Hand sanitizer formulation using orange peel essential oil

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Abstract. Hand sanitizer is mainly produced using 60% of alcohol as an active substance. Therefore, many hand sanitizers’ products are highly dominant with the alcohol smell. This research was aimed to formulate a sweet-scented hand sanitizer using a combination of orange essential oil as the addition of fragrant substance. A randomized block design (RBD) method was used, consists of one factor of essential oils proportion (i.e. baby orange (BO): sweet orange (SO)) in the formulation of hand sanitizer (P) with five levels. All treatment combination was carried out in five replicates. Physical properties (i.e. pH, density, and viscosity) and microbiological tests (i.e. total plate count and area of bacterial inhibition) were performed, as well as sensory tests to determine consumer response. The best results of the physical properties and the microbiological test were obtained from A2 treatment with proportion of BO: SO (0.75: 0.25), with the average of bacterial inhibition area of 6.77mm more efficient than that of the control. The sweet scene of the hand sanitizer product was clearly shown, as much as 77% of respondents favoured its aroma. The current study clearly shows that orange peels were potential as the additional ingredients in giving the sweet smell to the hand sanitizer.

1. Introduction

Nowadays, hand sanitizer has been widely used in any public area. Many commercial products can be found with highly alcohol aroma, caused by 60% of alcohol composition [1]. Various additional aroma ingredients have been applied, but mainly using a chemical compound which can cause irritating defection to the skin. Therefore, to carry out green chemistry production system, the agro-industrial by product can be used as the source of natural aroma.

Natural aroma can be obtained using essential oil, which is mainly consists of volatile compounds. One of the most abundant resources for essential oil is orange peels. Indonesian production of orange in 2019 is estimated to increase by 5% from 1.9 million metric tons. Orange by-product was generated around 50% of each fresh orange fruit [2], which mainly composed of peel, seed, and pulp. The compositions of orange by-product include fat, sugar, acid [3], insoluble carbohydrates [4], enzyme, pigments [5], pectin, and essential oil [2].

Essential oil extracted from orange peels has been used in food and pharmaceutical industries for its anti-inflammatory and anti-bacterial effects [6]. In addition, substantial quantity of this substance has been used for home care products such as toilet soaps, perfumes, and cosmetics [7]. Several studies were reported that the essential oil form orange peels contained biological activity effect, such as anti-fungal [8], anti-oxidant [9], anti-inflammatory, and anti-microbial activities [10,11]. There are also inhibitory effects to the microbial contaminant such as Salmonella and Streptococcus from the
orange peels [10]. Therefore, the present study was aimed to formulate a hand sanitizer with a sweet scent and antimicrobial activity using essential oil from two different types of orange peels.

2. Materials and Method

2.1. Sample preparation
Two type orange peels, include baby orange (BO) and sweet orange (SO), were obtained from Selorejo, Dau, Malang Regency, East Java, Indonesia. Prior to the extraction, both orange peels were pre-treated using pulsed electric field (PEF) and the extraction was conducted based on Sukardi et al. method [12] in Laboratory of Essential Oil, Universitas Brawijaya. Carbopol and alcohol were purchased from local store. A commercial product was used as control sample.

2.2. Hand sanitizer formulation
About 0.5 g of carbopol was diluted in 30 mL of distilled water at 80°C, the mixture was then stirred at 200 rpm for 5 minutes. Mixture of 2 drops trietanolamin, 0.2 g propil paraben, and 1 mL of glycerine diluted in 10 mL of alcohol 70% was prepared. The carbopol and alcohol mixture were then homogenised. The essential oil from BO and SO peels was then added to the homogenised mixture.

A randomized block design (RBD) was used with one factor of the essential oils proportion (BO:SO) with five levels of 1:0; 0.75:0.25; 0.5:0.5; 0.25:0.75; 0:1 (further labeled as A1-A5 treatment ID). These 5 different proportions of essential oils were added in the formulation of making the hand sanitizer. All treatments were carried out five times. The proportion of each compound is shown in Table 1.

| Compound         | Proportion |
|------------------|------------|
| Carbopol         | 0.5%       |
| Alcohol 70%      | 60%        |
| Glycerine        | 1%         |
| Trietanolamin    | 2 drops    |
| Essential oil    | 1%         |
| Distilled water  | 38.5%      |

2.3. Product characterization
Physical properties (i.e. pH, density, and viscosity) and microbiological tests of Salmonella sp. (i.e. total plate count and area of bacterial inhibition) were performed. 10 mL of the sample was measured using pH meter. The viscosity of the sample was determined using viscometer Brookfield with 50 mL of the sample for each measurement. Density of the sample was measured using Picknometer. MacConkey agar was prepared with Salmonella sp. as starter. The bacteria count was carried out using a colony counter, and analyzed using McNemar test. Sensory tests namely aroma, color, viscosity, sticky and clarity were also performed to determine consumer response for the best treatment. The sensory analysis was examined by involving 30 untrained respondents. The respondents were asked to apply the sample to their palms, and blindly rated for each characteristics of the test. Each characteristic has score of 1 (strongly disliked) to 5 (strongly liked).

