Oxidative Degradation of Carrot Residue with Sodium Hypochlorite

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***Abstract*—Oxidative degradation of carrot residue by sodium hypochlorite was investigated. The extraction products and oxidation residues were analyzed by Fourier transform infrared spectroscopy (FTIR). When the dosage of sodium hypochlorite ranged from 30 to 54 mL, the conversion of carrot residue was 31.33%, 29.80%, 26.37%, 24.50% and 50.40%, respectively. When the dosage of sodium hypochlorite was 54 mL, the degradation ability of carrot residue was the highest. The FTIR spectra of the extracts showed strong peaks at 54 mL and weak in the oxidized residue. Ultraviolet and fluorescence analysis showed that the oxidation products of carrot residue had fluorescence properties.**

Keywords—Carrot residue, Degradation, NaOCl, FTIR

I. INTRODUCTION

Carrot is a nutritious, crisp, tasty and homely vegetable. It is often called "small ginseng". Carrot contains a series of nutrients such as sugar, carotene, fat, vitamin A, vitamin B_1, vitamin B_2, volatile oil, anthocyanin, calcium, iron and so on[1,2]. Our country is rich in carrot resources. In recent years, the deep-processing products of carrot pulp, carrot juice and other series of carrots have developed very rapidly. With the production of these deep-processing products, at least 40% of carrot residues will be produced. Now, after processing carrot products, many enterprises generally use these remaining carrot residues as feed or dump them directly, which seriously wastes resources and pollutes the environment.

NaOCl, as a convenient, easily available and inexpensive oxidant, has the advantages of safety and mild reaction conditions, and has been widely used as an oxidizing agent[3-12]. In this paper, oxidation degradation of carrot residue with NaOCl is studied.

II. EXPERIMENTAL

A. Materials

Carrot residue used in this study was collected from Xuzhou city, Jiangsu, China. It was washed with de-ionized water, and dried in an oven at 60 oC for 12 h, then which was ground to pass through 20 mesh sieve and stored in a desiccator at room temperature before using. All chemicals used in the experiment are analytical grade, obtained from the commercial source, and were used without further purification.

B. Experimental Method

3.0 g carrot residue dried and an equal volume of NaOCl were added into three necked bottle and reacted for 3 h under ultrasonic at 60 oC. The reaction mixture was filtered to obtain oxidized residue and filtrate respectively. The filtrate was adjusted to 2~3 with concentrated hydrochloric acid, solid suspensions will precipitate and then filtrate again to obtain solid acid and filtrate insoluble in water. The filtrate is extracted with ethyl acetate to obtain ethyl acetate extract. Then the filtrate is dried, filtered and distilled with anhydrous magnesium sulfate to obtain concentrated solution.

The extracts oxidation residue ained were analyzed by FTIR spectroscopy (Alpha, Bruker company, German) using potassium bromide tableting method over a scan range of 500 to 4000 cm^{-1}.

Calculation formula of oxidation conversion rate (a%) of carrot residue:

$$\alpha = \frac{(m_0 - m_1)}{m_0} \times 100\%$$

m_0——Raw carrot residue(g)

m_1——Oxidized residue(g)

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III. Results and Discussion

A. Conversion Rate

With the degradation reaction of carrot residue and NaOCl, the reaction solution gradually changed from orange yellow to white. Carrot dregs were reacted with 30 mL, 36 mL, 42 mL, 48 mL and 54 mL sodium hypochlorite respectively. Their conversion rates were 31.33%, 29.80%, 26.37%, 24.50% and 50.40%, respectively. Conversion rates of oxidative degradation of carrot residue with NaOCl are shown in Figure 1. When the dosage of sodium hypochlorite is 54 mL, the degradation of carrot residue is more thorough.

