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A Review: Lycopene Extraction, Identification, And Its Applications.

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ABSTRACT- Lycopene is a substance that is a natural pigment. Found in fruits and vegetables such as tomato, guava, watermelon, apricot, papaya, red paper, etc. Lycopene contains important antioxidant properties that may reduce cancer and chronic diseases and give health benefits. Using the different solvents to extract lycopene. It can detect and identify by various analytical methods. Lycopene shows different activities like antibacterial, antioxidants, antifungal, and anti-cancer

KEYWORDS: Lycopene, solvent extraction, antibacterial activity, antioxidants, antifungal, and anti-cancer

I. INTRODUCTION

Food-based antioxidants protect the human body from free radicals such as reactive oxygen. Free radicals are thought to be the primary cause of age-related degenerative illnesses. Natural antioxidants, such as vitamins, carotenoids, and phenolic chemicals, can be found in fruits and vegetables (Oliveira et al., 2010).

Lycopene is a carotenoid, a natural pigment produced by plants and microbes; however, it is not produced by vertebrates or animals (Ranveer et al., 2020). Red fruits and vegetables such as guava, watermelon, papaya, grapefruit, tomato, and gac fruit (Bhumsaidon and Chamchong et al., 2016), also a matured ripen bitter melon (Raul and Interiano et al., 2009) contain lycopene, a natural red pigment (Ahmed et al., 2021). The liver, adrenal glands, fat, pancreas, and lungs all contain lycopene but are not produced (Ribaya-Mercado et al., 1995; Metkar et al., 2014). In plants, lycopene is a natural pigment that protects them from stress while also transferring light energy during photosynthesis (Kavitha, G., Kanimozhi, K. and Panneerselvam, A et al., 2017).

Houston was the first to isolate it from *Tamus communis* in 1873. There are no adverse side effects when taking up to 150 mg of lycopene per day from various sources (Nair and Lilwani et al., 2015).

Lycopene has antioxidant properties and lowers the risk of chronic diseases and cancer. Furthermore, lowering cholesterol levels in the blood protects against human cardiovascular illnesses. (Ahmed et al., 2021) also prevent bladder and digestive tract cancer (Kang et al., 2003; Krinsky and Johnson et al., 2005).

Lycopene is a highly unsaturated hydrocarbon with the formula of $C_{40}H_{56}$ (Kadam et al., 2017). It has 13 carbon-carbon double bonds, 11 of which are conjugated and organized in a straight line. (Joseph Levy and Yoav Sharoni et al., 2004). The vivid red color of lycopene is due to these conjugated double bonds (Raduly et al., 2011).

Lycopene is a lipophilic, or fat-soluble, antioxidant (Aghel N and Amirfakhrian S et al., 2011). It's a β -carotene acyclic isomer (Ranveer et al., 2020) & acyclic polyene structure (Akanbi and Oludemi et al., 2004; Gerster et al., 1997). Sun rays, thermal energy, and chemical processes influence the conversion of lycopene into various cis-trans isomers (Zechmeister et al., 1936). The plasma concentration of lycopene is somewhat higher than that of β -carotene (di Mascio, Raiser, and Sies et al., 1989).

Lycopene lacks provitamin A action because it lacks the β -ionone ring structure because of lycopene's highly conjugated nature (Hadley et al., 2002; Urbonaviciene, Viskelis, and Viškelis et al., 2005) (Urbonaviciene, Viskelis, and Viškelis et al., 2005). Lutein is also a non-vitamin A active carotenoid (Khachik, Beecher, and Cecil Smith et al., 1995). Lycopene has a 536.88 molecular weight (Nair and Lilwani et al., 2015). Lycopene contains 89.45 % carbon and 10.51 % hydrogen (Aghel N and Amirfakhrian S et al., 2011; Kong et al., 2010). Lycopene's method of action is determined by its location within the cell, where it lies parallel to the cell membrane's surface (Naz, Ambreen & Butt, Masood & Pasha, Imran & Nawaz, Haq. et al., 2013).

