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Article

The Effect Wilting Tangerine Peel on Characteristics of Powder used in Food Self-Heater

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Abstract

A food self-heater is a device designed to rapidly heat food by the utilization of exothermic or endothermic reactions. To yet, a food self-heater with a dedicated scent feature has not been developed. The fragrance utilized is derived from residual tangerine peel components. The objective of this study is to investigate the variations in the concentration of the limonene compound in essential oil extracted from tangerine peel, specifically examining the impact of tangerine peel wilting. Additionally, the study intends to identify the most effective food self-heating method by incorporating tangerine peel powder as an aromatic component in the self-heating process. The present study employed a Completely Randomized Design (CRD) consisting of five treatments and three replications. The treatments employed in this study encompassed varying durations of withering time for tangerine peel, denoted as A (0 hours), B (6 hours), C (12 hours), D (24 hours), and E (48 hours). The research findings indicated that the duration of drying tangerine peels had a notable impact on various factors including water content, yield, pH, color, duration for the aromatic self-heating meal to attain the optimal temperature, and aroma. However, no significant influence on limonene levels was seen. Based on the duration required for the aromatic food self-heater to attain the optimal temperature and the organoleptic aroma, treatment D (24-hour withering of tangerine peel) demonstrates the highest efficacy. This treatment exhibits a time frame of approximately 4.5 minutes for the aromatic food self-heater to reach the optimum temperature, accompanied by a fragrance rating of 4.2 in the organoleptic analysis.

INTRODUCTION

A food self-heater is a device designed to rapidly heat food by utilizing exothermic or endothermic reactions. In general, culinary items intended for cooking or heating are placed into a receptacle that houses a heating element. Subsequently, introduce water into the receptacle housing the heating package and the meal, until a rise in temperature is observed, at which point the food will undergo the process of cooking or become heated. Food self-heaters are constructed based on the fundamental principle of exothermic reactions. These devices often incorporate a combination of metal and water, resulting in the generation of hydrogen gas (H2). In the context of food, scent can serve as a stimulant for appetite enhancement. To date, there has been a lack of food self-heating devices that have a distinct aroma.

Plants that synthesize essential oils, such as cloves, cinnamon, pepper, nutmeg, and various others, have the ability to generate aromatic chemicals. In the context of economic value, it is more advantageous to utilize aromatic sources derived from waste raw materials for the advancement of aromatic instant heating products. This preference stems from the fact that non-waste vital plants possess a broader range of applications. Orange peel is considered to be one of the aromatic sources derived from waste raw materials. The orange peel typically comprises saponins, tannins, flavonoids, triterpenoids, and essential oils. The composition of essential oil constituents in orange peel typically consists of limonene (95%), myrsen (2%), octanal (1%), decanal (0.4%), citronellal (0.1%), neral (0.1%), geranial (0.1%), valensen (0.05%), sinnsial (0.02%), and sinensial (0.01%) [1]. The component limonene, which is present in orange peel, is responsible for the characteristic perfume of oranges and can serve as a source of fragrance.

The utilization of orange peel waste as an aromatic source in various food and non-food products has been extensively explored, as demonstrated by the research conducted by Alpin et al. (2022). Their study focuses on the development of a ready-to-drink beverage made from a combination of pomelo, baby, and lemon peels [2]. In addition, the essential oil of orange peel is beneficial for health as it has the ability to stabilize the nervous system and induce feelings of pleasure. This was demonstrated in a study conducted by Lestari (2020), which focused on the production of aromatherapy candles from orange peel waste [3]. According to Fitrah (2016), a study was conducted to examine the impact of providing Pontianak tangerine aromatherapy on the learning concentration of 8th grade students at SMP Muhammdiyah III Pontianak. The study found that there was a 3% increase in learning concentration following the administration of orange aromatherapy [4]. In addition, essential oils have the ability to alleviate nausea and increase appetite. This was demonstrated in a study conducted by Fithriana (2017), which investigated the effects of orange aromatherapy in reducing nausea and vomiting among pregnant women in the island of Lombok [5]. Fatmawati (2016) conducted a study on the utilization of aromatherapy as a stimulation to enhance food intake in toddlers [6].

