EFFECTIVENESS OF FOOT ODOR CONTROL SPRAY CONTAINING ESSENTIAL OIL FROM POMELO (CITRUS MAXIMA) PEEL

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ABSTRACT

This study a quasi-experimental research design to evaluate the effectiveness of a foot odor control spray containing essential oil extracted from pomelo peel. The research was conducted from February to April 2024, involving 30 specifically selected volunteers aged 20 to 59. Participants used the foot odor control spray at home over a period of seven days and completed a questionnaire afterwards. The questionnaire consisted of two parts: the first gathered general information, and the second assessed satisfaction with the product after use.

The data analysis involved descriptive statistics, which include counts, percentages, means, and standard deviations. The results from the returned questionnaires of all 30 participants, representing a 100% response rate, show that the overall effectiveness of satisfaction with the product's characteristics were rated as high ($\bar{x}$=4.38, SD=0.54). In terms of specific effectiveness of satisfaction aspects, the highest satisfaction was reported for the drying time ($\bar{x}$=4.53, SD=0.62). Product characteristics that achieved high levels of satisfaction include ease of use ($\bar{x}$=4.43, SD=0.62), product scent ($\bar{x}$=4.40, SD=0.62), gentleness and absence of irritation ($\bar{x}$=4.40, SD=0.56), efficiency in odor control after use ($\bar{x}$=4.36, SD=0.76), moisturization after use ($\bar{x}$=4.30, SD=0.65), and spray dispersion ($\bar{x}$=4.23, SD=0.56), respectively. This study clearly demonstrated the potential foot odor control spray plant products, Pomelo (*Citrus maxima*) Peel that could be useful in research and development of new natural compounds for controlling foot odor.

Keywords: Foot odor control spray, Essential oil, Pomelo peel

INTRODUCTION

Foot odor, or bromodosis, is an undesirable condition resulting from the accumulation of sweat and bacteria in individuals with severe foot odor. This condition is closely associated with an increase in bacteria and is a primary factor affecting the levels of isovaleric acid, leading to unpleasant smells. The factors contributing to severe foot odor are divided into internal and external factors. Internal factors include hyperhidrosis (excessive sweating), dietary choices, and certain medications. High consumption of strong-smelling foods, spicy foods, and external factors such as environmental conditions and weather also play a role Chuabprasit et al., (2023). Pitted keratolysis, a condition characterized by crater-like depressions on the skin's surface accompanied by odor, is common in occupations requiring prolonged wearing of occlusive footwear, such as high-top shoes and boots. This environment

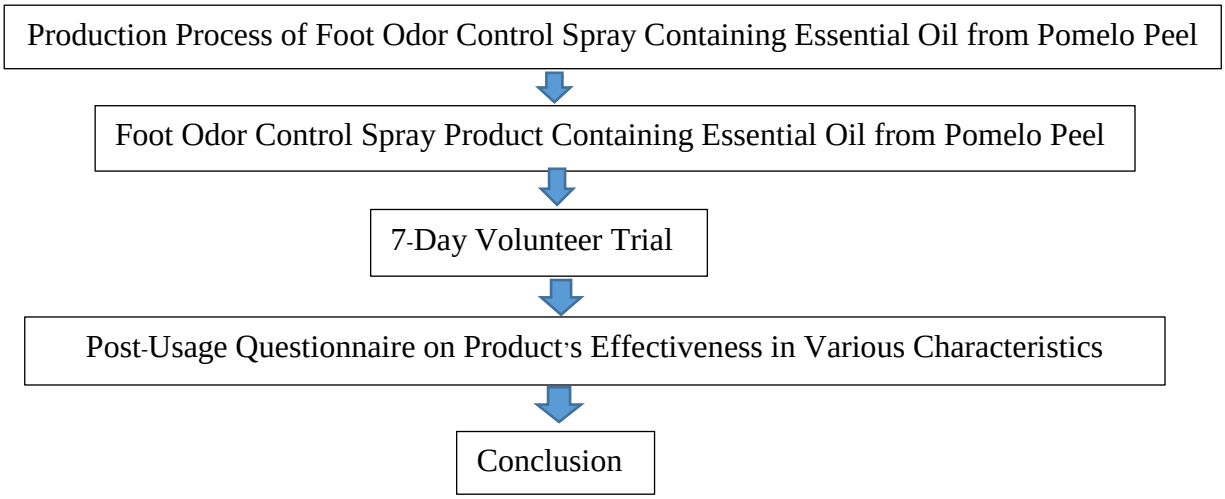
fosters bacterial growth and subsequent foot odor. It is often observed among certain professionals like military personnel, runners, athletes, farmers, fishermen, and industrial workers Bunyaratavej et al., (2015).