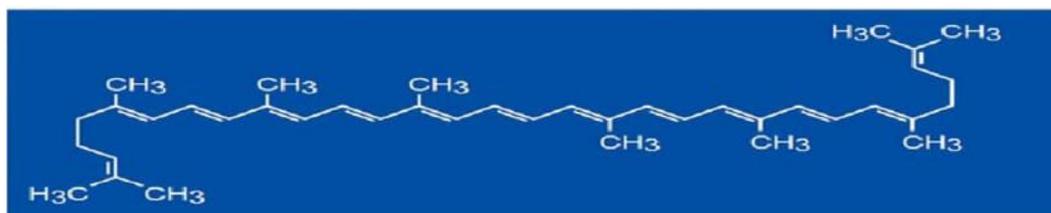


Figure 1 lycopene structure (Kadam et al., 2017)

Moreover, Organic solvents such as chloroform, hexane, benzene, methylene chloride, acetone, and petroleum ether are more soluble because of this chemical structure (Abdullah et al., 2019) and insoluble in water, almost insoluble in methanol and ethanol (Cámara et al. 2013). A single lycopene molecule can neutralize up to 13 free radicals, which can cause cell damage and cancer if allowed to build up (Joshi et al. n.d). According to studies, skin lycopene is more sensitive to UV light stress than β -carotene (Kelkel et al., 2011; Petyaev et al., 2019).

Lycopene has anti-inflammatory properties due to its antioxidant and free radical scavenging properties, which may help minimize cellular damage. It also protects cell membranes from lipid peroxidation by neutralizing hydroxyl radicals and has the potential to bind to DNA, providing further protection beyond antioxidant function (Pennathur et al., 2010).

In the field of food additives research, finding natural plant components with both antioxidant and antibacterial properties becomes an attractive target (Ma et al. 2014).

The effects of the antioxidants in human diets; Lycopene has the highest free radical scavenging activity. It's also the pigment with the second-highest concentration in human blood. Because of its ability to be reactive, this molecule possesses a lot of free radical features. In the presence of light, it oxidizes. In studies, lycopene's high oxidative characteristics have been connected to the prevention of chronic illnesses. Other studies have linked lycopene's free-radical scavenging properties to anti-cancer qualities, and more recent research has linked lycopene to in-vitro and in-vivo cancer prevention (Raul and Interiano et al., 2009).

II. LYCOPENE EXTRACTION METHODS:

The solvent extraction method for lycopene-containing fruits and vegetables like guava, watermelon, papaya, red grapefruit, tomato, red cabbage, beetroot, etc., are as mentioned below;

BENZENE EXTRACTION METHOD:

Initially, the benzene test aids in identifying lycopene in the residue. A simple liquid-liquid extraction method can be used to extract lycopene in the least amount of organic solvent. Recrystallization from ether cleansed the crystals. After that, the crystals were examined under a projection microscope (Nair and Lilwani et al., 2015).

METHANOL EXTRACTION METHOD:

Crude lycopene crystals emerged almost immediately in methanol, and the crystallization was completed by holding the liquid at room temperature and putting it in an ice bath. (Nair and Lilwani et al., 2015)

Moreover, under the microscope, certain colorless impurity compounds were observed with long, red lycopene prisms. Column chromatography on active acidic alumina with toluene as the eluent was used for further purification. The deep red zone had been gathered. The residue was dissolved in 2 mL benzene after the solvent had completely evaporated and colorless compounds after recrystallization with boiling methanol. Because crystalline lycopene is not isomerized and has a proclivity for autoxidation (or air oxidation), it was maintained in dark evacuated glass tubes before use. (Nair and Lilwani et al., 2015)

ACETONE - ETHANOL - HEXANE EXTRACTION METHOD:

The extraction was carried out at room temperature with the jars covered with aluminum foil to protect them from light. UV-Vis's spectroscopy was used to determine the purity and concentration of lycopene. The wavelength is 472 nm (Nair and Lilwani et al., 2015; Sadler G, Davis J, Dezman D, et al., 1990).

Ethanol is also the best solvent because ethanol is a non-toxic solvent with no substantial health risks. It's also a green solvent. Thus, it has a lower environmental impact than other, more harmful solvents. (Raul and Interiano et al., 2009)



ACETONE-PETROLEUM ETHER EXTRACTION METHOD:

The crude lycopene yield from acetone-petroleum ether extraction was higher than that from hexane extraction. Due to its high degree of unsaturation, lycopene displayed a stronger affinity for alumina during purification by column chromatography and was eluted after yellow-orange carotene pigments. The maximum absorbance of a typical carotenoid, such as lycopene, is 476nm.(Nair and Lilwani et al., 2015)

HEXANE EXTRACTION METHOD:

The substance-containing solvent is put in an ice bowl on a magnetic stirring plate and then occurs in phaseseparation. The containing lycopene extracts were wrapped with aluminum foil and kept in the freezer for further investigation.(Nair and Lilwani et al., 2015)

SUPERCritical FLUID EXTRACTION METHOD;

The CO2 method of supercritical fluid extraction has recently been proposed. This extraction method has the added benefit of employing non-organic solvents, but it requires large-scale facilities and has greater expenses. (Kavitha, G., Kanimozhi, K. and Panneerselvam, A et al., 2017; Gómez-Prieto et al., 2003).

