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Antimicrobial activity of hard candy with basil (*Ocimum sanctum* L.) essential oil addition

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ABSTRACT

The basil plant belongs to the Lamiaceae family and contains various active compounds, including phenols, saponins, alkaloids, flavonoids, tannins, and essential oils. These compounds have antimicrobial activity against *Streptococcus mutans* and *Candida albicans*, two types of bacteria that can cause bad breath. The addition of basil essential oil to hard candy has the potential to reduce bad breath. This study aimed to determine the concentration effect of basil essential oil on hard candy in inhibiting the growth of *Streptococcus mutans* and *Candida albicans* and its acceptance by the panelists. This research was conducted with five treatments with variations in the concentration of basil essential oil, which were 0, 0.25, 0.5, 0.75, and 1%. The results showed that the higher basil essential oil concentration in hard candy inhibited the growth of *Streptococcus mutans* and *Candida albicans*. The best treatment was at 0.75% basil essential oil, with sensory panelist acceptance for color 69%, aroma 57%, taste 43%, and overall 58%. Several compounds in basil essential oil, including *linalool, eugenol, caryophyllene,* and *trans-α-bergamotene,* are thought to contribute to the ability of this candy to inhibit microbial growth.

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1. INTRODUCTION

Halitosis has become a common issue for many individuals. It has been reported that 80-90% of halitosis originates from the oral cavity [1]. Causes within the oral cavity are typically associated with poor oral hygiene, dental caries, and oral infections [2]. The presence of certain microbial species also contributes to dental caries, mouth ulcers, and candidiasis, which are among the primary causes of halitosis. These microbes include *Streptococcus mutans* and *Candida species* [3], [4].

Basil (*Ocimum basilicum* L.) is a plant that grows abundantly in Indonesia. This plant has long been used in traditional Indonesian cuisine. Moreover, basil has been reported to alleviate bad breath, body odor, and various ailments such as fever, diarrhea, bloating or indigestion, lactation problems, rheumatism, mouth ulcers, and other health benefits [5]. The primary components of basil essential oil include citral (33.92%) with cis-citral (14.86%) and trans-citral (18.96%) as its major constituents [6]. Citral is a monoterpenoid compound [7] that possesses antimicrobial [8], flavoring, and preservative properties, and also plays a role in the synthesis of vitamin A. Basil essential oil exhibits antimicrobial activity against *Streptococcus mutans*, *Lactobacillus casei*, and *Candida albicans* at minimum inhibitory concentration (MIC) values of 0.08, 0.3, and 0.08% (v/v), respectively [9]. Basil essential oil exhibits antibacterial activity against *Staphylococcus*

aureus and *Escherichia coli* [10], with MICs of 0.5 and 0.25% (v/v), respectively. Its antimicrobial properties indicate potential for development in hard candy processing.

Hard candy is a non-crystalline confectionery product with a hard texture [11] made from a mixture of sucrose, glucose, water, and additional ingredients such as flavorings, colorants, and acidifiers. The primary ingredients in hard candy production are sucrose, water, and glucose syrup or inverted sugar. Other components include flavorings, colorants, and acidifiers. The addition of essential oils to hard candy can provide flavor while serving as a source of active compounds beneficial for oral health. Essential oils possess antimicrobial properties and have been applied to various types of food products, including basil essential oil (*Ocimum sanctum* L.) as an antimicrobial agent in soft candy [12], Aromatic ginger (*Kaempferia galanga* L.) in hard candy [13], and Trigona honey (*Trigona itama*) as well as microencapsulated patchouli oil (*Pogostemon cablin* Benth.)-based essential oils in hard candy [14]. Research on basil-infused hard candy remains limited, particularly concerning its activity against oral pathogens responsible for dental caries and halitosis. Therefore, this study is crucial to develop an optimal basil hard candy with antimicrobial properties against pathogenic microbes. The aim of this research was to determine the effect of essential oil concentration on antimicrobial activity and consumer acceptance, as well as to identify the most effective treatment.

2. RESEARCH METHOD

2.1. Essential oil distillation

The extraction of essential oil was carried out using the steam distillation method [15]. Three kilograms of wilted dried basil were placed in a distillation apparatus with a water-to-material ratio of 1:2. Steam distillation was performed at atmospheric pressure for 8 hours. The resulting steam was condensed to obtain the distillate, which was collected in a separating funnel. The distillate was left to stand for 24 hours until two layers formed, which were then separated.