Currently, foot odor remains a significant daily life issue, particularly in Thailand's tropical climate, which is conducive to sweat accumulation and humidity. This environment fosters the growth of skin-native bacteria, leading to infections. For over 90 years, foot odor has been linked to moist skin combined with organic foot debris or sweat, potentially leading to infections by bacteria such as *Micrococcus sedentarius*, resulting in significant odor. The most common symptom, occurring in 90% of cases, is a strong foot odor. About 80% of individuals experience moisture when removing socks, and 70% report itching, highlighting the need for products and methods to boost confidence and hygiene for individuals and their surroundings Leeyaphan (2017). Effective prevention includes regular foot washing and drying before wearing shoes to prevent moisture accumulation, a breeding ground for bacteria and fungi. Various products like roll-on deodorants, sprays, powders, and dry sticks are available to address foot odor with sprays being particularly popular for their convenience and quick-drying properties. Research both within Thailand and internationally focuses on production processes and ingredients for antiperspirant sprays, which often contain aluminum salts, potentially causing irritation (Pharmabeautycare, 2022). The use of antibacterial sprays derived from natural extracts presents an appealing alternative for individuals dealing with foot odor, as a substitute for synthetic chemicals. Research has indicated that extracts from the peels of citrus family plants contain key polyphenolic compounds such as catechins, epicatechin, procyanidins, and flavones, which possess properties capable of inhibiting microbial growth Dosoky et al., (2018). These citrus peels vary in their content of various substances, particularly phenolic compounds like ferulic, sinapic, coumaric, and caffeic acids Elkhatim et al., (2018). Pomelo is a key economic crop widely consumed and extensively cultivated in the province of Samut Songkhram. According to the Samut Songkhram Provincial Public Relations Office, pomelos are a highly demanded fruit by consumers and farmers in the area. Pomelo cultivation began in the year 1932 when farmers started planting seeds from consumed fruits. The high quality of the yield led to the expansion of cultivation to the present day. Currently, there are approximately 12,679 acres of pomelo orchards, with about 11,800 acres producing fruit (Department of Samut Songkhram Public Relations, 2022). But there are consequences, Pomelo peel, which are waste materials from agriculture that are abundant. There is a problem of waste from pomelo peel amounting to more than a hundred tons each year. In Samut sakhon area, goal programming is used to determine the goal according to the concept of sustainable agriculture. The goals are the highest average net return with lowest environmental impact quotient from the use of agricultural chemicals and the lowest working hours of labors Niemmanee and Phonphan (2020). In this study, the research team is interested and sees the benefits of pomelo peel is the alternative method to decrease waste materials from agriculture. To evaluate the effectiveness of a foot odor control spray containing essential oil extracted from pomelo peels in suppressing unwanted odors. Value by applying it to extracting essential oils from peel to use as ingredients in natural products.

RESEARCH OBJECTIVES

1. To study the production process of a foot odor control spray containing essential oil from pomelo peel.
2. To investigate the effectiveness of a foot odor control spray containing essential oil from pomelo peel.

Figure 1 Research Framework



RESEARCH METHODOLOGY

Research Design: Quasi-Experimental Research. Data collection period: February - April 2024.

Research Population: General population experiencing foot odor.

Sample Group for the Research: Individuals with foot odor issues from the Baan Eua Arthorn Maeklong housing project in Bangkaew sub-district, Mueang district, Samut Songkhram province. Total of 30 participants.

Due to the inability of the researcher to study the product with the entire population, volunteers who are representative of the target population must participate in the research project.