The aforementioned studies encompassed investigations that utilized orange peel waste as a primary study material. Hence, it is imperative to undertake a research study regarding the potential utilization of orange peel waste as a viable aromatic source in instant food heaters. The utilization of orange peel holds significant potential for the development of the orange processing business as an agricultural-based sector. Additionally, it can contribute to the production of taste in instant heaters, thereby offering many benefits such as mitigating environmental pollution caused by the accumulation of waste. Nevertheless, the volatile nature of essential oil at ambient temperature poses a challenge in preserving the essential oil content found in orange peel.

The present study aimed to investigate the variations in the concentration of limonene compound in tangerine peel essential oil, specifically examining the impact of tangerine peel dryness. Additionally, the study aimed to identify the most effective food self-heater by incorporating tangerine peel powder as an aromatic component.

EXPERIMENTAL SECTION

Materials

The primary constituent of this study comprises the byproduct derived from the rind of a specific variety of tangerine called 'Keprok Kacang' (Citrus reticulata), which is harvested directly from the plant. The constituents employed in the fabrication of instantaneous water heaters encompass aluminum (Al), sodium bicarbonate ($NaHCO_3$), and calcium oxide (CaO). The chemical analysis utilizes a range of materials including sodium hydroxide (NaOH) solution, distilled water, chloroform, silica gel, and various other analytical substances.

Instrumentation

The research employed many tools including a food dehydrator, blender, thermometer, digital scale, 40 grit sieve, measuring cup, plastic box, aluminum foil, GSM 120 non-woven fabric, and sealer. In the context of this study, the analytical techniques employed encompass a range of instruments and equipment, including steam distillation apparatus, the hunter lab, Chromatography-Flame Ionization Detector (GC-FID), an oven for controlled heating, a stopwatch for precise timing, an analytical balance for accurate measurements, a measuring flask for volumetric analysis, an Erlenmeyer flask for various laboratory procedures, litmus paper for pH determination, and a dropper pipette for controlled liquid dispensation.

Procedure

Research Design

The study employed a Completely Randomized Design (CRD) as the research methodology, consisting of 5 treatments and 3 replications. The data collected for each parameter was subjected to statistical analysis using the F test, followed by Duncan's New Multiple Range Test (DNMRT) at a significance level of 5%.

In this investigation, the tangerine peel wilting treatment for making tangerine peel powder is as follows:

Treatment A = wilted tangerine peel after 0 hours

Treatment B = wilted tangerine peel after 6 hours

Treatment C = wilted tangerine peel after 12 hours

Treatment D = wilting of tangerine peel after 24 hours

Treatment E = wilting of tangerine peel after 48 hours

The mathematical model employed in the design is as follows:

$$Y_{ij} = \mu + P_i + \varepsilon_{ij}$$

Where :

Y_{ij} = The observations obtained from the experimental unit that was subjected to the i-th treatment comparison within the j-th replication.

μ = General average value

P_i = Effect of peeling time on tangerine peel powder at level i (i=A, B, C, D, and E).

ε_{ij} = Experimental error at the ith time level after peeling the tangerine skin on the tangerine peel powder produced in the jth repetition.

i = Number of treatment (i=A, B, C, D, E)

j = Number of replication (j=1, 2, 3)

Research Stages

Raw Material Preparation

The utilized waste material consists of tangerine peels, with varying aging durations of 0, 6, 12, 24, and 48 hours. Tangerine peels are strategically positioned throughout unoccupied areas under controlled circumstances. The tangerine peel utilized in this study originates from tangerines harvested straight from the Kabun Baru Jambak region in Lubuk Alung, West Sumatra. This document provides a comprehensive account of the many stages of the research that were undertaken. Each stage of the research process is demarcated by a bolded title indicating the specific stage.

The Process of Creating Tangerine Peel Powder

The tangerine peel samples, each with different wilting times of 0 hours, 6 hours, 12 hours, 24 hours, and 48 hours, were subjected to a drying process using a food dehydrator at a temperature of 45 oC for approximately 4 hours. The subsequent step involves pulverizing the dehydrated tangerine peel utilizing a blender, thereafter proceeding to strain the resulting mixture through a 40 mesh sieve. The findings are stored in polypropylene containers.

RESULT AND DISCUSSION

Water Content

Water is a crucial and predominant constituent in food, present in variable proportions. The presence of water in food exerts an influence on various aspects of food products, including their physical, chemical, and sensory characteristics [7]. Table 1 presents the outcomes of the water content observations conducted on tangerine peel powder for each treatment, specifically focusing on the duration of wilting for the tangerine peel.