2.2. Hard candy preparation

Hard candy was prepared using the method described in [16]. White granulated sugar (120 g) was mixed with 20 ml of water and heated at 100 °C. Add 60 grams of glucose, and the mixture was further heated until the final hard-crack temperature of 150 °C was reached, then allowed to cool at 60 °C. Basil essential oil was added according to (0, 0.25, 0.5, 0.75, and 1%), poured into molds, and left to harden at room temperature. Hard candy was then removed from the molds and stored in sealed glass containers for subsequent testing.

2.3. Bacterial suspension

A single loop of each test bacterium was suspended in 10 ml of sterile physiological solution and homogenized using a vortex mixer. The absorbance was measured at a wavelength of 625 nm, and the turbidity suspension was adjusted to match the McFarland standard. One milliliter of the bacterial suspension was transferred into a test tube containing 9 ml of sterile distilled water, followed by serial dilutions up to 10^{-6}. The test solution was prepared by dissolving 3 g of hard candy in 6 ml of 10% dimethyl sulfoxide (DMSO) solution, which had been sterilized using an autoclave (121 °C, 2 atm for 15 minutes).

2.4. Inhibition zone activity test

Inhibition zone activity test was using the agar diffusion method with sterile paper discs (Kirby-Bauer method), and observed based on clear zones formed [17]. Sterile paper discs (6 mm in diameter) were soaked in the test solution for 25 minutes. A total of 3.4 g of Sabouraud Dextrose agar (SDA) medium was dissolved in 100 ml of distilled water, heated until completely dissolved, and sterilized in an autoclave at 121 °C for 15 minutes. Then, 12 ml of sterile SDA medium was poured into a sterile 10 cm petri dish. Once the medium was evenly spread and solidified, 0.1 ml of bacterial suspension was inoculated onto the petri dish and evenly spread using a Drigalsky spatula.

The soaked paper discs were then placed on the surface of the test medium, followed by incubation at 37 °C for 24 hours. The inhibition zones were determined by measuring the diameter of the clear zones formed around the discs. The inhibition zone diameters were categorized into four levels based on activity: weak (<5 mm), moderate (5-10 mm), strong (10-20 mm), and very strong (>20 mm).

2.5. Antimicrobial testing

The agar dilution method was employed to determine the MIC and IC_{50} values against *Streptococcus mutans* and *Candida albicans*, following the procedure described by [18]. The method was conducted using the pour-plate technique; 1 ml of bacterial suspension was inoculated into a sterile petri dish. After evenly spreading the suspension, 1 ml of the test solution was added to the dish. Subsequently, 12 ml of

sterile Mueller-Hinton agar (MHA) medium was poured into the petri dish, spread evenly, and allowed to solidify. The plates were incubated at 37 °C for 24 hours. After incubation, the number of colonies on the petri dishes was counted using a colony counter (Stuart Scientific). The MIC value was determined based on the average microbial growth at 24 and 48 hours. The results were used to calculate the MIC by averaging the number of colonies observed at the 10^{-5} dilution level (expressed in CFU/mL).

2.6. Preference test

The sensory preference assessment utilized a hedonic scale to evaluate panelists' acceptance of the color, aroma, taste, and overall characteristics of the hard candy [19]. The test involved 100 untrained panelists, both male and female, aged 19-25 years. The evaluation scale was based on the degree of liking, using seven categories: 1=strongly dislike, 2=dislike slightly, 3=dislike, 4=neutral, 5=like slightly, 6=like, and 7=strongly like.

