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Sulfur-Containing Compounds: Natural Potential Catalyst for the Isomerization of Phytofluene, Phytoene and Lycopene in Tomato Pulp

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Abstract

The effects of some sulfur-containing compounds on the isomerization and degradation of lycopene, phytofluene, and phytoene under different thermal treatment conditions were studied in detail. Isothiocyanates such as allyl isothiocyanate (AITC) and polysulfides like dimethyl trisulfide (DMTS) had the effect on the configuration of PTF (phytofluene), PT (phytoene), and lycopene. The proportion of their naturally occurring Z-isomers (Z1,2-PTF and 15-Z-PT) decreased and transformed into other isomers including all-trans configuration, while Z-lycopene increased significantly after thermal treatment, especially for 5-Z-lycopene.

Keywords: Sulphur; Natural Potential; Isothicynates, Phytone, lycopene, phytofluene; Phytoene; sulfur-containing compounds; Isomerization

Introduction

Introduction Tomato, as one of the most widely cultivated crops in the world, is rich in phenolic compounds, vitamin C, carotenoids, amino acids, etc. [1]. Tomato and tomato-based products play an important role in diet because of their unique flavour and high nutritional value Numerous epidemiological studies showed that tomato consumption can reduce the risk of many cancers, including breast and prostate cancer as well as chronic diseases such as cardiovascular disease and diabetes Carotenoids are the most important nutrients in tomato including lycopene, phytofluene (PTF), phytoene (PT), etc. Lycopene is the main carotenoid and responsible for the red color of tomatoes. pointed out that the health benefits of consuming tomato and its products may the synergies between lycopene and other ingredients, not only lycopene. As a matter of fact, PTF and PT are also important to human health. In an assessment in Luxembourg, the daily intake of PTF and PT contributed 16% of total daily carotenoid intake, which was higher than lycopene Particularly, PTF and PT are strongly present in their cis-isomers in natural plants. Due to their naturally existing cisisomers, the bioavailability and bioaccessibility of them are much higher than lycopene in the same food matrices In addition, PTF and PT are proved to have health-promoting actions, such as antioxidant and anti-inflammatory properties along with a reduced risk of various diseases [2].

Materials and Methods

Chemicals and Reagents The cherry tomatoes (Lycopersicon esculentum var. cerasiforme) IVF3535 were provided by Xinjiang Guannong Fruit &Antler CO., LTD.; extra virgin olive oil and fresh shii-take mushrooms were purchased at the local supermarket; all-E-lycopene was purchased from Huabei pharmaceutical factory; phytofluene and phytoene(a mixture of E/Z isomers) were purchased from Carotenature, Switzerland; methanol, acetonitrile, and methyltert-butyl ether (MTBE) for chromatography [3].