Table 1. Average Value of Water Content of Tangerine Peel Powder

Wiltiness in Tangerine Peel	Water Content (%)
A (0 hour)	15,82 ± 2,14 a
B (6 hours)	16,15 ± 0,57 a
C (12 hours)	17,39 ± 1,56 a b
D (24 hours)	18,81 ± 1,21 b c
E (48 hours)	20,53 ± 0,52 c

The results of variance analysis indicate that, at the 5% significance level, the dryness of tangerine peel has a significant effect on the water content value of tangerine peel powder. The average water content of tangerine peel powder with varying tangerine peel dryness ranges from 15.82% to 20.53%. The highest water content in tangerine peel powder was 20.53% in treatment E (withering tangerine peel for 48 hours), while the lowest water content was 15.82% in treatment A (withering tangerine peel for 0 hours). Consequently, the drying period of tangerine peel affects the produced water content. The greater the duration, the greater the water content produced. The increased water content of tangerine peel powder is caused by the fact that during the tangerine peel withering process, the tangerine peel is still enduring a respiration process. Respiration is the process by which carbohydrate molecules in fruit are broken down using oxygen (O_2) from the environment to produce carbon dioxide (CO_2), water (H_2O), and energy [8]. Consequently, the respiration process can reduce the fruit's quality and shelf life, resulting in physiological harm to the fruit [8]. Additionally, humidity levels can influence the respiration process. Low humidity and cool temperatures should be used to store citrus produce. In this investigation, tangerine peel was left at room temperature to hasten its decay. High temperature humidity will result in the absorption of water vapor from the air, resulting in damp material that will influence the increase in water content, thereby promoting physical damage to the tangerine rind [8].

In addition, it is believed that the high water content of tangerine peel powder is due to the presence of essential compounds that evaporate along with the water when heated. During heating, according to Abdul et al. (2013), hydrodiffusion of water vapor into the plant cell tissue causes it to burst and drive the oil out [9]. Once the tangerine peel's cell walls have been breached, the tangerine peel's oil glands are readily carried away by water vapor. According to Muhtadin et al. (2013), when heated in the oven, the pores in sweet tangerine rind will expand [10]. The evaporation of the sample's essential oil increases with the number and size of open pores. Consequently, the tangerine peel powder content results are considerable.

The value of pH

The pH level serves as a diagnostic tool to ascertain the acidity or alkalinity of tangerine peel powder subsequent to its treatment with tangerine peel. Table 2 displays the findings obtained from the examination of pH values.

Table 2. Ph Value of Tangerine Peel Powder

Wiltiness in Tangerine Peel	The value of pH	
A (0 hour)	5,44 ± 0,006	e
B (6 hours)	5,42 ± 0,006	d
C (12 hours)	5,37 ± 0,006	c
D (24 hours)	5,30 ± 0,010	b
E (48 hours)	5,27 ± 0,006	a

The findings from the variance analysis indicate that the duration of drying tangerine peel has a statistically significant impact, at a significance level of $\alpha = 5\%$, on the pH value of tangerine peel powder. The pH values of tangerine peel, which have been subjected to varying drying times, exhibit an average range of 5.27 to 5.44. In treatment A, the tangerine peel powder exhibited the highest pH value of 5.44, whereas treatment E resulted in the lowest pH value of 5.27 for the tangerine peel powder. The occurrence of this phenomenon can be attributed to metabolic activities taking place within tangerine peels. The fruit undergoes physical and chemical changes as a result of these metabolic activities. The physiological deterioration of fruit subsequent to harvest encompasses several manifestations such as the formation of blisters, peeling, desiccation, bruising, and rot. When cells that have been injured are exposed to atmospheric oxygen, they undergo a reaction that leads to the synthesis of polyphenol enzymes, so initiating the process of decay. If the process of respiration persists, the fruit will undergo wilting and subsequent decay, resulting in the loss of its nutritional content [8]. The occurrence of this situation will initiate the glycolysis process, resulting in a reduction in pH [8].

Tangerine Peel Essential Oil Yield

The essential oil yield refers to the quantification of essential oil obtained from the distillation process in relation to the quantity of raw materials extracted. The essential oil yield outcomes are presented in Table 3.