III.IDENTIFICATION OF LYCOPENE:

Different techniques analyzed the obtained lycopene; explained below;

THIN-LAYER CHROMATOGRAPHY (TLC) :

TLC was used to analyze and detect lycopene. A pencil line was drawn 1cm from the bottom of the TLC plate to prepare the silica plates. Glass spotters were used to spot the samples. It was done with an organic solvent (9.8:0.2, methanol: chloroform). For 5-10 minutes, a TLC plate was placed in the tank. The plate's edge was marked to show how far the solvent had progressed up the plate. The TLC plate was dried in the hood, the pigments were penciled in, and the plate was examined. The formula was used to calculate the Rf value. RF value = solute travel distance divided by solvent travel distance(Kadam et al., 2017).

UV-SPECTROSCOPY:

A UV visible spectrophotometer was used to scan the pure lycopene, which was dissolved in hexane and scanned at 350 to 600 nm wavelengths. (Ranveer et al., 2020). In addition, they mostly obtain peaks at 445,472 and 503nm(Nedamani et al. n.d.),(Ranveer et al. 2020).For example, the maximum wavelength of pure

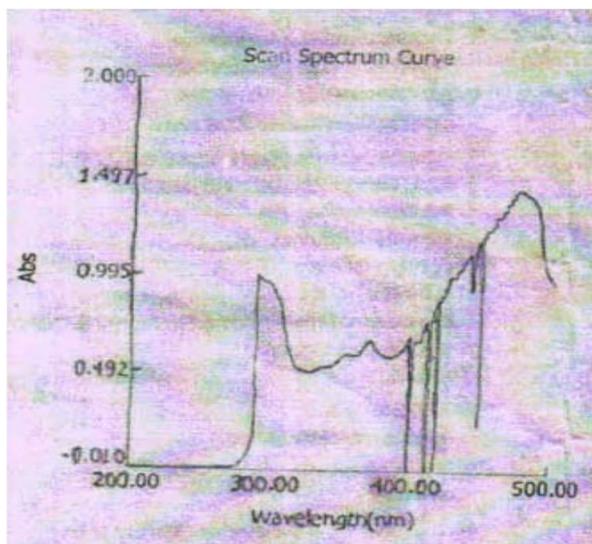


Figure 2 Scan spectrum curve of lycopene tomato

lycopene from tomatoes described in the literature is 472.2nm, which is closer to the maximum wavelength of pure lycopene from tomatoes. (Sriram, Reetha, and Saranraj 2013).

HIGH LIQUID CHROMATOGRAPHY (HPLC):

Determining lycopene in separated and purified crude material is necessary for these research activities, and a rapid, reliable, and easy HPLC approach is required (Devarapalli et al., 2014). Several columns, including C-8 and C-18, were employed to determine the stationary phase. The non-polar C-18 analytical chromatographic column was chosen as the stationary phase for separating and identifying the non-polar hydrophobic lycopene molecules. The 3 m particle size produces narrow peaks that are well spaced (Devarapalli et al., 2014).

FOURIER TRANSFORM INFRARED SPECTROSCOPY (FT-IR)

An FT-IR spectrophotometer (Cary-630, Agilent technology, Mumbai) was used to record infrared spectra. The FT-IR was measured in cuvettes with calcium fluoride windows after the pure lycopene crystals were reconstituted with dichloromethane. The spectrum was taken between the wavelengths of 4000 and 650 cm^{-1} . For functional group analysis, the infrared absorption spectrum was recorded and analyzed (Ranveer et al., 2020).

COLUMN CHROMATOGRAPHY:

Column chromatography is an excellent method for separating and purifying compounds from impurities that have comparable properties to the substance (Li n.d.).

A 5ml pipette was used to fill a packed chromatographic column. As an adsorbent, 1.5 to 2.0 g of neutral Silica was applied. All organic solution was collected, as well as 10 mL of hexane (the first eluent) and 10 mL of 10:90 acetone: hexane (the second eluent). The beaker was placed under the column, and lycopene extract was added.