Effect of the Types of Sulfur-Containing Compounds on the Isomerization and Degradation of PTF, PT, and Lycopene Different types of isothiocyanates (MITC, BITC, AITC) and polysulfides (DADS, DATS, DMTS) were first dissolved in olive oil at a concentration of 20 mg/g, and then 5% olive oil with or without (control group) sulfur-containing compounds was blended into tomato pulp as a mediator of the E/Z-isomerization. The final concentration for isothiocyanates and polysulfides in tomato puree-olive oil mixture was 1 mg/g. Obtained mixture was added into a 20 mL screw-capped glass bottle and air was purged by nitrogen gas. The mixture was then heated at 80°C for 1 h in a water bath. After thermal treatment, samples were immediately cooled down and stored at −20 °C until analysis. 2.3. Effect of the Concentration of DMTS and AITC on the Isomerization and Degradation of PTF, PT, and Lycopene One of the polysulfides and isothiocyanates each—DMTS and AITC—were selected to investigate the effect of concentration on the isomerization and degradation during thermal treatment. Briefly, DMTS and AITC were both dissolved in olive oil in the concentration of 4, 10, 20, 40, 80, and 100 mg/g, respectively, then 5% olive oil was blended into tomato pulp. The concentration of DMTS or AITC in mixture was 0.2, 0.5, 1, 2, 4, and 5 mg/g in the end. The mixture was then put into a glass bottle, purged of air by nitrogen gas, and heated at 80°C for 1 h in a water bath. After thermal treatment, samples were immediately cooled down and stored at −20°C until analysis. 2.4. Effect of the Reaction Temperature on the Isomerization and Degradation of PTF, PT, and Lycopene One of the isothiocyanates (AITC) and polysulfides (DMTS) each were chosen for further study. DMTS and AITC were dissolved in olive oil at a concentration of 20 mg/g, respectively, and then 5% olive oil was blended into tomato pulp. The final concentration of DMTS and AITC was 1 mg/g mixture. Then the mixture was heated at different temperature (40°C, 60°C, 80°C, 100°C, 120°C) for 1 h. After the thermal treatment, samples were immediately cooled down and stored at −20°C until analysis. 2.5. Effect of the Reaction Time on the Isomerization and Degradation of PTF, PT, and Lycopene DMTS and AITC were dissolved in olive oil at a concentration of 20 mg/g, and then 5% olive oil was blended into tomato pulp. The final concentration of DMTS and AITC was 1 mg/g

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mixture. Then the mixture was heated at 80°C for 0, 10, 20, 30, 60, 90, and 120 min. After the thermal treatment, samples were immediately cooled down and stored at −20°C until analysis. 2.6. Preparation of the Tomato and Shii-Take Mushroom Mixture Different proportion (10%, 20%, 30%, 40%, 50%) of shii-take mushroom and 5% olive oil were added into the tomato pulp. The mixture was homogenized by a food processor and then transferred into a 50 mL screw-capped glass bottle and air was purged by nitrogen gas. The mixture was then heated at 80°C for 1 h in a water bath. After thermal treatment, samples were immediately cooled down and stored at −20°C until analysis [4] .

Extraction of Carotenoids Carotenoids extraction from the tomato : briefly, about 5 g of the tomato pulp were added into triangle beaker with 20 mL extraction solvent: n-hexane: methanol: acetone (2:1:1, v/v/v), and then stirred 20 min under the dim light to prevent the degradation of carotenoids. The supernatant was collected by vacuum filtering, and filtered residue was repeated extraction two times until the color faded. The supernatant was combined together and the organic phase which containing carotenoids was separated with separating funnel, and then concentrated by rotary evaporator at 35°C. The concentrated extraction was dissolved in ethyl acetate and diluted with methanol: MTBE (1:1, v/v) to a proper concentration. Carotenoid extraction from the aqueous micellar phase: 3 mL of the micellar was extracted three times with 5 mL of hexane and methanol (1:1 v/v). The organic phase was collected and evaporated to dryness under nitrogen and dissolved in 100 μL methanol: MTBE (1:1, v/v) for the HPLC quantification [5] .

Conclusions

This study investigated the isomerization and degradation of lycopene, PTF, and PT in tomato pulp with sulfur-containing compounds. Sulfur-containing compounds had the effect on the isomerization of lycopene, PTF, and PT, and increasing the heating temperature, time, and concentration of DMTS and AITC could promote the isomerization reaction effectively. Meanwhile, the isomers of PTF and PT had good thermal stability. Moreover, the bioaccessibility of lycopene could increase significantly with the addition of shii-take mushroom containing sulfur compounds, although this had no positive effect on that of PTF and PT. However, the bioaccessibility of PTF and PT were still far higher than that of lycopene. According to the study, cooking or processing tomatoes with the foods containing sulfur-containing compounds could improve the absorbency of total carotenoids. These findings can provide a reference to forecast their expected isomeric profiles in tomato and other carotenoid-containing manufacturing.

Acknowledgement:

None

Conflict of Interest:

None

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