Table 3. Average Yield of Tangerine Peel Essential Oil

Wiltiness in Tangerine Peel	Yield (%)
A (0 hour)	8,27 ± 0,23 d
B (6 hours)	7,73 ± 0,46 c d
C (12 hours)	7,47 ± 0,46 b c
D (24 hours)	6,80 ± 0,00 a b
E (48 hours)	6,27 ± 0,46 a

The analysis of variance results indicate that the drying time of tangerine peel has a statistically significant impact, at a significance level of α = 5%, on the yield value of tangerine peel oil. The average output of tangerine peel oil exhibited variations across different drying times of tangerine peels, ranging from 6.27% to 8.27%. Treatment A, which involved withering tangerine peel immediately after harvest, resulted in the maximum output of tangerine peel oil at 8.27%. Conversely, treatment E, which involved withering tangerine peel after 48 hours, yielded the lowest amount of tangerine peel oil at 6.27%. Hence, as the duration of tangerine peel withering increases, there is a corresponding decrease in the quantity of tangerine peel oil obtained. This phenomenon can be attributed to the potential oil loss resulting from the withering and drying processes, hence leading to a drop in overall yield. The declining yield suggests a corresponding decrease in the production of tangerine peel essential oil. The extraction method has been found to contribute to an increase in yield value [11], while pest infestations have also been identified as a factor [12].

In addition to this, the yield achieved might be altered by the interaction between the solvent and the source material. There is a positive correlation between the quantity of raw materials utilized and the oil content present in the material. However, it should be noted that an excessive amount of essential oil distillation tends to lead to a drop in distillation yields [13]. Insufficient diffusion and suboptimal surface extraction of essential oil may occur when the mass of the raw material exceeds the capacity of the solvent. Consequently, a significant quantity of essential oils remains within the tissue of the raw material. Insufficient mass of raw material in the water-steam distillation process can also result in inefficiency, as it promotes the direct evaporation of more solvent vapor into the condenser rather than facilitating diffusion into the tissue and subsequent extraction of essential oil to the surface [13].

Limonene Content in Tangerine Peel Essential Oil

The concentration of limonene in samples of essential oil extracted from tangerine peels was quantified using a gas chromatography apparatus equipped with a Flame Ionization Detector (FID). The approach utilized in this study is founded upon the calibration curve method, which involves the comparison of a sample solution with a known concentration to a sample solution with an unknown concentration in order to determine the levels of the latter. The limonene solution utilized is of a typical concentration of 65%, while the tangerine peel oil employed possesses a concentration of 0.4%. Subsequently, the injection process is executed within the gas chromatography system. The quantification of limonene content in the tangerine peel essential oil sample is accomplished by introducing the sample into the gas chromatography instrument and afterwards measuring the resulting area. Subsequently, the acquired area is utilized for the computation of the limonene concentration present within the specimen. The present study aimed to analyze the limonene compounds present in tangerine peel essential oil in order to determine their presence or absence following the wilting of the tangerine peel. This investigation was conducted due to the volatility of essential oil components at ambient temperature. The subsequent findings depict the chromatogram outcomes of essential oil samples in relation to the treatment used.

