EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 5
Issue: 5
510-513
Year: 2018

LYCOPENE IN TOMATO BASED PRODUCTS, FRUITS AND VEGETABLES: IT'S ROLE IN HEALTH AND PREVANTION OF DISEASE

Omkar Kamble*, Priya Mourya, Rahul Marathe, Dnyaneshwar Pawar and Prajakta Kshirsagar

Department of Chemistry, Dr. D. Y. Patil Arts, Commerce and Science College, Pimpri, Pune–411018. (Maharashtra, India).

***Corresponding Author: Omkar Kamble**
Department of Chemistry, Dr. D. Y. Patil Arts, Commerce and Science College, Pimpri, Pune-411018. (Maharashtra, India).

Article Received on 27/02/2018 **Article Revised on 20/03/2018** **Article Accepted on 09/04/2018**

ABSTRACT
Lycopene; a non-provitamin A carotenoid is responsible for the red to pink colours seen in tomatoes, pink grapefruit, and other foods of fruit and vegetable origin. Processed tomato products are the primary source of dietary lycopene. Lycopene has unique structural and chemical features that may contribute to specific biological properties. Unlike many other natural compounds; lycopene is generally stable to processing when the lycopene content in tomato pastes ranged from 50.97±1.08 mg/kg in vital tomato paste to 68.12±1.44 mg/kg in Gino tomato paste. In the fruits, lycopene content ranged from 0.47±0.04 mg/kg in grape fruits (white) to 32.15±0.70 mg/kg in watermelon. Among the yellowish-red vegetables, lycopene content ranged from 14.88±0.70 mg/kg in red bell pepper to 45.49±0.98 mg/kg in ripe tomato fruit. In green leafy vegetables, lycopene ranged from 4.96±0.13 mg/kg in waterleaf to 11.79±0.28 mg/kg in bitter leaf. This study has shown that tomato paste is very rich in lycopene followed by fresh ripe tomato fruit, watermelon and fresh chilli pepper. Bitter leaf and Pumpkin leaf were observed to have the highest lycopene content amongst the green leafy vegetables. Tomato paste, fresh tomato watermelon and pumpkin should be regularly included in the diet for adequate supply of lycopene n present in the plant tissue matrix. Dietary intake of lycopene is associated with reduced risk of prostate cancer (PCa). We conducted a clinical trial in men with prostate cancer to investigate the biological and clinical effects of lycopene supplementation. Twenty-six men with prostate cancer were randomly assigned to receive a lycopene supplement or no supplement for three weeks before radical prostatectomy.

INTRODUCTION
Lycopene; a member of carotenoid family; is a lipidzluble antioxidant synthesized by many plants and microorganisms but not by animals and humans1 where it serves as an accessory light-gathering pigment and protects them against the toxic effects of oxygen and light. It is a red pigment without provitamin - A activity that imparts colour to many fruits and vegetables. Tomatoes and processed tomato products (juice, sauce, soup, pizza and spaghetti sauce) constitute the major sources and accounts for more than 85% of all the dietary sources of lycopene. The content differs with the varieties of tomatoes and increases as the fruit ripens2. It varies from 0.85mg to 13.6 mg/ 100g. The other source includes watermelon, pink grape fruit, guava and papaya. Although it has been used as a food colorant for many years, it has recently received attention with respect to its antioxidant activity and potential in preventing prostate cancer and cardiovascular diseases in humans. In turn, this has led to the idea of increasing levels of lycopene in crops, particularly tomatoes by genetic crosses in order tin crease the amounts in the diets. Tomato is second-only to potato in global vegetable production [14% of total vegetable production worldwide (FAO, 2006)]. The high consumption rate of tomato is due to year round availability, relatively low prices, well-established storage and handling practices, and its role as a source of vitamins, minerals and carotenoids (mainly lycopene) Lycopene, a carotenoid with a high oxygen free radical scavenging and quenching capacity (Di Mascio *et al.*,1989), has been related to reducing the risk of prostate cancer in studies conducted in North America, as well as several other types of cancer in a number of studies North America, Europe, China, and Japan (Clinton,1998; Giovannucci, 1999). The lycopene content of tomato fruit can be influenced by several factors: genotype, environmental conditions (temperature and light), cropping system(fertilisation or mineral nutrition, irrigation, grafting),and the phonological stage of plants and/or fruit (Dumas*et al*., 2003; Fernandez *et al*., 2004; Serio *et al*., 2006). Epidemiological evidence linked diet rich in fresh fruits and vegetable to protection against chronic degenerative diseases (Joshipura *et al*., 1999; Cox *et al*., 2000) Cancer has emerged as a major public health problem all over the world. The World Cancer Research Fund (2007) suggests that fruits and vegetables protect against several types of cancer. Some medical research studies have reported fruits and