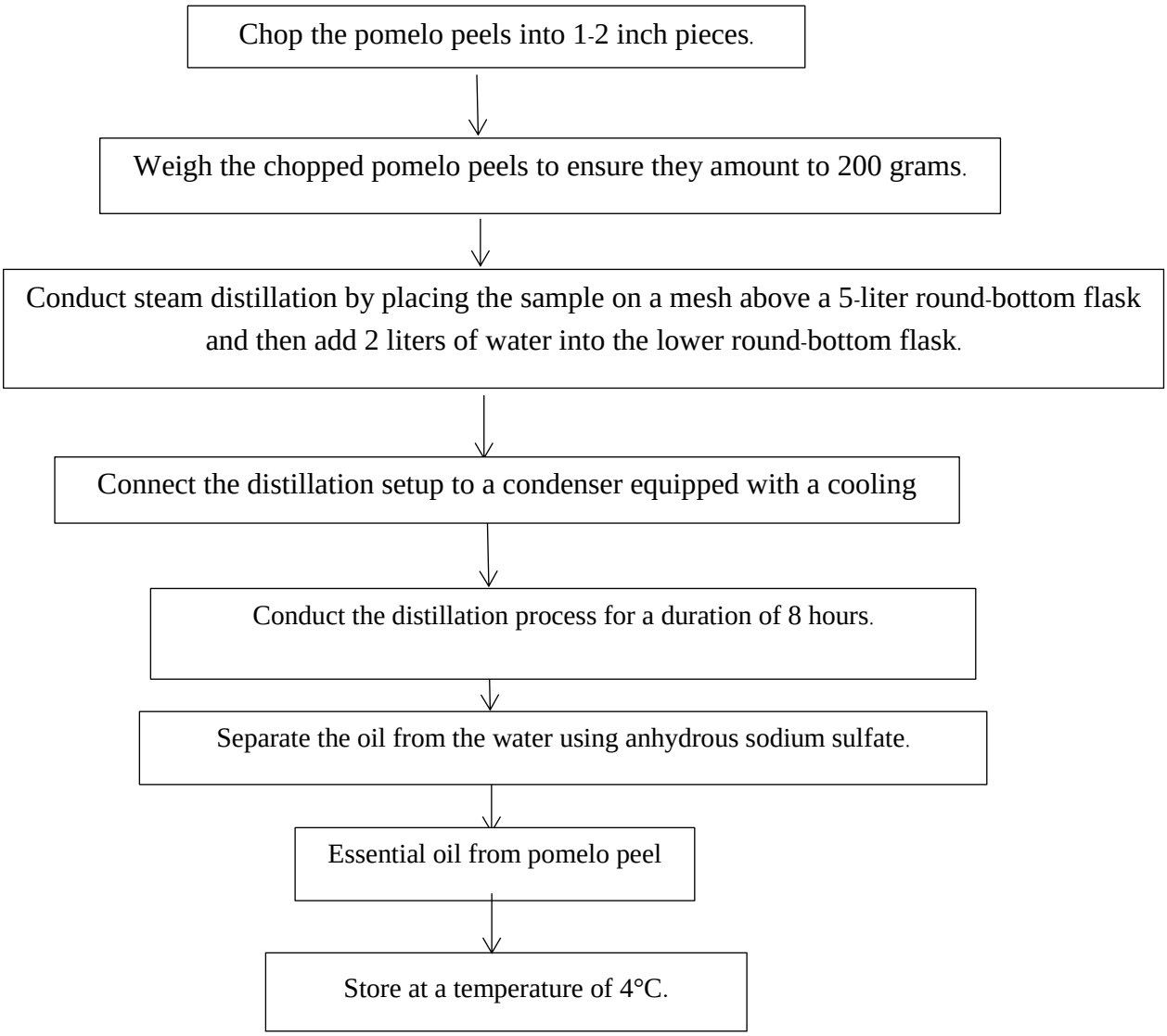
1. Criteria for Inclusion: Characteristics of Participants to be Selected for the Research Project**

1.1 Either male or female
1.2 Aged between 18-50 years
1.3 Experiencing issues with foot odor
1.4 Willing to participate in the research
1.5 In good physical health
1.6 No irritation or allergic reactions to the skin after using the foot odor control spray