Lycopene, having 13 double bonds, was more strongly attracted to silica gel than beta-carotene and similar carotenes, which contain 11 to 12 double bonds. As a result, the yellow carotene band progressed faster down the column than the orange-red lycopene band because they have a polar hydroxyl group that was strongly attracted to silica gel and yellow xanthophyll pigment trails behind the lycopene band (Kadam et al., 2017).

NUCLEAR MAGNETIC RESONANCE (NMR)

NMR was used to determine the structure of pure lycopene. A Bruker 800 MHz was used for the NMR investigations. The TMS signal (= 0.00 ppm) was used to reference proton spectra for lycopene measurement. Chemical changes in lipid extractions were compared to commercial lycopene standards (Ranveer et al., 2020).

IV. ACTIVITY OF LYCOPENE

Lycopene has antibacterial, antifungal, antioxidant, and anti-cancer properties that increase its importance.

ANTIBACTERIAL ACTIVITY:

Antibacterial activity can be detected by the agar well diffusion method, MIC, MBC, or disc diffusion method. Dhanawade and Sakhare et al. (2014) used the agar well diffusion approach for antibacterial efficacy against *Bacillus Subtilis*, showing a decreasing growth rate.

ANTIFUNGAL ACTIVITY:

Kavitha, G., Kanimozhi, K. and Panneerselvam, A et al. 2017 detected antifungal activity by using potato dextrose agar plate seeding with 24hr old culture of fungal species followed by MIC, which shows increasing concentration give higher sensitivity.

Effect of Lycopene on the dimorphic transition of fungal cells:

In its mode of action, because it can cause severely invasive mycoses, including candidiasis, the opportunistic dimorphous pathogen *C. Albicans* is becoming more important in human health. We conducted an in vitro test of the antifungal effects of lycopene on the mycelial forms of *C. Albicans* that were produced by supplementing with 20% FBS to examine the antifungal effects of lycopene in the human body. In the presence of lycopene, serum-induced mycelia were considerably slowed in their growth and formation. In the absence of lycopene, the mycelium produced was normal (Sung, W. S., Lee, I. S., & Lee, D. G. et al., 2007).

ANTIOXIDANT ACTIVITY:

Many methods were proposed to measure the antioxidant activity.

- Lycopene DPPH Scavenging Power
- ABTS assay: 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid),
- superoxide anion scavenging assay
- Hydroxyl radical scavenging assay (Abdullah et al. 2019)

ANTI-CANCER ACTIVITY:

The MTT assay and apoptosis experiment can be used to evaluate the anti-cancer activity of lycopene-loaded niosomes in vitro. MTT assay can test the cytotoxic activity of manufactured nano-liposomes loaded with lycopene, commercialized lycopene formulation (Lycored), and Cisplatin on cells. (Lycored)(PK and P et al., 2016).

In its mode of action, lycopene's anti-cancer activity was mediated through cell cycle arrest, immune system regulation, and apoptosis induction. Consumption of carotenoids like Lycopene and loaded natural Lycopene to nanoparticles has been proven to improve anti-cancer activity. The impact is related to the stimulation of cancer cell apoptosis and the reduction of cancer cell growth. Lycopene promotes cell cycle arrest at G0/G1 by blocking the S phase. It enhances apoptosis induction by increasing the amounts of pro-apoptotic markers p53, Bax, and caspase-3 while decreasing the anti-apoptotic marker Bcl-2 (Ahmed et al., 2021).

V. APPLICATION OF LYCOPENE

APPLICATION OF THE MICROCAPSULES TO A FOOD SYSTEM

Microcapsulization is formed from lycopene. The cake was chosen as the model system for microcapsule application. The standard cake was made, and the microcapsules were mixed with 50 percent milk and added to cake compositions. After that, free-form lycopene was added to the mix. The formulation contained the same amount of lycopene, combining the flour and the milk. The apparent color study used a colorimeter to take objective measures by direct reflection. The measurements were taken using D65 illumination, a viewing angle of 10 degrees, and the RSIN mode. Each sample was cut into 2 cm thick slices for the measurements, with five readings performed at random places. (Rocha-Selmi, Favaro-Trindade, and Grosso et al., 2013)

COLORANT FOR FOOD:

The usage of lycopene as a natural food colorant (Choi et al., 2012). Extracted lycopene was mixed with regular orange food coloring to make sugar cubes. The outcomes were examined after 24 hours (Harini, Judia, and Sumathy et al., 2016).