3. Results and Discussion

3.1. Product characteristics
Table 2 shows, that, in average, the pH of hand sanitizer was ranged from 4.50-4.66. This result indicates that the product is safe for the skin as shown by its pH tolerant at 4.5-6.5 [13]. The low pH of the product was possibly caused by the addition of orange peel essential oil as it has lower range pH of 3.33-3.35. On the other hand, the pH of mixture of carbopol and alcohol was 5.86. Therefore, the pH fluctuation in this study was not significantly different.
Table 2. Physico-chemical characteristics of hand sanitizer from each treatment

| Treatment ID (BO:SO) | pH    | Density (g/mL) | Viscosity (cP) | TPC   | Area Inhibition (mm) |
|----------------------|-------|----------------|----------------|-------|----------------------|
| A1 (1.00: 0.00)      | 4.60  | 0.995          | 11140          | 191.4 | 3.86                 |
| A2 (0.75: 0.25)      | 4.50  | 0.996          | 10900          | 148.6 | 6.77                 |
| A3 (0.50: 0.50)      | 4.55  | 0.963          | 10060          | 178.2 | 4.32                 |
| A4 (0.25: 0.75)      | 4.56  | 0.970          | 9080           | 201.6 | 5.26                 |
| A5 (0.00: 1.00)      | 4.66  | 0.971          | 10160          | 188.6 | 6.74                 |

Note: letter notation above each parameter value (a, b, c, and d) denote significant differences among treatment from five replicates.

The results indicated that all treatments have the density approximately in the range of 0.970-0.996 g/mL, which already met with the expected specification. The density of this product was lower than water, it means the product can be easily applied to the skin. Increasing in density value to above the density of water indicates that the gel is hardly spread to the skin.

The viscosity of the hand sanitizers was inclined to be higher with the addition of BO. The result indicated that essential oil of BO contains more resin than that of the SO, which is difficult to evaporate leading to much higher viscosity [14]. However, the viscosity of the resulted hand sanitizer was still in accordance with the specification standard (2381-165893cP). This value means that the product can be easily poured and dripped on the palm of the hand.

The experimental results also confirmed that all treatments have anti-microbial activities, as indicated by a reduction in the number of the microbe and the area of inhibition. The high amount of area inhibition was caused by enzyme contained in the orange peels essential oil. The specific enzyme was called limonene [6], which can disturb microbial cell permeability, then caused cell to lysis [15].

Based on the quality parameters tested, the findings demonstrated that treatment of A2 with addition of 0.75 BO and 0.25 SO was selected as the best treatment. A2 treatment has the superior anti-microbial activities, as well as the highest value in physical characteristics. The best treatment was then compared to the commercial hand sanitizer as control, which can be seen in the Table 3. The results clearly shown the hand sanitizer resulted from A2 treatment was more efficient in the anti-septic activity, caused higher of microbial inhibition mainly by limonene enzyme. These results were similar to the investigation of Shetty [10], which gave in the range of 10 to 15 mg/mL for Streptococcus mutans and Lactobacillus acidophilus.

Table 3. Hand sanitizer comparison

| Compound      | Control | A2   |
|---------------|---------|------|
| pH            | 5.76    | 4.5  |
| Density (g/ml)| 0.937   | 0.966|
| Viscosity (cP)| 9800    | 10900|
| TPC           | 206     | 148.6|
| Area inhibition (mm)| 1.82 | 6.77 |

3.2. Consumer acceptance
The hand sanitizer from the selected best treatment (i.e. A2 treatment) was then evaluated using sensory analysis test. The result shows that the sweet scent aroma from orange peel essential oil was favored by all respondents, as depicted in Table 4. Same level of score was evaluated in the thickness and sticky of the product. The findings in this study indicated that the resulted hand sanitizer was marketable and has the potential for further mass production or commercialization.
4. Conclusions
This study demonstrated that essential oil from orange peels is potential to be used as additional ingredient for enhancing the aroma hand sanitizer. The best treatment was obtained from A2 treatment, in which the formulation with the proportion of 0.75:0.25 (BO:SO) produced hand sanitizer with acceptable physical and microbial quality parameters. The characterization of the resulted hand sanitizer has an average of bacterial inhibition area of 6.77mm which was more efficient than the control sample. The sensory test results revealed that the sweet scene of the product was 77% liked by the respondents. The findings also confirmed that the addition of essential oil from orange peels can enhance the anti-microbial activity of hand sanitizer.

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| Table 4. Consumer response of hand sanitizer from A2 treatment |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Responses | Colour | Clarity | Aroma | Thickness | Sticky |
| Score 5 | 40 | 53 | 23 | 7 | 23 |
| Score 4 | 30 | 7 | 77 | 33 | 37 |
| Score 3 | 30 | 40 | 0 | 50 | 40 |
| Score 2 | 0 | 0 | 0 | 10 | 0 |
| Score 1 | 0 | 0 | 0 | 0 | 0 |

Note. Value was shown in the percentage
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