2.7. Effectiveness testing

The best treatment was determined using the effectiveness index method [20]. Parameters were categorized into qualitative (organoleptic) and quantitative (physical, chemical, and antimicrobial) groups. Each parameter was assigned a weighted value (BV) based on its relative importance in influencing research outcomes or consumer acceptance, with weights ranging from 0 to 1. The weighted value was calculated by dividing the score of each treatment by the total weight. The effectiveness score was calculated using (1).

$$Effectiveness\ Score = \frac{Treatment\ value - worst\ value}{Best\ value - worst\ value} \quad (1)$$

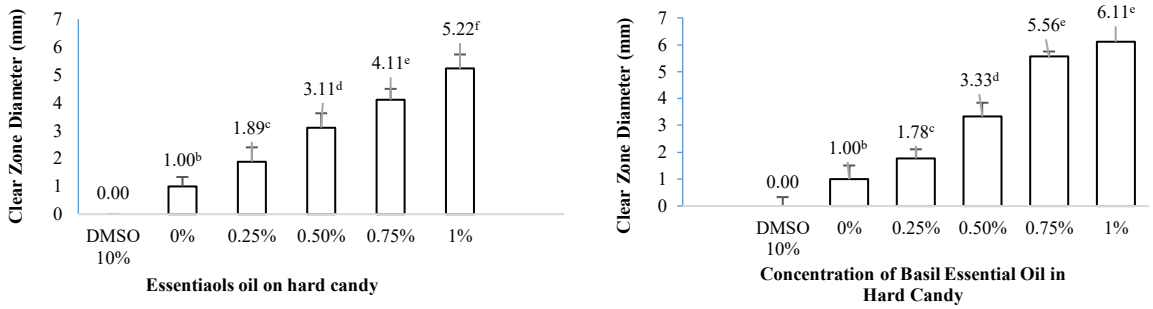
3. RESULTS AND DISCUSSION

3.1. Inhibition zone activity

The inhibition zone activity of hard candy was determined by observing the diameter of the clear zone around the discs, indicating the presence or absence of antibacterial compounds capable of inhibiting microbial growth [21]. The antibacterial activity test results revealed that increasing the concentration of basil essential oil in hard candy significantly enhanced the diameter of the inhibition zones for *Streptococcus mutans* and *Candida albicans* ($p < 0.05$), as shown in Figure 1.

The data demonstrated that higher concentrations of basil essential oil in the hard candy corresponded to larger inhibition zone diameters. The results indicated that the variation in basil essential oil concentrations significantly affected the inhibition zone diameter for *Streptococcus mutans*. The strength of the inhibition zone is categorized as weak (<5 mm), moderate (5-10 mm), strong (10-20 mm), and very strong (>20 mm) [17]. Based on Figure 1(a), at 1% concentration, the essential oil produced the largest inhibition zone with 5.22 mm diameter (moderate), while the smallest was observed in the control (10% DMSO), which showed no clear zone. The DMSO solvent did not exhibit any inhibitory effect, resulting in an inhibition zone diameter of 0.00 mm [22]. At basil essential oil concentrations of 0, 0.25, 0.5, and 0.75%, the inhibition zones against *Streptococcus mutans* were classified as weak (<5 mm). The concentration of basil essential oil in the hard candy was too low to effectively inhibit *Streptococcus mutans*. The antibacterial effectiveness of a compound is influenced by both its concentration and the type of active substance; thus, the higher the concentration of the active compound, the greater its effectiveness [23]. The inhibition zone of *Streptococcus mutans* in basil hard candy seems to be *Kaempferia galanga* L., which ranges from 1.33 to 5.44 mm [13]. *Kaempferia galanga* L. essential oil contains *ethyl p-methoxycinnamate, methyl cinnamate,* and *pentadecane,* which exhibit antibacterial activity [13], while basil contains alkaloids, flavonoids, terpenoids, and saponins known for their antibacterial properties.

Based on the research results, variations in the concentration of basil essential oil in hard candy had a significant effect on the diameter of the *Candida albicans* inhibition zone. The inhibition zone diameters were classified as weak to moderate. As shown in Figure 1(b), the largest inhibition zone was observed at 1% basil essential oil (6.11 mm), followed by 0.75% (5.56 mm), both of which fall within the moderate category. The smallest inhibition zone was recorded in the control sample (10% DMSO), with a diameter of 0.00 mm. Basil essential oil concentrations of 0, 0.25, and 0.5% exhibited weak inhibition (<5 mm) against the growth of *Candida albicans*. These concentrations were likely too low to effectively inhibit fungal growth. The variation in inhibitory strength is influenced by the specificity of the active compounds to certain microorganisms, the susceptibility of *Candida albicans* to basil essential oil components, and the concentration of active compounds used [23]. The inhibition zone of basil essential oil against *Candida albicans* is greater than *Kaempferia galanga* L. essential oil, which ranges from 1.44 to 5.56 mm [13], indicating that basil is more effective in inhibiting *Candida albicans*.