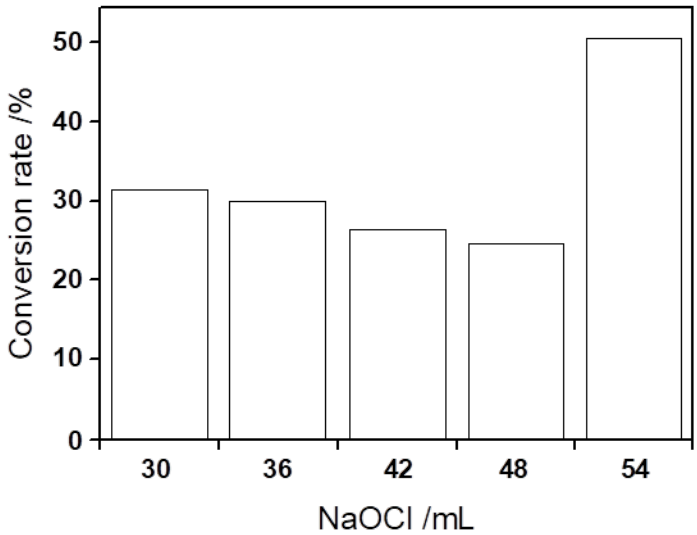

Figure 1. Conversion rate of oxidative degradation of carrot residue with NaOCl

B. FTIR Analysis

FTIR spectra of extracts, raw materials and oxidation residues of carrot residue with NaOCl are shown in Figure 2 and Figure 3. A strong and broad absorption peak at about 3500 cm^{-1} is stretching vibration of hydroxyl group. The C-H absorption peak of methyl and methylene appeared at about 2940 cm^{-1}. At about 1730 cm^{-1}, strong absorption indicates carbonyl, while no absorption at 2720 cm^{-1} indicates that it is not aldehyde group. The strong absorption peak at about 1615 cm-1 implies a carbon carbon double bond. At 1300 cm^{-1} and 1100 cm^{-1}, the peak is C-O bond stretching vibration. As can be seen from Figure 2, the content of hydroxyl group was higher in 48 and 54 ml sodium hypochlorite extract. With the increase of NaOCl dosage, the absorption strength of carbonyl and methylene methylene increased. The peak of carbonyl absorption is strongest in the extract. The C-O absorption peak is strongest in 54 ml sodium hypochlorite extract. As can be seen from Figure 3, there are functional groups such as hydroxyl, aliphatic hydrocarbon, carbonyl,carbon oxygen and double bond in raw and oxidation residues, hydroxyl peak is the strongest absorption peak. With the increase of sodium hypochlorite consumption, the absorption intensity of each peak decreases.

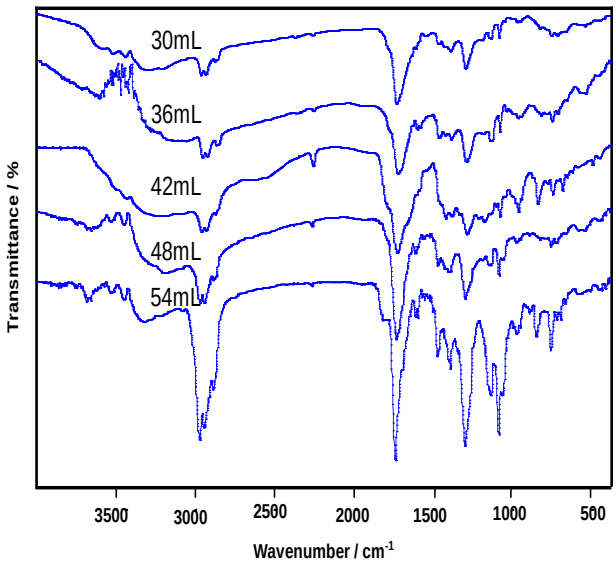

Figure 2. FTIR spectra of extract of oxidative degradation of carrot residue with NaOCl

