, Cheng-Hung, Hsin-Chun and Kai-Min (2019) on lime (*Citrus aurantifolia* Swingle) essential oils, it was found that essential oils and oleoresin were found in citrus peels and produced by the cells within the rind, the bulk of which were mainly obtained as byproducts of the juice manufacturing industry (Jantan et. al., in Li-Yun, et. al., 2019). The study identified 60 volatile compounds of lime essential oil

(LEO) with GC/MS, of which the predominant constituents were limonene, γ -terpinene, and β -pinene. UK Cleaning Product Industry Association (UKCPI) (2015) explains that limonene is a naturally occurring compound found mainly in the skin of certain plants and fruits, including lemons and oranges. It is used in cleaning products for two reasons: it has a pleasant, lemon-orange smell, and it acts as a solvent to help clean. UKCPI (2020) further observes that peeling orange releases orange oil into the air while orange oil is 90% limonene. Found in a vast array of cleaning products, cosmetics, food flavourings and even aromatherapy, Limonene comes in two forms: d-limonene and l-limonene. The d-limonene form is used in food-grade products, as well as cleaning and beauty products, and is prized mainly for its smell. It is also used in hospital laboratories when cleaning tissue samples for analysis. On the other hand, the l-limonene version has a more pine-like scent but is used mainly as a solvent in industrial cleaning products. In a study by Idoko, (2019), he observes that d-Limonene is an important additive to cleaning products in the preparation of hand cleansers to give a lemon-orange fragrance. Limonene is reported to be used as a paint stripper, as a constituent of some paints and used as an alternative fragrance to turpentine (Idoko, 2019). Lime is used for bathing and washing of hair, and also, used as a deodorizer to freshen up smelly garbage and composite pile. It also acts as natural room freshener (Effiom, Avoaja, Ohaeri, 2012). In the opinion of Martinko (2018), lemons, limes and oranges are great for cleaning, especially when combined with basic household products like vinegar and baking soda. This is because citrus contains d-limonene, a natural solvent that cuts through grease and dirt, and leaves a house smelling fresher than ever. Parke (2017) notes that, limes with their high acidity levels and ability to combat bacteria is the most common fruit used in household cleaning. For removing rust for example, Parke (2017) writes, “put salt on the rust, then squeeze the lime juice over the salt and rust. Allow this solution to work for two to three hours and then scrub the area with the lime rind to remove the rust.” Parke further notes that limes may also replace vinegar in homemade cleaning solutions as a lime based formula can cut through grease and hard water build up. Lime based solution combined with six (6) drops of lime essential oil, borax, vinegar, and cups of hot water can be used for general cleaning purposes (Parke, 2017). Also, Marty (2020), states that limes, like lemons, seem to have an endless usefulness as they are used in culinary dishes, staples of the men’s fragrance industry, and in powerful cleaners. Limes feature a distinctive fragrance that is sharp and refreshing but specifically, lime oil offers cleansing properties that can help keep a home healthy as well as the skin. Lime oil is extracted from the peel of the lime by cold pressing fresh lime peels or through steam distillation of dried lime peels. In modern times, lime oil is cultivated mainly in Italy, Africa, and the Americas. Marty (2020), asserts that lime essential oil boosts antibacterial and antimicrobial properties that help to prevent bacterial infection and this is a plus for its disinfectant abilities. Another study published in the Journal of Essential Oil Research demonstrated that sabinene showed antibacterial activity against both gram-positive and gram-negative bacteria. The compound was effective in the complete elimination of *Staphylococcus aureus* and *E. coli* bacteria. A study published in Poultry Science found that linalool—a major component of lime oil—is an effective insecticidal and antimicrobial compound. Linalool is also responsible for the slightly sweet fragrance of lime essential oil. This chemical compound was also shown to have antifungal properties that can boost immune health. As a