(a) (b)

Figure 1. Inhibition zones of basil essential oil hard candy against microbial growth of (a) *Streptococcus mutans* and (b) *Candida albicans*

Figure 2 illustrates that the use of basil essential oil exhibits superior antibacterial activity compared to treatments without essential oil, as evidenced by the smallest inhibition zone observed with 10% DMSO, where Figure 2(a) shows the *Streptococcus mutans* and Figure 2(b) shows the *Candida albicans*. DMSO, a versatile organic solvent capable of dissolving both polar and non-polar compounds, is not bactericidal and thus does not interfere with the action of antibacterial compounds [24]. Basil possesses antibacterial properties due to the presence of alkaloids, flavonoids, terpenoids, and saponins [25]. Terpenoids, such as citral, are the main components of basil leaf essential oil. These compounds can disrupt bacterial cell membrane permeability, precipitate proteins, and inactivate enzymatic activity within bacterial cells. Additionally, essential oils containing hydroxyl (-OH) and carbonyl functional groups exhibit antibacterial activity by denaturing proteins and nucleic acids, thereby disrupting metabolism or causing cell death [26]. Another compound, alkaloids, functions by interfering with the peptidoglycan components of bacterial cell walls [27]. This disruption prevents the formation of an intact cell wall, ultimately leading to cell death. Basil also contains other essential oil components, such as eugenol, methyl chavicol, and terpineol. The mechanisms of eugenol and terpineol include disrupting the outer bacterial membrane, mitochondria, and cellular structures [28].

(a) (b)

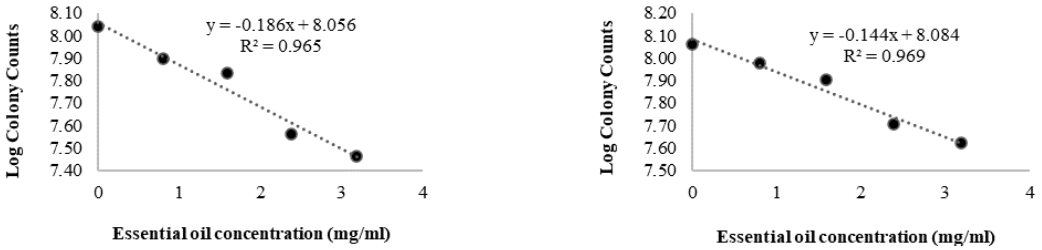
Figure 2. Inhibition zones of basil essential oil hard candy against microbial growth of (a) *Streptococcus mutans* and (b) *Candida albicans*

3.2. Concentration inhibiting 50% (IC_{50}) and minimum inhibitory concentration

IC_{50} is used to determine the minimum concentration of an antibacterial solution required to inhibit 50% of the growth of a specific bacterium. The MIC indicates the minimum concentration of an antibacterial solution necessary to kill a specific bacterium [29]. The logarithmic curves, shown in Figure 3, depict the relationship between the log of colony count and the concentration of basil essential oil in hard candy.

Based on Figure 3, the logarithmic curve equations display a linear trend, where higher concentrations of basil essential oil correspond to a lower log of bacterial colony count. Calculations revealed that the IC_{50} of hard candy for *Streptococcus mutans* growth was 1.614 mg/ml, as shown in Figure 3(a). At a basil essential oil concentration of 1.614 mg/mL, the hard candy inhibited 50% of bacterial growth (IC_{50}). The MIC value was determined to be 5.362 mg/mL, indicating that this concentration was required to achieve

complete inhibition of *Streptococcus mutans* growth. Calculations revealed that the IC_{50} for *Candida albicans* growth was 2.078 mg/ml, as shown in Figure 3(b). At a basil essential oil concentration of 2.078 mg/mL, the hard candy inhibited 50% of *Candida albicans* growth (IC_{50}).