The pigment extract was applied to a variety of foods at a concentration of 50-200 mg/kg, including commercial margarine, a spread of cream and cheese, as well as laboratory-prepared pork sausage, ice cream, sponge cake, Kunafa dessert cooked rice, popcorn, extruded snack food that is ready to eat as well as fruit juice (Amr and Hussein et al., 2013) and beverages (Baysal, Ersus, and Starmans et al., 2000).

Food colorants have long been the subject of customer complaints, owing to the terrible reputation of the original synthetic pigments, which had only a cosmetic purpose and were linked to health problems (Jaswir et al., 2011).

Moreover, it also aids in essential in vivo biological processes such as growth control, cell-to-cell communication, and hormone modulation (George et al., 2004).

CANCER TREATMENT:

It is beneficial in the treatment of cancer patients who are undergoing chemoprevention. Many studies on rats, rabbits, and human tumor cells suggest that the presence of lycopene prevents the cells from growing out of control. Leukemia is a cancer that is extremely difficult to treat in humans. Lycopene is one of the treatments that can aid in the early stages of treatment. Prostate, pancreas, and stomach cancers are other malignancies that lycopene can aid with (Choksi and Joshi et al., 2007; Sies and Liu et al., 1996). When the lycopene nano-niosomes were incubated with the cells, indicating showed lycopene-loaded nano-niosomes are extremely hazardous to the HeLa cell line and MCF cells. These findings showed that lycopene released from nano-niosomes promoted death in HeLa and MCF-7 cells, suggesting that it could be effective for anti-cancer applications (PK and P, et al., 2016).



VI. CONCLUSION:

Lycopene which has the antioxidant potential can be extracted through various solvents like benzene, methanol, ethanol, petroleum ether, acetone, and hexane. It is also identified by different analytic instruments such as chromatography (TLC, HPLC, column chromatography), FT-IR, NMR, UV-spectroscopy, and the nano particle-sized lycopene identified by the Transmission Electron Microscope. Antibacterial efficacy against Bacillus Subtilis is significantly improved. Lycopene has a substantial antifungal effect on Candida albicans by causing severe damage to the yeast's cell membranes. Lycopene has a high antioxidant and anti-cancer activity. Also, the natural pigment color of lycopene is used as a color agent.

VII .PLANTS USE FOR LYCOPENE EXTRACTION AND IT'S APPLICATIONS:

<u>Plant</u>	<u>Part</u>	<u>Application</u>	<u>Reference</u>
Tomato	Fruit Peel Seed Tomato's pomace Seed oil Fresh pulp Boiled pulp Dried slices (sulfated) Dried slices (non-sulfated) Dried pulp (sulfated) Juice Sauce	-	(Ranveer et al. 2020) (Ahmed et al. 2021) (PK and P 2016) (Metkar et al. 2014) (Akanbi and Oludemi 2004) (Choksi and Joshi 2007)(Sies and Liu 1996)(Sung, W. S., Lee, I. S., & Lee, D. G. et al., 2007)
Watermelon	Red flesh	-	(Kadam 2017). (Choksi and Joshi 2007) (Sies and Liu 1996) (PK and P 2016)
bitter melon	Aril (red seed)	-	(Raul and Interiano 2009)
-	Oil dispersed lycopene	Microcapsules in a Food System	(Rocha-Selmi, Favaro-Trindade, and Grosso 2013)
Papaya	Red flesh	Food colorant	(Harini, Judia, and Sumathy 2016) (Choksi and Joshi 2007) (Sies and Liu 1996) (PK and P 2016)
Gac	Gac aril	-	(Bhumsaidon and Chamchong 2016)
Aglaonema aroid Apricot Arbutus Aubergine Berry Bitter nightshade Calendula Carrot Citrus Cuckoo Pint Cowberry Cloudberry Cranberry Damask rose	Fruit Fruit Leaf Fruit Fruit Fruit Flower Root Fruit Tuber Fruit Fruit Fruit Fruit	-	(Choksi and Joshi 2007)