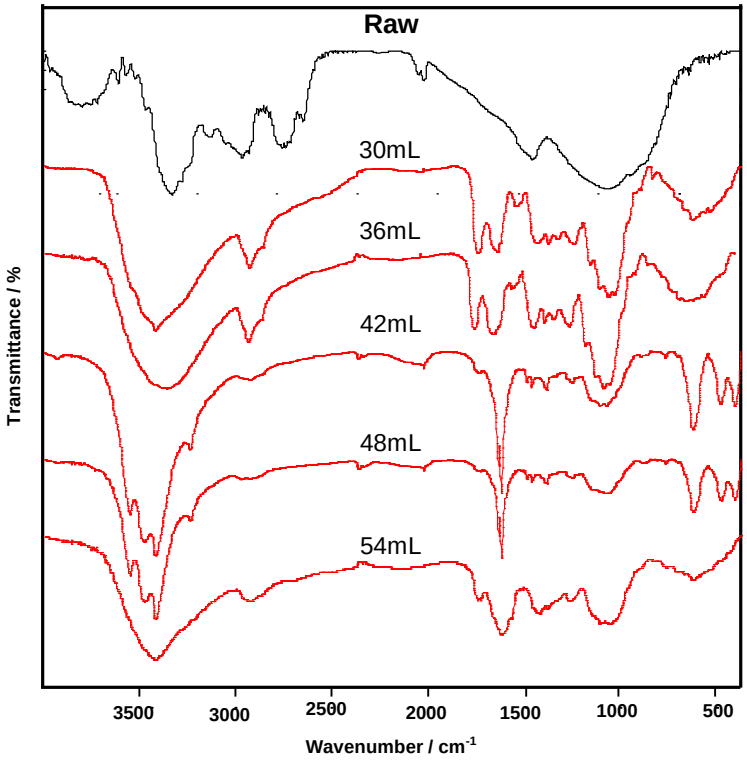

Figure 3. FTIR spectra of raw materials and oxidation residues of carrot residue with NaOCl

C. Ultraviolet and Fluorescence Analysis of Oxidation Products

The wavelength of oxidation product of carrot residue is 272 nm and Abs absorbance is 0.558. According to the wavelength of ultraviolet radiation is 272 nm, Ex is 272 nm, and fluorescence analysis is measured, As shown in Fig. 4. The emission wavelength of Em is 330 nm and the height of H is 42.48, showing that the oxidation products of carrot residue with NaOCl oxidation degradation were fluorescent.

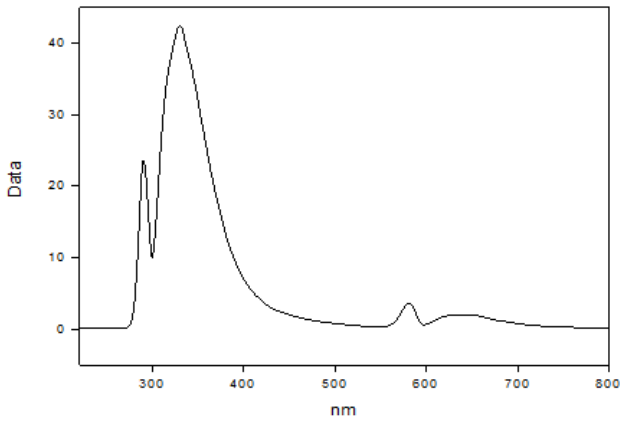

Figure 4. Fluorescence of oxidation products of carrot residue

IV. Summary

Oxidative degradation of carrot residue by sodium hypochlorite was investigated. With the increase of sodium hypochlorite dosage, the conversion decreased first and then increased, and the highest was 50.40% at 54 ml. with the increase of sodium hypochlorite content, the absorption peak strengths of oxygen-containing functional groups, carbonyl functional groups and methylene functional groups decreased, the absorption intensity was the strongest at 54 ml. With the increase of sodium hypochlorite dosage, the absorption peaks of functional groups of carrot residues decreased. Ultraviolet and fluorescence analysis showed that the oxidation products of carrot residue had fluorescence properties.

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