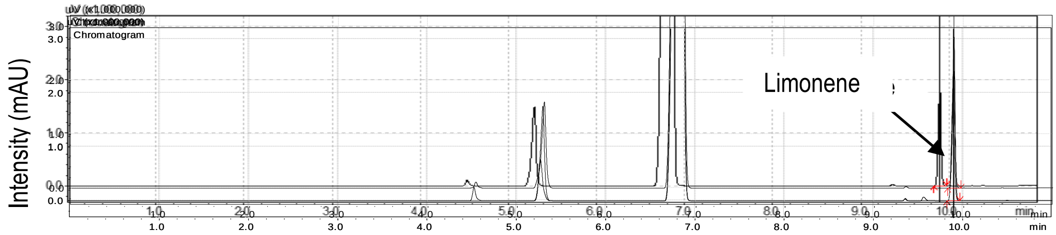

Fig 1. Chromotogram of Limonene Measurement Results for Sample A

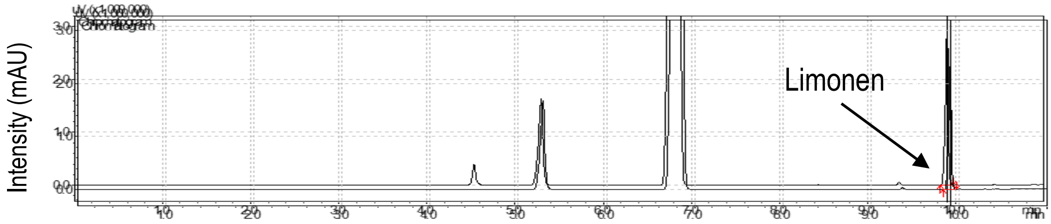

Fig 2. Chromotogram of Limonene Measurement Results for Sample B

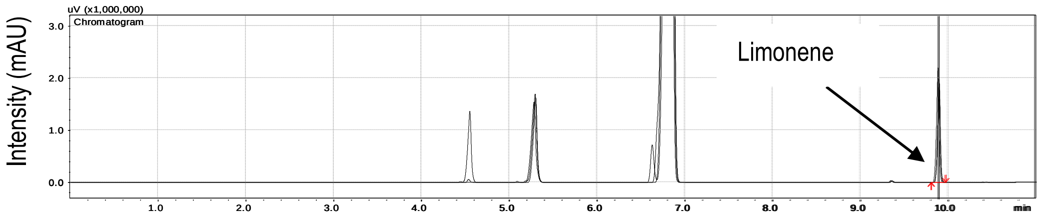

Fig 3. Chromotogram of Limonene Measurement Results for Sample C

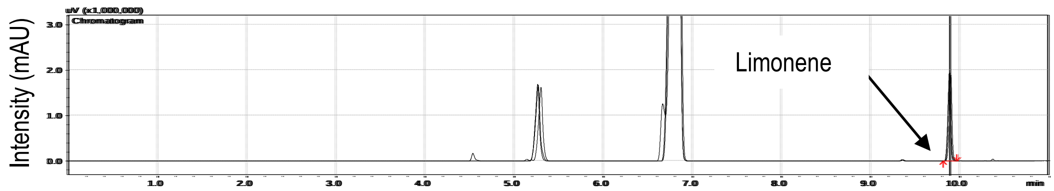

Fig 4. Chromotogram of Limonene Measurement Results for Sample D

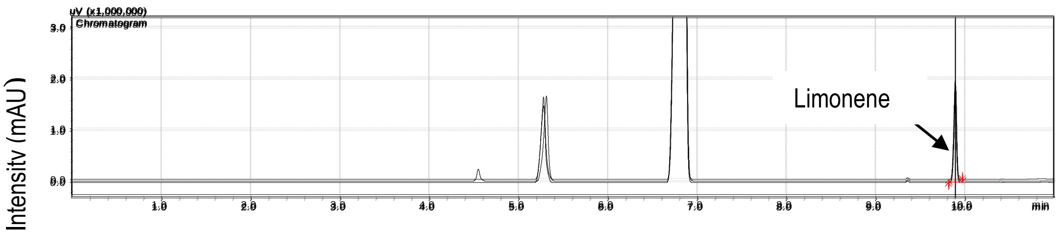

Fig 5. Chromotogram of Limonene Measurement Results for Sample E

From the picture above, it can be seen that tangerine peel essential oil that has been treated with tangerine peel drying time still contains limonene compounds. This is proven in the chromotogram of the limonene measurement results which is marked by a red line followed by an arrow.

Table 4. Results of analysis of limonene levels in tangerine peel essential oil

Wiltiness in Tangerine Peel	Limonene Content (%)
A (0 hour)	94,19 ± 20,93
B (6 hours)	91,38 ± 23,01
C (12 hours)	72,92 ± 5,77
D (24 hours)	69,00 ± 0,42
E (48 hours)	63,15 ± 7,17

The analysis of variance results indicate that the wilt of tangerine peel does not have a statistically significant impact, at a significance level of $\alpha = 5\%$, on the analysis of limonene content in tangerine peel essential oil. The mean limonene content of tangerine peel essential oil exhibited variations due to variances in the duration of tangerine peel drying, ranging from 63.15% to 94.19%. In treatment A, the essential oil extracted from tangerine peel exhibited the maximum concentration of limonene at 94.19%. Conversely, treatment E, which involved withering the tangerine peel for 48 hours, had the lowest concentration of limonene in the essential oil at 63.15%. Consequently, as the duration of tangerine peel wilting increases, there will be a corresponding reduction in the concentration of limonene present in the essential oil derived from tangerine peel. The evaporation of volatile chemicals in tangerine peel oil can be attributed to various factors, including cell wall degradation, elevated compound levels resulting from oxidation processes, and hydrolysis of glycoside forms [14]. Hence, as the duration of tangerine peel withering increases, there is a corresponding drop in the quantities of limonene obtained. In addition, it should be noted that the dehydration procedure of tangerine peel results in the depletion of some limonene compounds due to the adverse effects of the applied heat, which can lead to the degradation or elimination of volatile constituents, including essential oil compounds [15]. Muhtadin et al. (2013) reported that the application of heat in an oven induces the opening of pores within sweet tangerine peel. The evaporation of essential oils in the sample is enhanced by a higher quantity and larger dimensions of open pores [10].