Date palm	Fruit		
Eggplant	Fruit		
European nettle	Plant		
Gazania	Plant		
Grapefruit	Fruit		
Guava	Fruit		
Mango	Fruit		
Palm	Oil		
Peach	Fruit		
Pepper	Fruit		
Pepper berry	Fruit		
Persimmon	Fruit		
Plum	Fruit		
Pumpkin	fruit		
Ramanas rose	Plant		
Rose	Fruit		
Rutabaga	Root		
Saffron	Seed		
Sallow thorn	Fruit		
Tea	Leaf		
Turnip	Root		
Yew	Fruit		
	Fruit		
Rosehip puree	-	-	(Sies and Liu 1996)
Pitanga	-	-	(PK and P 2016)

REFERENCES

1. Abdullah, Mai Adnan et al. 2019. "Extraction, Purification, and Characterization of Lycopene from Jordanian Vine Tomato Cultivar, and Study of Its Potential Natural Antioxidant Effect on Samen Baladi." *Current Research in Nutrition and Food Science* 7(2): 532–46
2. Aghel N, and Amirfakhrian S. 2011a. 6 *Jundishapur Journal of Natural Pharmaceutical Products ISOLATION AND QUANTIFICATION OF LYCOPENE FROM TOMATO CULTIVATED IN DEZFOUL, IRAN.*
3. Ambreen Naz, Masood Sadiq Butt, Imran Pasha and Haq Nawaz, 2013. Antioxidant Indices of Watermelon Juice and Lycopene Extract. *Pakistan Journal of Nutrition*, 12: 255-260.
4. ———. 2011b. 6 *Jundishapur Journal of Natural Pharmaceutical Products ISOLATION AND QUANTIFICATION OF LYCOPENE FROM TOMATO CULTIVATED IN DEZFOUL, IRAN.*
5. Ahmed, Habiba A. et al. 2021. "Lycopene Nanoparticles Ameliorate The Antioxidants, Antimicrobial And Anticancer Potencies Of Tomato Pomace." *Egyptian Journal of Chemistry* 64(7): 3739–49.
6. Akanbi, C. T., and F. O. Oludemi. 2004. "Effect of Processing and Packaging on the Lycopene Content of Tomato Products." *International Journal of Food Properties* 7(1): 139–52
7. Amr, Ayed S, and Deema S Hussein. 2013. 9 *Jordan Journal of Agricultural Sciences Tomato Pomace Pigment : Extraction and Use as Food Colorant.*
8. Baysal, T., S. Ersus, and D. A.J. Starmans. 2000. "Supercritical CO2 Extraction of β -Carotene and Lycopene from Tomato Paste Waste." *Journal of Agricultural and Food Chemistry* 48(11): 5507–11.
9. Bhumsaidon, Apinya, and MontipChamchong. 2016. "Variation of Lycopene and Beta-Carotene Contents after Harvesting of Gac Fruit and Its Prediction." *Agriculture and Natural Resources* 50(4): 257–63.

