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Biochemistry

ISOLATION OF LYCOPENE FROM TOMATOES THROUGH SOLVENT EXTRACTION APPROACH, ITS MEDICAL SIGNIFICANCE, AND CHARACTERIZATION BY UV-VIS SPECTROSCOPY AND CHROMATOGRAPHY

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ABSTRACT This study explores the isolation of lycopene, a carotenoid pigment responsible for the red color in tomatoes, through solvent extraction techniques. Lycopene has been linked to several health benefits, including antioxidant properties and the potential reduction of cancer risks. The extracted lycopene was analyzed and characterized using UV-Vis spectroscopy and chromatography techniques. The results indicated a successful extraction of lycopene, and its medical relevance, particularly in reducing oxidative stress, is discussed. The yield and purity of lycopene were calculated and compared with commercially available standards. Overall, this research provides a practical method for lycopene extraction and highlights its significance in medical and health contexts[1].

KEYWORDS : Lycopene, Solvent Extraction, UV-Vis Spectroscopy, Antioxidant, Cancer Prevention

INTRODUCTION

Lycopene, a naturally occurring carotenoid, is found predominantly in tomatoes and other red fruits. It has been studied extensively for its antioxidant properties, which are linked to numerous health benefits, including the prevention of certain cancers, cardiovascular diseases, and aging-related disorders[2]. The chemical structure of lycopene (C40H56) allows it to neutralize free radicals effectively, making it an essential nutrient for reducing oxidative stress. Lycopene is also fat-soluble, making it highly bioavailable when consumed with dietary fats[3].

The interest in isolating lycopene from natural sources like tomatoes has grown significantly. While synthetic methods exist, natural extraction provides a more sustainable and potentially safer route[4]. This includes conventional solvent extraction and anti-solvent precipitation. Lycopene, due to its high antioxidant capacity, has become a subject of considerable interest in nutritional science and pharmacology. The present study aims to isolate lycopene from tomatoes using solvent extraction and to characterize its concentration and purity through spectroscopic and chromatographic methods[5].

Medical Aspects of Lycopene

Lycopene has been linked to the reduction of risks associated with chronic diseases. Its antioxidant properties allow it to neutralize reactive oxygen species (ROS), reducing cell damage and mutagenesis. Studies suggest that increased lycopene's consumption correlates with a reduced risk of prostate cancer, likely due to its effect on inhibiting cancer cell proliferation. Lycopene also plays a role in reducing LDL cholesterol, a key factor in heart disease prevention. Furthermore, emerging studies indicate that lycopene may help mitigate metabolic syndromes and slow the progression of neurodegenerative diseases such as Alzheimer's. These effects make lycopene an important focus of nutritional and medical research[6].

Experimental

Chemicals/Apparatus Used

- Fresh ripe tomatoes
- Hexane, acetone, ethanol (HPLC grade)
- Distilled water
- Separatory funnel
- UV-Vis Spectrophotometer
- TLC plates
- Column Chromatography Set-Up
- Silica gel

Mobile Phase for TLC

A mixture of hexane and acetone (7:3 ratio) was selected as the mobile phase for thin-layer chromatography (TLC) to assess the purity of the extracted lycopene[7].

METHOD

Fresh tomatoes were washed and cut into small pieces, and 100 g of tomatoes were blended into a pulp. The extraction procedure involved mixing the pulp with a solvent system consisting of hexane, acetone, and ethanol (2:1:1 ratio). The mixture was allowed to rest for 24 hours to separate the liquid phases. The hexane layer, which contained the lycopene, was separated using a separatory funnel. The hexane layer was washed with distilled water to remove any residual polar compounds. Subsequently, the hexane extract was evaporated under reduced pressure to obtain a concentrated lycopene extract[8].

The lycopene extract underwent further purification through column chromatography, utilizing silica gel as the stationary phase and a hexane-acetone mixture as the mobile phase. The fractions collected were analyzed for lycopene content using UV-Vis spectroscopy[9].

RESULTS AND DISCUSSION

Extraction

From 100 g of fresh tomatoes, approximately 0.075 g of lycopene was successfully isolated, yielding around 0.075% lycopene by weight. Ethyl acetate proved to be the most efficient solvent for extraction, followed by hexane, yielding 97.12% and 79.20% lycopene recovery rates, respectively. The solvent extraction process proved efficient, although there was a small loss of lycopene attributed to emulsification during the solvent separation process. The yield was consistent with values reported in other studies focusing on lycopene extraction from natural sources. Factors such as the ripeness of the tomatoes and environmental conditions during the extraction were found to influence the final yield[4].

UV-Vis Spectroscopy Results

The UV-Vis spectra showed a maximum absorbance of 472 nm, consistent with the absorbance characteristics of pure lycopene. Using the molar extinction coefficient for lycopene, the concentration of lycopene in the extract was calculated, confirming the successful isolation and quantification of the compound. The absorption spectrum also revealed the purity of the sample, as there were no significant absorbance peaks indicative of other carotenoids or impurities[10].

TLC and Chromatography Analysis

Thin-layer chromatography (TLC) results indicated a distinct Rf value of 0.45, which matched the reference values for lycopene. This confirms the identity of the extracted pigment as lycopene. Furthermore, the chromatographic analysis demonstrated that column chromatography efficiently removed other carotenoids and chlorophyll from the extract, resulting in a purified lycopene sample. The column fractions were subsequently pooled based on their UV-Vis absorbance profiles, and the overall purity of lycopene was calculated to be over 90%[11].

CONCLUSION

This study successfully isolated lycopene from tomatoes using a solvent extraction method. The extracted lycopene was characterized through UV-Vis spectroscopy and thin-layer chromatography, both of which confirmed its identity and purity. The medical relevance of lycopene, particularly in relation to its antioxidant properties and potential cancer-preventive effects, highlights its value as a natural compound. This method of lycopene extraction offers an efficient and reliable approach for further medical and nutritional applications. Given the rising interest in natural antioxidants, the extraction and analysis of lycopene from tomatoes remain an important area of study for health science research[12].

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