(a) (b)

Figure 3. Inhibition curve of basil essential oil hard candy against the growth of (a) *Streptococcus mutans* and (*b) Candida albicans*

3.3. Identification of volatile components

The volatile components identified in basil hard candy are presented in Table 1 (see in Appendix). The identification results obtained through gas chromatography-mass spectrometry (GC-MS) analysis revealed several compounds, including linalool, eugenol, caryophyllene, and trans-α-bergamotene. Caryophyllene was detected in relatively high amounts. Linalool is an active antimicrobial compound [30]. As a terpenoid alcohol, it exhibits bactericidal activity against vegetative cells [31]. Similarly, eugenol demonstrates antimicrobial activity against *Streptococcus mutans* [32]. Caryophyllene has been shown to possess antibacterial, antioxidant, antifungal, and potent cytotoxic properties [33]. Trans-α-bergamotene also exhibits antimicrobial activity, effectively targeting microbes such as *Streptococcus mutans* and *Candida albicans*. Additionally, it is particularly effective against gram-positive bacteria, including *Streptococcus albus*, and fungi such as *Aspergillus niger* [34].

3.4. Preferences

3.4.1. Color

Color plays an important role in the presentation of a food product to determine consumer acceptance. Consumers tend to be attracted to food products with appealing colors [35]. Based on the data from the preference test of basil hard candy color shown in Figure 4. The addition of 0.75% basil essential oil in the hard candy treatment resulted in the highest measured color value of 69%. The color of the hard candy is influenced by the concentration of the added essential oil. The higher the concentration, the more intense the resulting color [36].

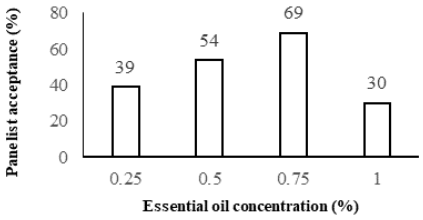


Figure 4. Percentage of hard candy color acceptance

3.4.2. Aroma

Aroma is an important indicator in food products as it can determine whether a product is accepted or not [36]. Based on the data from the preference test of basil hard candy aroma, shown in Figure 5. The addition of 0.75% basil essential oil in the hard candy resulted in the highest aroma score of 57%. The more basil essential oil added to the hard candy, the stronger the characteristic basil aroma. This distinctive aroma is attributed to the presence of several volatile compounds in the essential oil, as shown in Table 1. Some of these compounds include cineole, eugenol, and others. The aroma of the hard candy in this study is influenced by the volatile compounds present in the basil essential oil added during the processing stage [37]. The basil plant contains essential oils that impart a unique taste and aroma [38]. Basil leaf essential oil

primarily consists of geranial (*E-citral*, 43.74%), neral (*Z-citral*, 31.19%), linalool (7.03%), nerol (6.93%), and geraniol (4.62%).

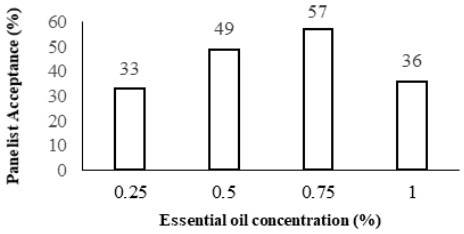


Figure 5. Percentage of hard candy aroma acceptance

3.4.3. Taste

Taste is one of the factors that determines the quality of food. Based on the data from the preference test for the taste of basil hard candy, shown in Figure 6. The hard candy formulation containing 0.25% basil essential oil showed the highest taste score, at 47%. This occurred because the addition of basil essential oil at a 0.25% concentration was minimal, thus not overpowering the characteristic basil taste, making it acceptable to the panelists. The distinctive basil flavor in the basil essential oil hard candy is influenced by the compounds contained in the basil essential oil. The essential oil composition in the basil plant determines the specific aroma and flavor of the herb [39]. The higher the concentration of essential oil added, the stronger the characteristic basil taste becomes.

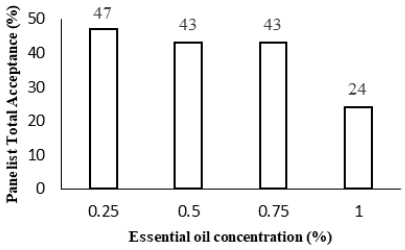


Figure 6. Bar chart of the percentage of taste acceptance

3.4.4. Overall

Overall preference is an assessment conducted on all organoleptic quality parameters, namely color, aroma, and taste. The organoleptic characteristics of basil hard candy tested in this study were generally acceptable to the panelists. Based on the data from the preference test for the overall basil hard candy shown in Figure 7, the hard candy sample with 0.75% basil essential oil was favored by the panelists. This indicates that the panelists preferred the hard candy with a moderate amount of basil essential oil, not too little nor too much. From the sensory data above, it can be concluded that the panelists' overall preference for color, aroma, and taste significantly influences their overall acceptance of the tested product. Additionally, if there are many factors that are less favored, it will lower the overall acceptance of the panelists [39].

