

Extraction of essential oil from baby Java orange (*Citrus sinensis*) solid waste using water and steam distillation

I A Dewi, A M Prastyo and S Wijana

Department of Agro-industrial Technology, Faculty of Agricultural Technology,
Universitas Brawijaya, Malang, Indonesia

E-mail: ikaatsaridewi@ub.ac.id

Abstract. Baby java orange (*Citrus sinensis*) is commonly consumed as juice. Processing of baby java orange leaves organic waste which consist of the mesocarp, exocarp, seed, and wall of the orange. Therefore, it is necessary to process baby java orange waste to be valuable products. The purpose of this study was to provide added value to unutilized baby java orange waste, and to find out the pretreatment of time-delay process that maximize the yield of essential oil produced. Essential oil processing can be done by water and steam distillation. The study used randomized block design with one factor namely distillation time-delay process by air drying consisted of 4 levels i.e. the distillation delay for 2, 4, 6, and 8 days. The best treatment was determined based on the yield. The best essential oil from baby java orange waste was obtained from the treatment of distillation delay-process of 8 days. This pretreatment generated yield value of 0.63% with moisture content of 24.21%. By estimating the price of essential oil showed that this effort not only reduced the bulky organic waste but also provided potential economical value.

1. Introduction

Orange is one of Indonesian widely cultivated commodity. Malang Regency has productively cultivated baby java orange. Baby java orange belongs to sweet oranges due to its dominant distinctive sweetness so it is commonly processed as fruit juice [1]. However, baby java orange contains vitamin, nutrient, minerals, and volatile compound which could be extracted as essential oil [2].

The high productivity of baby java orange in Malang is not accompanied by sufficient post-harvest process. As a result, plenty of unprocessed matter such as mesocarp, exocarp, seed, and wall of the orange that have potential economic value remained wasted. Un-processed parts of oranges contain high amount of aromatic volatile compound which can be processed into essential oil [3]. Volatile compound is commonly found in epidermis, flavedo, albedo, and oil glands [4]. Processing of these untreated parts of baby java orange may become the first step to produce value added by-product considering the fact that orange's essential oil are sold IDR 600,000 to IDR 700,000 each kilogram [5]. The final product may undergo another process to become industrial derivative products such as perfume, soap, air freshener, health products and many more [6].



Essential oil extraction can be done through distillation. There are some techniques of distillation which can be used, they are: steam distillation, water distillation, and water and steam distillation which was used in this research. Water and steam distillation works by separating or clarifying water-insoluble compound. The first step that needs to be done is air drying of baby java orange organic solid waste in order to disintegrate the orange cells and to facilitate releasing the oil [7].

One example of material handling process as pretreatment of distillation is air drying. Selected material is put in a room avoided by direct sun exposure but still aerated. This pretreatment is chosen because it doesn't cause excessive heat which can lead to water and volatile substances evaporation. Another advantage of air drying is the low required cost [8]. Sipahelut [9] stated air drying executed before distillation to extract essential oils could reduce moisture content and resulted in higher yields.

The study aims to discover the pretreatment of delay process time that maximize the yield of essential oil produced. The estimation of the gross revenue from this product is presented.

2. Materials and Methods

2.1. Instruments and materials

The instruments used in this study were water and steam distillation unit. Baby java orange organic solid waste was obtained from street juice vendor nearby the orange plantation in Dau Subdistrict, Malang District, East Java Province. As additional material, water was used in distillation process [10].

2.2. Research design

Research design had been carried out to determine the best treatment that produced the best essential oil out of baby java orange waste. Several analysis including yield and moisture content were done. This study used Randomized Block Design accomplished by using 1 factor, which was air drying duration: 2; 4; 6; and 8 days. Each of these 4 levels has been repeated 5 times.

2.3. Essential oil production

The production of essential oil was started by preparing organic solid waste from baby java orange. As many of 2.5 kg of baby java orange waste were air-dried for 2, 4, 6 and 8 days. After this time-delay process pretreatment, the waste were chopped into smaller pieces with maximum area of 4 cm². Before the process of distillation, water content of each treatment was measured.

