

**Industrial Sour Orange (*Citrus aurantium*) Waste Peels as a Source of Essential Oil:  
Extraction and Utilization in Food Industry**

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**Abstract**

Fruit peel waste represents a significant portion of agricultural by-products generated during food processing and consumption. The citrus fruit peels are rich in essential oils, which have valuable applications in various industries like food, pharmaceutical, cosmetics, and cleaning. Extracting essential oils from orange peels waste not only provides economic benefits but also promotes sustainable waste management. The sour orange (*Citrus aurantium*) peels are known to be rich in essential oil but considered as a waste product. Therefore, this research study was conducted to extract essential oil from waste sour orange peels using steam distillation and to evaluate its physico-chemical characteristics. The essential oil was extracted by Kjeldahl apparatus using four different treatments. The extraction using distilled water (T<sub>1</sub>) as Control and others were carried out by 3% (T<sub>2</sub>), 5% (T<sub>3</sub>), and 7% (T<sub>4</sub>) NaHCO<sub>3</sub> solutions. The oil and water phase were separated in a 250ml separating funnel with n-hexane. The extracted essential oil was stored for 4 months under normal atmospheric conditions (30°C and 75-80% RH). The physico-chemical characteristics such as density, specific gravity, yield % and pH were analyzed using Standard AOAC methods after extraction and during storage. Sensory evaluation on color and odor was conducted using 30 semi-trained panelists. The results indicated that the T<sub>3</sub> treatment with 5% of NaHCO<sub>3</sub> was found to be the best considering the density 0.91g/cm<sup>3</sup>, specific gravity 0.83, yield of 3.15% (w/w), and the pH of 6.57. Non-significant differences were observed in these quality parameters with other treatments. Results revealed that, using 5% NaHCO<sub>3</sub> solution for essential oil extraction from sour orange peel resulted in a higher oil yield compared with distilled water. The extracted oil has a distinct pale yellowish color with a fresh and tangy odor. The treatment T<sub>3</sub> exhibited that the oil had a distinct color and odor even at the end of the storage period. The pH value of the essential oil was the highest in the T<sub>4</sub> treatment and may be due to the pH of the extracted solution used. Microbial studies were carried out at the end of 4 months of storage and the products were free from microbial activities and contamination. Based on the yield %, quality characteristics and microbial stability, the essential oil extraction using 5% NaHCO<sub>3</sub> was found to be the best treatments, and the oil could be used for 4 months without any significant changes in the quality characteristics.

**Keywords:** *Essential oil, Physico-chemical characteristics, Sour orange peels, Steam distillation, Waste management*