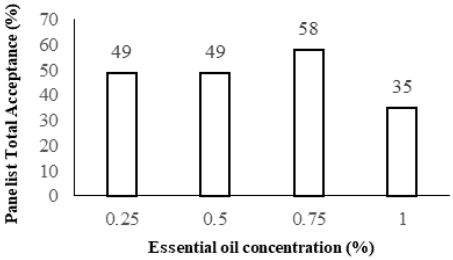


Figure 7. Overall hard candy acceptance

3.5. Effectiveness value

The effectiveness test was conducted to determine the best sample based on the selected parameters. The effectiveness value indicates the best sample [20]. The best treatment in the production of hard candy with varying concentrations of basil essential oil was chosen based on the results of the hedonic tests, which include color, aroma, taste, overall preference, and the inhibition zone test (disk method). The higher the level of importance, the higher the weight value assigned to the variable [20].

Table 2 shows that the hard candy sample with the best treatment, which involved the addition of 0.75% basil essential oil, resulted in an effectiveness value of 0.90. The hard candy with 0.75% basil essential oil had organoleptic values (somewhat liked to highly liked) for the color parameter at 69%, aroma at 57%, taste at 43%, and overall acceptance at 58%. Based on the inhibition zones, the antibacterial activity against *Streptococcus mutans* and *Candida albicans* showed apparent zone diameters of 4.11 mm (weak) and 5.56 mm (moderate), respectively.

Table 2. The effectiveness value of basil essential oil hard candy

Concentration of basil essential oil (%)	Effectiveness value
0.25	0.32
0.50	0.60
0.75	0.90
1.00	0.40

4. CONCLUSION

The higher basil essential oil added to hard candy would increase its ability to hold the *Streptococcus mutans* and *Candida albicans* growth. The best treatment was at 0.75% concentration, where the candy showed potent inhibition, and the highest sensory acceptance showed an effectiveness value of 0.9. The clear zones around the candy in tests showed how well it worked, with 4.11 and 5.56 mm diameters. The antimicrobial activity is likely attributable to active phytochemicals in basil essential oil, including linalool, eugenol, caryophyllene, and trans-α-bergamotene.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

This investigation related to human use, which was represented by panelist acceptance parameter. Organoleptic test of basil hard candy as a food product. In this test, some human senses were involved to characterize the sensory quality of the product; however, in this case, the tested product was a commercial food for ready-to-eat and safe, without risk ingredient manipulation, so that ethical approval is not available in this study. This study used the treatment agent of basil leaf *(Ocimum basilicum)* which in daily life, people know as **c**ulinary use, is generally recognized as safe (GRAS) by the U.S. Food and Drug Administration (FDA) when used in normal food amounts. In these amounts, basil does not pose health risks for most people. In addition, no sensitive personal data was requested from all panelists who joined this study.

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DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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APPENDIX

Table 1. Basil volatile components

No.	Compound	Ret. time	Area	Percentage (%)	Similarity
	Acyclic monoterpene				
1.	1,3,6-Octatriene, 3,7-dimethyl-, (Z)-	10.902	87126577	2.32	98
2.	2,2-Dimethylocta-3,4-dienal	15.979	25848828	0.69	90
3.	Ascaridole	20.246	9902119	0.26	78
	Bicyclic monoterpene				
4.	(+)-4-Carene	9.591	6275381	0.17	95
5.	trans-Pinocarvyl acetate	14.111	8224778	0.22	74
	Cyclic monoterpene				