disinfectant, lime essential oil helps to disinfect surfaces and clean the home. Its refreshing fragrance boosts added cleansing properties by freshening air and making the home smell amazing. Researchers found that lime oil can be combined with vinegar to clean copper cookware and to polish brass, and aluminum. It also effectively bleaches clothing, removes ink, and mineral stains from clothing when mixed with peroxide (Marty, 2020). Giving an example of this, Marty adds that lime oil can be used just like lemon oil to clean surfaces in the home by adding twenty (20) drops of lime oil to a large mop bucket filled with warm water. The lime oil also works to restore wood surfaces, making wood floors gleam and shine. Accordingly, “by adding for instance, twenty (20) drops of lime essential oil and twenty (20) drops of lemon essential oil to a large spray bottle filled to the top with distilled water, you spray the surfaces with the oil and let it sit for five (5) minutes before wiping it clean with a damp towel to get a wonderful result.” In order to remove grease spots on clothing with lime essential oil, a simple addition of three (3) drops to a cotton pad or cotton ball and gently dabbing the grease spot or letting the cotton pad sit for two (2) to three (3) minutes removes the grease. The process can however be repeated if after rinsing, the stain remains. Similarly, Marty (2020) notes that in cases where there is a stubborn sticker on a glassware or cookware, lime oil can take such stickers and sticker residue off by simply mixing two (2) drops of lime essential oil with two (2) drops of coconut oil. A person then proceeds to rub the spot in firm, circular motions until the sticker is gone. After this, the spot should be wiped clean with a damp cloth. Lime essential oil as a natural astringent, helps to remove oil and dirt that can clog pores and cause acne. The astringent nature of this oil also helps to tighten pores, reducing their appearance. For instance, an addition of two (2) drops of lime essential oil to a face wash cleanses and purifies skin. This implies that the addition of lime to a cleaning product can work well against bacteria, mold, and other organic matter. Moreover, lime can break down and remove mineral build-up. This is why most cleaning agents for metal, dishwasher, bathroom, oven, carpet, window, tiles, and dish cleaners all tend to have citric acid as an active agent. As regards the preparation of lime solution, the materials needed according to Abazie (2019) include: Lime peels (can be a combination of navel lime and clementine), distilled white vinegar, water (optional), airtight glass container, a strainer, and a spray bottle. To prepare the solution, the first step that is required is the collection of lime peels which will be stored in an airtight glass container. Secondly, once the container is full, one is required to cover the peels with white vinegar and date the jar. Next is to allow the solution to sit for about 2 weeks (when ready, the vinegar should have a strong citrus odor and be yellowish in color). Lastly, is to strain the peels and dilute with water if one so desire; the concentration depends on the intended use and preference.

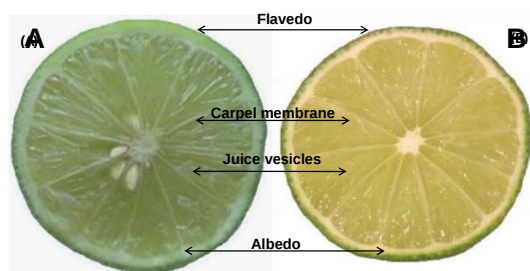


Fig. 1 Cross section of lime fruit (A) Mexican lime and (B) Persian

METHODOLOGY

This study adopted the survey method while the sample size was made up of 150 respondents. Of the 150 persons selected, 135 responses were gathered. The multi-stage sampling technique was used. Basically, Ikwuano Local Government Area in Abia Central Senatorial district of Abia state is made up of four major clans: Ibere, Oboro, Ariam-Ushaka and Oloko. In the first stage, simple random sampling was used to select two clans out of the four clans. To avoid being biased, the names of the clans were written, squeezed and put in a basket and the researcher randomly picked Oboro and Ariam-Ushaka. From the two clans comprising thirty five villages, fifteen villages (from Oboro - 9 and Ariam-Ushaka - 6) were selected, while in the third stage, five households were selected from each village for the distribution of the questionnaires.

Measurement of Variables

Questionnaires were used to collect data for the study. The questionnaires which were used to measure the variables contained only closed-ended questions which were mainly likert type of questions. Furthermore, the data gathered were analyzed quantitatively using frequency counts, means and percentages. The benchmark for weighted mean is 3.00. However, each research question has a grand mean of responses from the respondents which determines acceptance or rejection.

RESULTS AND DISCUSSION

Results in Table I show that 77.7% of the respondents were within the age bracket of 25-34, 14.07 % were within the age limit of 35 – 44; however, respondents within the age bracket of 45 and above constituted 8.1%. From the table, majority of the respondents were within the age bracket of 25 to 34. Also from the table, majority of the respondents constituting 60.7% were married, 24.4% of the respondents were single while 14.8% were neither married nor single. The table further indicates that 2.2% of the respondents had Ordinary Level certificates, 40% had between Ordinary National Diplomas and National Certificate of Education; 6.7% did not have formal education, while the majority (51.1%) of the respondents had degrees.