Color analysis of tangerine peel powder

The Hunterlab color Ez spectrophotometer is utilized for color analysis, yielding three distinct color parameters: L*, a*, and b*. Table 5 displays the outcomes of color analysis conducted on tangerine peel powder, considering different time intervals following the peeling of the tangerine peel.

Table 5. Average Value of Tangerine Peel Powder Color Analysis

Wiltiness in Tangerine Peel	Value of oHue ± SD	Color
A (0 hour)	81,93 ± 0,03 a	Yellow brown
B (6 hours)	84,46 ± 0,02 d	Yellow brown
C (12 hours)	84,82 ± 0,02 e	Yellow brown
D (24 hours)	84,34 ± 0,03 c	Yellow brown
E (48 hours)	83,70 ± 0,03 b	Yellow brown

The findings from the variance analysis indicate that the duration of skin drying significantly impacts the color analysis of tangerine peel powder at a significance level of α = 5%. The mean Hue0 value of tangerine peel powder falls within the range of 81.93 to 84.82. The resulting tangerine peel powder exhibits a brownish yellow hue. The alteration of color from green to yellow in tangerine peel is attributed to the degradation of chlorophyll, which can be induced by several factors such as a decline in pH, oxidation, heating, and the enzymatic activity of chlorophyllase [16]. The enzyme chlorophyllase facilitates the breakdown of chlorophyll into phytol and forfirin nuclei. The chlorophyll molecule has the potential to undergo a process wherein the magnesium (Mg) atom present in its porphyrin group is dissociated, resulting in the conversion of chlorophyll into pheophytin. Consequently, a modification in color transpires. The breakdown of chloroplasts occurs prior to the loss of green pigmentation in the tissue. The manifestation of alternative colors arises from the deterioration of the green hue, as the presence of this color had previously obscured the perception of other hues. The color transition occurs from green, primarily due to the presence of chlorophyll, to red and yellow hues, which can be attributed to several natural fruit dyes such as anthocyanins, xanthophylls, lycopene, xarothene, and others (Reference 16). Furthermore, the enzyme facilitates the process of hydroxylation, converting monophenol into o-diphenol and subsequently into o-quinone [17]. The formation of quinones gives rise to highly reactive molecules that typically undergo subsequent reactions with other quinones, amino acids, and proteins, resulting in the production of dark-colored compounds. This process ultimately leads to the generation of brown spot pigments [17].

Long Time for Aromatic Food Self-Heater to Reach Optimum Temperature

The experiment conducted aimed to measure the duration required for the fragrant food self-heater to attain its optimal temperature. Table 6 presents the duration required for the aromatic food self-heater to attain the optimal temperature.

Table 6. Length of Time for Aromatic Self-Heater Food to Reach Optimum Temperature

Wiltiness in Tangerine Peel	Period (minute)	
A (0 hour)	12,00 ± 1,41	e
B (6 hours)	10,00 ± 1,41	d
C (12 hours)	8,00 ± 0,00	c
D (24 hours)	4,50 ± 0,71	b
E (48 hours)	2,50 ± 0,71	a

The findings from the variance analysis indicate that the drying time of tangerine peel has a statistically significant impact, at a significance level of $\alpha = 5\%$, on the optimal temperature in the food self-heater. According to the data presented in Table 8, it is evident that the duration for the aromatic self-heater to attain the optimal temperature is longest in treatment A, specifically 12 minutes, following the tangerine peel withering treatment at 0 hours. Conversely, the treatment that achieves the optimal temperature most rapidly is treatment E, specifically within 2.50 minutes, subsequent to the tangerine peel drying treatment after 48 hours. The high water content included in tangerine peel powder is the cause of this phenomenon. The chemical reaction between Calcium Oxide (CaO) and water vapor present in the dehydrated substance will result in a reduction of the material's water content [18]. In the event of a high water content in the tangerine peel powder, the particles inside the food self-heater substance will initiate a reaction with the tangerine peel powder. Consequently, an increase in the water content within the substance will result in an accelerated exothermic reaction of the food self-heater. This phenomenon arises as a consequence of the thermal energy transfer from the system to the surrounding environment, leading to an increase in the temperature of the environment [19]. Consequently, the pace at which heat is produced by a material will be accelerated when the material exhibits a high level of water content.