Table 1. Basil volatile components *(continued)*

No.	Compound	Ret. time	Area	Percentage (%)	Similarity
6.	D-Limonene	10.139	106999525	2.85	93
	Oxygenated monoterpene				
7.	4-Acetyl-1-methylcyclohexene	14.98	13120331	0.35	93
8.	2,6-Octadien-1-ol, 3,7-dimethyl-, (Z)-	19.982	16379206	0.44	91
9.	Neral	20.592	977179549	26.05	96
	Monoterpene				
10.	β-Myrcene	8.219	73434299	1.96	93
11.	α-Phellandrene	9.087	14207184	0.38	88
12.	1,3-Cyclohexadiene, 1-methyl-4-(1-methylethyl)-	9.371	12540475	0.33	79
13.	o-Cymene	9.726	9140371	0.24	90
14.	Eucalyptol	10.283	8249781	0.22	93
15.	trans-β-Ocimene	10.414	51713306	1.38	98
16.	β-Pinene	11.374	9765124	0.26	85
17.	γ-Terpinene	11.554	6101282	0.16	97
18.	L-Fenchone	12.962	52228680	1.39	87
19.	6-Octenal, 3,7-dimethyl-, (R)-	16.179	9863738	0.26	87
20.	α-Terpineol	18.023	74737670	1.99	96
	Alcohol				
21.	2-Furanmethanol, 5-ethenyltetrahydro-α,α,5-trimethyl-, cis-	12.08	29849761	0.80	96
22.	Linalool	13.5	518860745	13.83	97
23.	cis-Chrysanthemyl alcohol	15.878	18451075	0.49	90
24.	Terpinen-4-ol	17.323	15770373	0.42	94
25.	2,6-Octadien-1-ol, 3,7-dimethyl-, (Z)-	21.276	11164478	0.30	92
26.	2,6-Octadien-1-ol, 3,7-dimethyl-, formate, (Z)-	22.385	42487847	1.13	94
	Benzene derivative, Ether				
27.	Estragole	18.377	21774664	0.58	96
28.	Eugenol	25.911	5530552	0.15	93
29.	Caryophyllene oxide	34.507	42338536	1.13	86
	Cycloalkane				
30.	Ethylidenecyclooctane	15.33	15660932	0.42	86
	Esther				
31.	1-Octen-3-yl-acetate	14.227	6859825	0.42	91
	Furan				
32.	3-Methyl-2-(2-methyl-2-butenyl)-furan	13.307	9319472	0.18	94
	Keton				
33.	5-Hepten-2-one, 6-methyl-	8.111	262515316	0.25	96
34.	6-Methyl-3,5-heptadiene-2-one	13.899	16324803	7.00	94
	Pyran				
35.	2H-Pyran,3,6-dihydro-4-methyl-2-(2-methyl-1propenyl)- / nerol oxide	16.259	7437011	0.44	95
	Sesquiterpene				
36.	γ-Elemene	25.512	6791554	0.20	81
37.	β-Bourbonene	27.022	20690595	0.18	91
38.	trans-α-Bergamotene	28.418	305496496	0.55	97
39.	Caryophyllene	28.606	255566899	8.14	96
40.	Humulene	30.063	67418248	6.81	95
41.	Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, (1S-cis)-	33.054	48693666	1.80	91
42.	Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl) (1α,4a.beta.,8α)-	31.069	7932945	1.30	92
43.	α-Guaiene	31.555	12421407	0.21	91
44.	β-Bisabolene	32.432	46144169	0.33	95
45.	Copaene	33.386	100459727	1.23	95
	Oxygenated sesquiterpenes				
46.	Caryophylla-4(12),8(13)-dien-5 α-ol	37.617	7144854	2.68	85
	Eugenol				
47.	2,6-Octadien-1-ol, 3,7-dimethyl-, formate, (Z)-	23.382	20621083	0.19	95
48.	2,6-Octadien-1-ol, 3,7-dimethyl-, acetate, (Z)-	26.25	76053738	0.55	96
	Other Compounds				
49.	Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-, [1S-(1α,2β,4β)]-	27.378	30781991	2.03	95
50.	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-	28.01	9206469	0.82	95
51.	10,10-Dimethyl-2,6-dimethylenebicyclo[7.2.0]undecane	28.941	11112436	0.25	94
52.	(E)-β-Famesene	30.236	8637055	0.30	92
53.	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-methylene-,[1R-(1R*,4Z,9S*)]-	31.423	51631003	0.23	92
54.	Pentadecane	32.011	67260267	1.38	96

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