10. Cámara, Montaña, et al. 2013. "Lycopene: A Review of Chemical and Biological Activity Related to Beneficial Health Effects." In *Studies in Natural Products Chemistry*, Elsevier BV, 383–426
11. Choi, Jae-Suk. 2012. A Simple Method for the Isolation of Lycopene from *Lycopersicon Esculentum* Production of Natural Bio-Active Compounds from Marine Sources View Project Hair Growth Promoting Effects of Rice Bran Supercritical CO₂ Extract View Project. <https://www.researchgate.net/publication/263672292>.
12. Choksi, Pratik M., and Vishal Y. Joshi. 2007. "A Review on Lycopene - Extraction, Purification, Stability, and Applications." *International Journal of Food Properties* 10(2): 289–98.
13. Devarapalli, Kezia. 2014. HPLC Method for the Determination of Lycopene in Crude Oleoresin Extracts Production of Viral Vaccines View Project Development of Bioprocess Technology for Amidases Production in Submerged and Solid State Fermentations View Project. <https://www.researchgate.net/publication/215535307>.
14. Dhanawade, Sohan Sunil, and Aditya Vikas Sakhare. 2014. *International Journal of Science and Research* Isolation of Lycopene from Tomato and Study of Its Antimicrobial Activity. www.ijsr.net.
15. George, Binoy, Charanjit Kaur, D. S. Khurdiya, and H. C. Kapoor. 2004. "Antioxidants in Tomato (*Lycopersium Esculentum*) as a Function of Genotype." *Food Chemistry* 84(1): 45–51
16. Gerster, Helga. 1997. "The Potential Role of Lycopene for Human Health." *Journal of the American College of Nutrition* 16(2): 109–26.
17. Gómez-Prieto, M. Salud, M. Mar Caja, Marta Herraiz, and Guillermo Santa-María. 2003. "Supercritical Fluid Extraction of All-Trans-Lycopene from Tomato." *Journal of Agricultural and Food Chemistry* 51(1): 3–7.
18. Hadley, Craig W, Elizabeth C Miller, Steven J Schwartz, and Steven K Clinton. 2002. 227 *Exp Bioi Med* Tomatoes, Lycopene, and Prostate Cancer: Progress and Promise.
19. Harini, Ms, V Judia, and Harriet Sumathy. 2016. "Extraction and Application of Lycopene from Papaya." *International Journal of Medicine and Pharmaceutical Research* 4(5): 293–96. <https://www.researchgate.net/publication/329059281>
20. Jaswir, Irwandi, DediNoviendri, Reno FitriHasrini, and FitriOctavianti. 2011. "Carotenoids: Sources, Medicinal Properties and Their Application in Food and Nutraceutical Industry." *Journal of Medicinal Plant Research* 5(33): 7119–31.
21. Joshi, P K et al. Detection of Lycopene in Tomato Puree.
22. Kadam, Aditi B. 2017. "Studies on Extraction, Isolation, and Application of Lycopene." *International Journal for Research in Applied Science and Engineering Technology* V(X): 2104–8
23. Kang, D.-K et al. 2003. 16 *J. Anim Sci* Use of Lycopene, an Antioxidant Carotenoid, in Laying Hens for Egg Yolk Pigmentation.
24. Kavitha, G., Kanimozhi, K. and Panneerselvam, A.2017 "Antimicrobial efficacy of lycopene compound against some pathogens" *international journal of Current Research*, 9, (05), 50184-50186.
25. Kelkel, Mareike, Marc Schumacher, Mario Dicato, and Marc Diederich. 2011. "Antioxidant and Anti-Proliferative Properties of Lycopene." In *Free Radical Research*, 925–40.
26. Khachik, Frederick, Gary R Beecher, and J Cecil Smith. 22 *Journal of Cellular Biochemistry, Supplement* Lutein, Lycopene, and Their Oxidative Metabolites in Chemoprevention of Cancer
27. Kong, Kin Weng, et al. 2010. "Revealing the Power of the Natural Red Pigment Lycopene." *Molecules* 15(2): 959–87.
28. Krinsky, Norman I., and Elizabeth J. Johnson. 2005. "Carotenoid Actions and Their Relation to Health and Disease." *Molecular Aspects of Medicine* 26(6): 459–516
29. Kunthakudee, N, P Ramakul, and U Pancharoen. Optimization of Different Parameters for Lycopene Extraction from Tomato Paste with Non-Toxic Solvent.
30. Li, Mengying. Investigating the Techniques of Solid-Liquid Extraction by Isolating Lycopene from Tomato Paste and Column Chromatography & Thin-Layer Chromatography (TLC) by Purifying lycopene.
31. Ma, Yuhua, et al. 2014. "Components, Antioxidant and Antibacterial Activity of Tomato Seed Oil." *Food Science and Technology Research* 20(1): 1–6.
32. di Mascio, Paolo, Stephan Raiser, and Helmut Sies. 1989. 274 *ARCHIVES OF BIOCHEMISTRY AND BIOPHYSICS* Lycopene as the Most Efficient Biological Carotenoid Singlet Oxygen Quencher'.
33. Metkar, Sanjay, SupriyaSaptarshi, Aditi Kadam, and Sanjay K Metkar Research Scholar. 2014. "STUDIES ON EXTRACTION, ISOLATION, AND APPLICATIONS OF LYCOPENE." *Indo-American Journal of Pharmaceutical Research*. www.iajpr.com.