2. Criteria for Exclusion: Characteristics of Participants to be Excluded from the Research Project

2.1 Unable to participate in all activities of the project
2.2 Does not have a problem with foot odor
2.3 Chooses to withdraw from the research project
2.4 Has chronic diseases
2.5 Experiences irritation or allergic reactions to the skin after using the foot odor control spray

Figure 2 Method of extracting essential oil from pomelo peel using steam distillation



Source: Sukatta et al., (2010)

Figure 3 Pomelo (*Citrus maxima*) Peel oil from pomelo peel

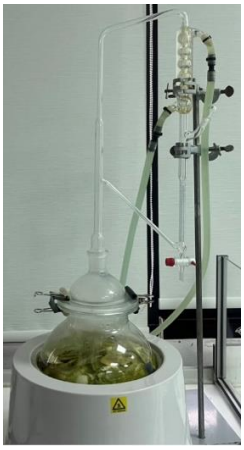


Figure 4 Steam distillation

Figure 5 Essential

Table 1 Components of products that can be developed of a foot odor control spray containing essential oil from pomelo peel.

No	Material	Properties	Percent
1	Pomelo essential oil	Anti-bacterial and clean fragrance.	0.5
2	Menthol	Provides a cool, refreshing feeling.	5
3	Camphor	Gives a cool, fragrant sensation.	5
4	Aloe vera	Moisturizes the skin, making it smooth and firm.	3
5	Propylene glycol (PG)	Moisture-retaining agent	5
6	D-panthenol	Restores dry skin to become smooth and elastic, inhibits inflammation, and helps reduce skin irritation.	1
7	α - Bisabolol	Reduces inflammation and irritation, redness, and itching on the skin.	0.5
8	Ethanol	Solvent used in cosmetics manufacturing.	62
9	Distilled water	Solvent	18