Organoleptic test (Aroma)

The olfactory perception of a product significantly impacts customer preferences, since it is closely linked to the sense of smell, hence eliciting a propensity to consume or utilize said product [20]. The fragrance emanating from tangerine peel generates a unique tangerine scent and possesses a strong intensity. Table 7 displays the outcomes of the fragrance organoleptic examination.

Table 7. Average Organoleptic Aroma Values in food self-heaters

Wiltiness in Tangerine Peel	Aroma
A (0 hour)	2,56 ± 0,77 a
B (6 hours)	3,36 ± 0,70 b
C (12 hours)	4,20 ± 0,81 c
D (24 hours)	4,20 ± 0,86 c
E (48 hours)	3,92 ± 0,95 c

The findings from the variance analysis indicate that the duration of drying tangerine peel has a statistically significant impact, at a significance level of $\alpha = 5\%$, on the sensory perception of scent in food self-heaters. The range of the average organoleptic aroma value was observed to be between 2.56 and 4.20. The treatments that resulted in the highest average preference for aroma among the panelists were C (withering of tangerine peel after 12 hours) and D (withering of tangerine peel after 24 hours), with an average value of 4.20. On the other hand, treatment A (withering of tangerine coolies after 0 hours) had the lowest average preference for aroma among the panelists, with a value of 2.56. The gustatory experience of this fragrant self-heating comestible is accompanied by an unfavorable lingering sensation on the palate. Therefore, based on the analysis of the sensory perception of aroma, it can be observed that an increase in the concentration of limonene in tangerine peel powder is directly associated with a higher level of aversion expressed by the panelists towards the odour. This phenomenon is believed to occur due to the heightened aftertaste, which subsequently impacts the panelists' inclination towards the aroma emitted by the self-heating food device. Nevertheless, there was a notable distinction between treatment E, characterized by the withering of tangerine peel after 48 hours, which received a moderate level of approval from the judges. This phenomenon is believed to occur as a result of treatment E, which exhibits a slightly disagreeable olfactory characteristic attributed to the extensive wilting of the tangerine peel, hence facilitating the emergence of a putrid odour.

Mandei (2014) posits that the measurement of fragrance presents challenges, often leading to divergent perspectives when evaluating its quality [21]. Divergent viewpoints arise due to variations in individuals' olfactory perceptions, whereby despite their ability to discern numerous scents, personal preferences for specific odors differ among individuals. Overall, the panelists' preference for fragrance was classified as favorable among the panelists. The fragrance emitted by the food self-heater is said to be influenced by the characteristic scent of tangerine peel powder. The origin of the characteristic scent of tangerines is believed to be attributed to the presence of aroma-forming chemicals within the peel of the tangerine fruit.

The primary constituent of tangerine peel essential oil is d-Limonene, as indicated by previous research [22]. Limonene is a colorless liquid that belongs to the class of cyclic terpene hydrocarbons. The d-isomer of limonene is responsible for imparting a highly potent aroma reminiscent of tangerines [23].

CONCLUSION

The findings of the study indicate that the drying duration of tangerine peel has a statistically significant impact, at a significance level of 5%, on many factors including water content, pH level, yield, color, time required for the aromatic food self-heater to reach its optimal temperature, and the organoleptic scent of the food self-heater. However, it does not significantly impact the concentration of limonene in essential oil derived from tangerine peel. The treatment that yielded the most favorable outcomes in terms of the time required for the aromatic food self-heater to reach the optimal temperature and the organoleptic aroma is treatment D, which involved withering the tangerine peel for 24 hours. In this treatment, the aromatic food self-heater took approximately 4.5 minutes to reach the optimal temperature, and the organoleptic aroma received a rating of 4.2, indicating a favorable response. Nevertheless, this study possesses a limitation, namely pertaining to the ultimate olfactory sensation resulting from the incorporation of tangerine peel powder into the self-heating food product. Hence, scholars propose conducting additional investigations pertaining to endeavors aimed at eradicating the ultimate olfactory sensation generated throughout the use of tangerine peel.

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