34. Nair, Vrinda, and Simran Lilwani. 1 IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB Extraction and Isolation of Lycopene Form Various Natural Sources. www.iosrjournals.org49].
35. Nedamani, AzadehRanjbar, Elham RanjbarNedamani, A Ranjbar, and E Ranjbar. Brief Report Antimicrobial Property of Lycopene Oleoresin on Some Food Pathogens Running Head: Lycopene Oleoresin Antibacterial Potent Numerical Modeling of the Effect of Processing Factors on Dried Apple and Orange View Project 2017-2020 PROVIDE-Protein Valorization through Informatics, Hydrolysis, and Separation View Project Brief Report Antimicrobial Property of Lycopene Oleoresin on Some Food Pathogens Running Head: Lycopene Oleoresin Antibacterial Potent. www.SID.ir.
36. Oliveira, Daniela Da Silva et al. 2010. "Carotenoids and Vitamin C during Handling and Distribution of Guava (*Psidium Guajava* L.), Mango (*Mangifera Indica* L.), and Papaya (*Carica Papaya* L.) at Commercial Restaurants." *Journal of Agricultural and Food Chemistry* 58(10): 6166–72.
37. Pennathur, Subramaniam et al. 2010. "Potent Antioxidative Activity of Lycopene: A Potential Role in Scavenging Hypochlorous Acid." *Free Radical Biology and Medicine* 49(2): 205–13.
38. Petyaev, Ivan M. et al. 2019. "Lycopene Presence in Facial Skin Corneocytes and Sebum and Its Association with Circulating Lycopene Isomer Profile: Effects of Age and Dietary Supplementation." *Food Science and Nutrition* 7(4): 1157–65.
39. PK, Sharma, and Saxena P. 2016. "Novel Encapsulation of Lycopene in Niosomes and Assessment of Its Anticancer Activity." *Journal of Bioequivalence & Bioavailability* 8(5).
40. Raduly, Monica Florentina, et al. 2011. 6 Article in Digest Journal of Nanomaterials and Biostructures Lycopene Determination in Tomatoes by Different Spectral Techniques (UV-VIS, FTIR, and HPLC). <https://www.researchgate.net/publication/234164549>.
41. Ranveer, R. C., N. B. Rathod, P. P. Debaje, and A. K. Sahoo. 2020. "Extraction, Purification and Characterization of Lycopene from Tomato (*CvVijeta*) Processing Industry Waste." *European Journal of Nutrition & Food Safety*: 83–90.
42. Raul, Luis, and Jimenez Interiano. 2009. Proximate Characterization and Lycopene Determination in Bitter Melon Seed Aril. <http://scholarworks.uark.edu/cheguht/18>.
43. Ribaya-Mercado, Judy D, MarjanGarmyn, Barbara A Gilchrest, and Robert M Russell. 1995. 125 J. Nutr Biochemical and Molecular Roles of Nutrients Skin Lycopene Is Destroyed Preferentially over β -Carotene during Ultraviolet Irradiation in Humans¹ '2
44. Rocha-Selmi, Glaucia A., Carmen S. Favaro-Trindade, and Carlos R.F. Grosso. 2013. "Morphology, Stability, and Application of Lycopene Microcapsules Produced by Complex Coacervation." *Journal of Chemistry*
45. Sadler, G., Davis, J., &Dezman, D. (1990). Rapid extraction of lycopene and β -carotene from reconstituted tomato paste and pink grapefruit homogenates. *Journal of food science*, 55(5), 1460-1461.
46. Sies, Helmut, and Simin Liu. 1996. Lycopene: A Biologically Important Carotenoid for Humans? Mark Failla Plasma Lycopene, Ot Her CarrotEnoids, and t He Risk of T Type 2 Diabet Es in Women.
47. Sharoni, Y., Danilenko, M., Dubi, N., Ben-Dor, A., & Levy, J. (2004). Carotenoids and transcription. *Archives of Biochemistry and Biophysics*, 430(1), 89-96.
48. Sriram, N., D. Reetha, and P. Saranraj. 2013. "Biological Degradation of Reactive Dyes by Using Bacteria Isolated from Dye Effluent Contaminated Soil." *Middle East Journal of Scientific Research* 17(12): 1695–1700.
49. Sung, W. S., Lee, I. S., & Lee, D. G. (2007). Damage to the cytoplasmic membrane and cell death caused by Lycopene in *Candida albicans*. *Journal of microbiology and biotechnology*, 17(11), 1797-1804.
50. Urbonaviciene, Dalia, Pranas Viskelis, and Jonas Viškelis. 2005. "Lycopene and β -Carotene in Non-Blanched and Blanched Tomatoes." Article in *Journal of Food Agriculture and Environment*. <https://www.researchgate.net/publication/267029714>.
51. Zechmeister, By L, A L Lerosen, F W Went, and Linus Pauling. 1936. 2 Jour. Cell. and Comp. Physiol 10 Nielsen, N., Virchow's Arch. f. Path



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