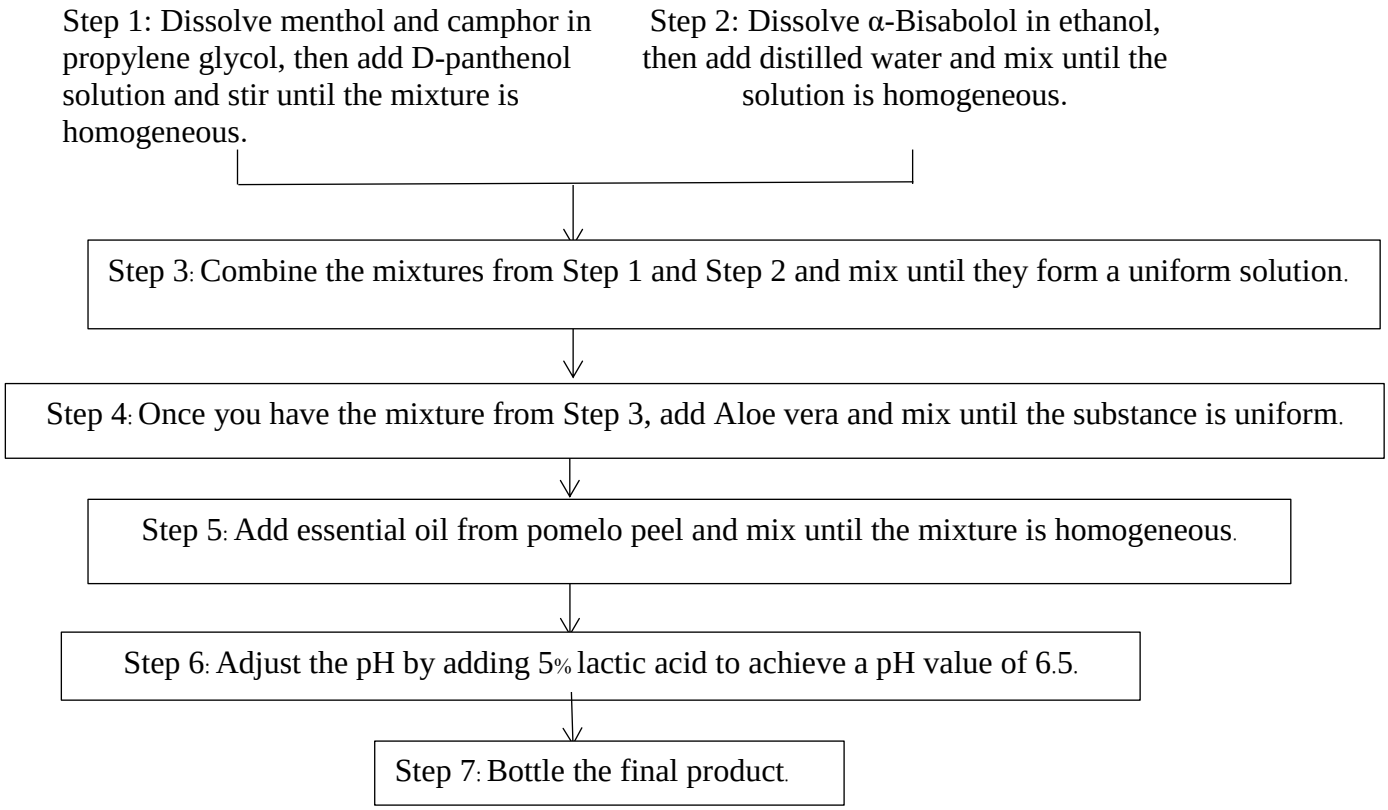


Figure 6 Production process of foot odor control spray containing essential oil from pomelo peel

Source: Adapted from the formula by Ditnoi et al., (2013)

Figure 7 A foot odor control spray containing essential oil from pomelo peel

Figure 8 Bottle the final product 30 ml

Research location

At the Laboratory of the Science and Technology Service Center, College of Allied Health Sciences, Suan Sunandha Rajabhat University, Samut Songkhram Campus.

Statistical Analysis

The experimental results were analyzed using methods to compare differences between means, counts percentages and standard deviations utilizing SPSS software version 28.0.

Human Research Ethics

This research project has been reviewed and approved by the Human Research Ethics Committee of the Institute of Research and Development at Suan Sunandha Rajabhat University on November 14, 2023, with Certificate Number: COA.1-073/2023.

RESEARCH RESULTS

Preparation of essential oil from pomelo peel

Preparations of pomelo peel extracts by using steam distillation provided essential oils with yields and physical characteristics. For isolation of *Citrus maxima*, generated the liquid oils with yields of 2.63% according to dry weight (v/w). These distillate oils were less dense than water, clear and colorless, with characteristic odors

Table 2 The results present the analysis of percentages and general data on the behaviors and needs of consumers regarding the foot odor control spray product (n = 30 participants).

General Information	Number (Person)	Percentage
1. Gender		
Male	16	53.3
Female	14	46.7
2.Age		
Below 20 years	2	6.7
21-40 years	19	63.3
41-59 years	9	30.0
3. Income		
Lower than 5,000 Baht/Month	6	20.0
5,001 – 10,000 Baht/Month	3	10.0
10,001 - 15,000 Baht/Month	11	36.7
15,001 – 20,000 Baht/Month	6	20.0
More than 20,001 Baht/Month	4	13.3

From number, percentage, general information about behavior and consumer demand for foot odor spray products found that the majority of the participants were male, totaling 16 individuals, representing 53.3% of the sample. Females made up 14 participants, accounting for 46.7%. The age group most represented was 21-40 years, with 19 individuals or 63.3% of the sample, followed by the 41-59 years age group, which included 9 individuals or 30%. The least represented age group was under 20 years, with 2 individuals making up 6.7%.

In terms of income, the majority earned between 10,001 - 15,000 THB per month, consisting of 11 individuals or 36.7%. This was followed by those earning less than 5,000 THB per month and those earning 15,001 – 20,000 THB per month, each group containing 6 individuals or 20%. Those earning more than 20,001 THB per month comprised 4 individuals or 13.3%. The group earning between 5,001 - 10,000 THB per month was the smallest, with 3 individuals or 10%.