Distillation process was started by filling 2.5 L of water into the kettle (distillatory cylinder), then heated up to 100-115°C. The material was distilled for 4 hours. Remaining water and waste after distillation were measured. From this process, baby java orange essential oil was obtained. The yield was determined by following formula [11].

$$\text{Yield} = \frac{\text{Oil volume} \times \text{Essential oil specific gravity}}{\text{Total distilled material}} \times 100\% \quad (1)$$

3. Results and Discussion

3.1. Moisture content and yield

The air drying of baby java orange organic solid waste was done by spreading material in a room that was not exposed directly to the sun. The delay process was carried out at a temperature range of 24 °C to 26.9 °C and room humidity ranged from 60% to 83%. The time-delay process resulted in reduced moisture content in the material due to water evaporation. The decrease in moisture content is parallel with an increase in time-delay process, as shown in Figure 1.

Average yield of baby java orange waste essential oil was rising as the increased distillation delay time of 2 days, 4 days, 6 days and 8 days. Correlation between average yield value and time-delay process is presented on Table 1.

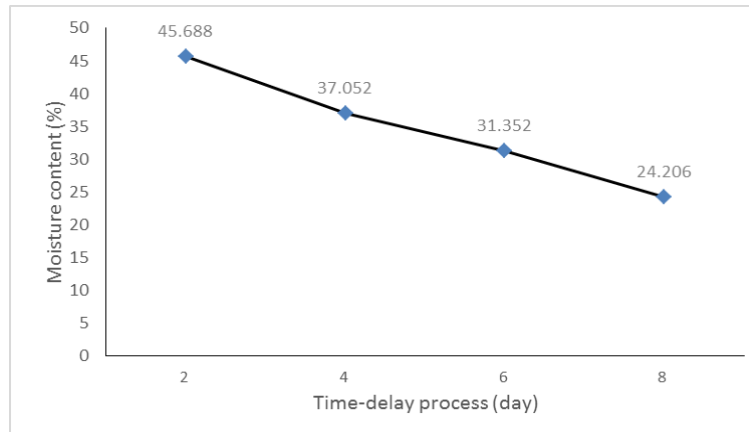


Figure 1. The effect of time-delay process on moisture content of baby java orange organic waste prior to distillation

Essential oil yield is affected by its moisture content since the less water in material, the more essential oil yield [9]. According to [12][13], water evaporation caused oil cell to rupture which allows the vapor to enter the cell and pulls out the oil. Damage to the pores could affect the damage of oil cell walls so that the oil and the content of volatile compounds in it would be more easily taken. Treatment of distillation delay process for 8 days is the best treatment because it affected the decrease in moisture content and damage to the texture of the material distilled. According to [14], the longer the delay process, the more essential oil produced.

Table 1. The Effect of Time-Delay Process of Distillation on Essential Oil Yield ($\alpha=5\%$)

Time-Delay Process (Days)	Average (%)	Least significant difference	Notation
2	0.18 ± 0.018	0.28	a
4	0.41 ± 0.038	0.51	b
6	0.48 ± 0.047	0.58	b
8	0.63 ± 0.095	-	c

Note: different notation indicates considerable difference among treatments

3.2. Gross revenue estimation

Opportunity of utilization of baby java orange waste to be essential oil is very high. The production figures of baby java orange in Dau Subdistrict in 2011 reached 24.5 million kg and continues to increase every year [15]. From the whole fruit, the waste of baby orange processed into juice reached 54.9%. Suppose that 50% of total waste in one year can be utilized to become essential oil. By considering the average yield of essential oil of about 0.63%, the amount of essential oil obtained can reach approximately 42,369 kg per year. Given the high price of citrus essential oil can attain IDR 700,000/kg [5], the gross revenue from the production of essential oils of baby java orange waste if accumulated in one year can reach IDR 29,658,300,000.

Citrus waste contains many kinds of bioactive compounds which can be used as anti-cholesterol, healthy digestion, improve respiratory conditions, as peptin flour, and utilization as essential oil [3]. From essential oil, many benefits can be obtained.

4. Conclusion

Time-delay process of the production of baby java orange juice waste into essential oil showed significant effect to the yield. The best treatment was obtained from distillation delay process of air drying for 8 days. This pretreatment generated yield value of 0.63% with moisture content of 24.206%.

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