Table I: Personal Characteristics of Respondents

Characteristics	Frequency	Percent
Age		
25 – 34years	105	77.7
35 – 44 years	19	14.07
45 years – and above	11	8.1
Marital Status		
Single	33	24.4
Married	82	60.7
Others	20	14.8
Educational Level		
O' Level	9	6.7
OND/NCE	54	40
Degree	69	51.1
No formal education	3	2.2

Table II demonstrates the ways by which respondents use lime solution. Accordingly, the mean values indicate that the sum of 3.3 respondents agreed that lime solution allows for the addition of other essential oils including fresh aromatic, antiseptic herbs. The examples given by respondents include lavender, rosemary, thyme, sage, or mint and this deters ant and mice in addition to giving off a fresher smell. Also, the sum of 3.4 shows that respondents agreed that using warm water with the lime solution enhanced killing of germs. They added that they usually allow the solution to sit for some time on the surface to enable it reach its full antimicrobial potential, before rinsing or wiping the surface; while for deeper cleansing and stain removal, the solution is allowed to sit for up to ten minutes, and sometimes, up to an hour as an easy way to fight mold and mildew on the bathroom tile. However, when it comes to the frequency of usage, the sum of 2.5 respondents agreed to using lime solution often. This implies that the level of usage is low. The findings above are in line with Marty (2020) who stated that lime essential oil helps to prevent bacterial infection because of its disinfectant abilities.

TableII: Ways by which Households Used Lime Solution in Cleaning Tiles n= 135

S/N	Ways	SA F(%)	A F(%)	SD F(%)	D F(%)	Total	Mean
1	Spraying or dispensing lime solution from buckets on to the tiles.	79 (59)	30 (22.2)	9 (6.6)	17 (12.6)	135	3.3
2	Mixing lime solution with other essential oils or herbs to increase it aromatherapy and fresher scent.	84 (62.2)	25 (18.5)	12 (8.8)	14 (10.4)	135	3.3
3	Using warm water with the lime solution to enhance killing of germs	88 (65.2)	24 (17.8)	18 (13.3)	5 (3.7)	135	3.4
4	We use lime solution often	57 (42.2)	13 (9.6)	39 (28.9)	26 (19.3)	135	2.7

Grand Mean = 3.2

In Table III, the sum of 3.4 respondents agreed that lime solution is not only effective in cleaning tiles but also other household equipment like kitchen counters, sinks, shower, toilets, bathtub, stainless steel appliances, inside the fridge, and other durable, sealed surfaces. It is also used to remove unwanted odors, such as egg smell, garlic and onion odor and flavor from cutting boards. Again, the sum of 3.3 concurred that lime solution is homemade, inexpensive, and does not constitute a complex process while 3.4 acknowledged that the materials needed to prepare lime solution are accessible. The sum of 3.3 admitted that lime solution is environmentally safe as it contains non-toxic chemicals the same way the sum of 3.4 accepted that lime solution is effective in cleaning tiles because lime and vinegar both have active antiseptic potentials. In like manner,

the sum of 3.3 agreed that lime solution leaves tiles feeling refreshed and scented, even as they added that lime solution provides adequate protection because of its antimicrobial and antibacterial properties. These findings are in agreement with the submission of Abazie (2019) that lime has been used to produce “homemade enzyme” solution which is able to act as a multipurpose cleaning agent and can be as effective as any other chemical detergent in the market. The findings further support the position of Effiom, *et. al*, (2012) that lime is used for bathing and washing of hair, and also, used as a deodorizer to freshen up smelly garbage and composite pile and also as natural room freshener.

Table IV: Advantages of Using Lime Solution to Clean Tiles by Households n = 135

S/N	Advantages	SA F (%)	A F (%)	SD F (%)	D F (%)	Total	Mean
1	Lime solution is effective in cleaning tiles and can also serve as a multipurpose cleaning agent.	91 (67.4)	19 (14.1)	8 (5.9)	17 (12.6)	135	3.4
2	Lime solution is homemade, inexpensive, and does not constitute a complex process.	84 (62.2)	22 (16.3)	20 (14.8)	9 (6.7)	135 (50)	3.3
3	Materials needed to prepare lime solution are easily available and accessible	83 (61.5)	24 (17.8)	8 (5.9)	16 (11.9)	135	3.4
4	Lime solution is environmentally safe as it contains non-toxic chemicals.	98 (72.6)	13 (9.6)	16 (11.9)	12 (8.8)	135	3.3
5	Lime solution is effective in cleaning tiles because lime has active antiseptic potentials like vinegar	72 (53.3)	49 (36.3)	9 (6.7)	5 (3.7)	135	3.4
6	It leaves tiles feeling refreshed and scented.	74 (54.8)	40 (26.6)	13 (9.6)	8 (5.9)	135	3.3