Table 3 The average consumer preference scores for various characteristics of the foot odor control spray containing essential oil from pomelo peel after Use (n = 30 participants)

Characteristic	($\bar{x}$)	(S.D.)	Interpretation
1. Product Scent	4.40	0.62	High
2. Spray Dispersion	4.23	0.56	High
3. Drying Time	4.53	0.62	Highest
4. Moisturization After Use	4.30	0.65	High
Total	4.36	0.47	High

Mean ($\bar{x}$) and Standard Deviation (S.D.) of the test of the foot odor control spray containing essential oil from pomelo peel after use indicate that the overall mean ($\bar{x}$) is 4.36 with a standard deviation (S.D.) of 0.47, categorized as high. The analysis of individual attributes shows that the highest mean ($\bar{x}$) is for the drying time, at 4.53 with a standard deviation (S.D.) of 0.62, rated as very high. This is followed by the product scent, with a mean of 4.40 and a standard deviation (S.D.) of 0.62, also rated as high. Moisturization after use has a mean ($\bar{x}$) of 4.30 with a standard deviation (S.D.) of 0.65, rated as high. The lowest mean ($\bar{x}$ is for spray dispersion, at 4.23 with a standard deviation (S.D.) of 0.56, still rated as high.

Table 4 The level of consumer satisfaction with the product for the foot odor control spray containing essential oil from pomelo peel after use (continued) (n = 30 participants)

Characteristics of the Product	($\bar{x}$)	(S.D.)	Interpretation
1. Efficiency in odor control after use	4.36	0.76	High
2. Ease of use of the product	4.43	0.62	High
3. Gentleness and non-irritation	4.40	0.56	High
Total	4.40	0.62	High

From Table 4.6, the mean ($\bar{x}$) and standard deviation (S.D.) for the characteristics of the foot odor control spray containing essential oil from pomelo peel after use indicate an overall mean ($\bar{x}$) of 4.40 with a standard deviation (S.D.) of 0.62, categorized as high. Detailed analysis of each attribute shows that the highest mean ($\bar{x}$) is for the ease of use of the product, at 4.43 with a standard deviation (S.D.) of 0.62, rated as high. Following this, the gentleness and non-irritation of the product have a mean ($\bar{x}$) of 4.40 with a standard deviation (S.D.) of 0.56, also rated as high. The lowest mean is for the efficiency in odor control after use, with a mean ($\bar{x}$) of 4.36 and a standard deviation (S.D.) of 0.76, rated as high.

SUMMARY AND DISCUSSION OF RESULTS

Discussion of the research on the development of foot odor control spray containing essential oil from pomelo peel:

Part 1: The development of the foot odor control spray was successful and consistent with the research hypothesis. The product developed with pomelo peel essential oil was found to be effective, offering a pleasant scent and sufficient volatility for odor control. This aligns with research on the efficiency of lemon and tea tree scents, which are known for their pleasant aromas and effective odor control properties, as documented by rissa Ditnoi (2013).

Part 2: Satisfaction after using the foot odor control spray containing essential oil from pomelo peel. Descriptive statistics were used to analyze the data, including counts, percentages, means, and standard deviations. The results from the returned questionnaires of all 30 participants, representing a 100% response rate, show that the overall effectiveness of satisfaction with the product's characteristics were rated as high ($\bar{x}$=4.38, SD=0.54). In terms of specific effectiveness of satisfaction aspects, the highest satisfaction was reported for the

drying time ($\bar{x}$= 4.53, SD= 0.62). Product characteristics that achieved high levels of satisfaction include ease of use ($\bar{x}$=4.43, SD=0.62), product scent ($\bar{x}$=4.40, SD=0.62), gentleness and absence of irritation ($\bar{x}$=4.40, SD=0.56), efficiency in odor control after use ($\bar{x}$=4.36, SD=0.76), moisturization after use ($\bar{x}$=4.30, SD=0.65), and spray dispersion ($\bar{x}$=4.23, SD=0.56), respectively.

In conclusion, Essential Oil from Pomelo (*Citrus maxima*) Peel with potential anti-bacteria efficacy and could be an advantage candidate for further research and development of new natural substance for controlling unpleasant smell.

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