Grand Mean = 3.4

In Table IV, there is a twist as the mean sum of 2.7 respondents disagreed that storage of lime peels is quite challenging as peels can develop molds if not properly stored. The sum of 3.3 respondents said that gathering the lime peels and buying the right kind of white vinegar can prove difficult, just as a much larger figure (3.4) agreed that the preparation process of lime

solution is time consuming as it requires monitoring and waiting for up to three weeks to encourage infusion. Meanwhile, the sum of 2.7 respondents indicated that the preparation of lime solution can be problematic to those allergic to citrus fruits. This is in support of the assertion by Marty (2020), that lime oil can cause skin irritation in sensitive individuals because like most citrus oil, lime oil is photosensitive. She notes that chemical compounds in lime oil speed up the burning process and sun exposure can cause sun blisters or severe burns.

Table IV: Challenges of Using Lime Solutions to Clean Tiles by Households n = 135

S/N	Challenges	SA F (%)	A F (%)	SD F (%)	D F (%)	Total	Mean
1	Storage of lime peels is quite challenging as peels can develop molds if not properly kept.	42 (31.1)	37 (27.4)	36 (26.7)	20 (14.8)	135	2.7
2	Gathering lime peels and sometimes, getting the right kind of white vinegar is difficult.	84 (62.2)	22 (16.3)	20 (14.8)	9 (6.7)	135	3.3
3	Production of lime solution is time consuming as it requires monitoring and waiting for up to three weeks to encourage infusion.	98 (72.6)	13 (9.6)	8 (5.9)	16 (11.9)	135	3.4
4	Preparation of lime solution can be problematic to those allergic to citrus fruits.	42 (31.1)	37 (27.4)	30 (22.2)	26 (19.3)	135	2.7

Grand Mean = 3.0

CONCLUSION

In conclusion, this study found that in the course of preparation, lime solution allows for the addition of other essential oils including fresh aromatic, antiseptic herbs. The examples given by respondents included lavender, rosemary, thyme, sage, or mint. Also, the use of warm water with the lime solution enhances the killing of germs especially if the solution is allowed to sit for some time on the surface to enable it reach its full antimicrobial potential. However, the level of usage among the people of Ikwuano is still very low. Similarly, the study found that lime solution is not only effective in cleaning tiles but also other household equipment, thereby making it a multipurpose cleanser. Again, lime solution is homemade and inexpensive, but more importantly, the study found that lime solution is not only environmentally safe as it contains non-toxic chemicals but it also leaves tiles feeling refreshed and scented. Conversely, the study discovered that the storage of lime peels is quite challenging as peels can develop molds if not properly stored. In the same vein, buying the right kind of white vinegar can prove difficult, just as the preparation

process of lime solution can be time consuming and also problematic to those allergic to citrus fruits.

Thus, in view of the above findings as well as the efforts by governments, manufacturers, and relevant stakeholders to rid the environment of biochemical waste, lime solution is therefore a viable alternative for cleaning tiles. Lime contains antiseptic properties which makes it a potential cleaning composition for tiles since the main purpose of cleaning is to achieve a durable and bacteria free environment hence, lime solution presents a better option for households who are not only concerned about an efficient cleaning agent that can serve for multipurpose uses, but one that leaves the tiles freshly scented and nice.

RECOMMENDATIONS

In line with the findings of this study, the following recommendations suffice:

- i. There is need for policies that promote and support the use of lime as an important agent for cleaning in homes. This could be in form of awareness creation and educational programmes to promote lime consumption. Such should be based on local knowledge regarding the demographic and socio-cultural factors that may affect consumer choice.
- ii. Attention should focus on the processing of lime into forms that can be stored.
- iii. It is also recommended that further studies should be carried out on ways to improve lime solution such that its cleaning abilities can be extended to other floor types like marbles and other sensitive stone surfaces.

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