vegetables, especially tomato as the good food sources of Lycopene (Stahl *et al*., 200, Heinrich *et al*., 2003, Etiman*et al*., 2004, Sesso *et al*., 2004). La, Vecchia (2002) had also revealed that high intake of tomato products reduced the risk of prostate cancer which is likely due to the action of the lycopene content. Some medical research studies have reported fruits and vegetables, especially tomato as the good food sources of Lycopene (Stahl *et al*., 200, Heinrich *et al*., 2003, Etiman*et al*., 2004, Sesso *et al*., 2004). La, Vecchia (2002) had also revealed that high intake of tomato products reduced the risk of prostate cancer which is likely due to the action of the lycopene content.

Lycopene chemistry, isomerization and degradation

It is a highly unsaturated, 40 carbon acyclic molecule containing 11 conjugated and 2 unconjugated double bonds arranged in all trans configuration in tomatoes the most thermodynamically stable form. The acyclic structure of lycopene makes it more soluble in organic solvents such as chloroform, hexane, benzene, methylene chloride, acetone and petroleum ether.

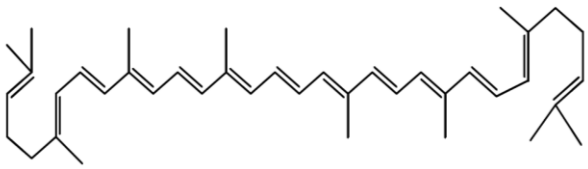


Figure 1: Structure of Lycopene

The seven double bonds can isomerize and form mono- or poly- *cis* isomers upon exposure to heat, light, certain chemical reactions or during processing or storage.4, 10Interestingly, *cis*-isomers account for over 50% of the total lycopene in human serum and over 80% in tissues such as prostate. Lycopene degradation occurs with light, heat, oxygen, metallic ions of copper and iron catalysing oxidation andacids.4 The potential of these non-enzymatic reactions to affect lycopene destruction.

Lycopene rich by products from food processing: Food processing by products from the tomato puree and sauce industry are commonly used in the development of lycopene-rich products (Table 3). Previously, Al-Wandawi *et.al*.18 had reported that tomato skins contained a high amount of lycopene Nowadays, there is an increasing trend towards utilization of food processing by-products as a source of functionalcomponents.20 Many studies have been carried out on the extraction of lycopene from by-products especially tomato waste. Optimization of the solvent extraction procedure was also performed to obtain a maximum lycopene yield from tomato peels using response surfacemethodology.21 Application of high hydrostatic pressure processing without heating was reported to provide an increased yield of lycopene from tomato paste waste. 22High pressure processing of tomato paste waste for 1 min gives a higher lycopene yield than solvent extraction for30 min.23 The Extract or Naviglio has been introduced to obtain higher purity lycopene from tomato by products through pressurized extraction. This extraction method requires tap water as extracting solvent with minimum organic solvent and the by-products can be further used as live stock feed. Furthermore, enzymatic treatment using cellulose and pectinase could offer one fold higher in the recovery of lycopene from tomatowaste.26 Lavecchia and Zuorro27 reported that enzymatic treatment on tomato peels was able to increase the lycopene yield 20-fold.

MATERIAL AND METHOD

Sample Collection and preparation: Twenty varieties of tomato based products, fresh fruits and vegetable samples (tomato paste Ciao, Vitali, Gino and tomasonia) tomato sauce (Geshia), watermelon, grapefruit, orange, pawpaw, carrot, mango, pineapple, chilli pepper, red bell pepper, fresh tomato, waterleaf, spinach, pumpkin leaf, garden egg leaf and bitter leaf were obtained from four main markets in Ibadan. In the case of fruits, special care was taken to select the most mature samples

About 1-2kg of each sample of fruits and vegetables were obtained from each market outlet. The edible portion of fruits and vegetable samples from the different outlets were washed and rinsed with water several times and finally rinsed with deionized water to remove contamination. Each sample was cut into smaller pieces, homogenized to obtain a uniform single composite sample of the same type of fruits and vegetables.

Lycopene extraction

The extraction of lycopene from the food samples was performed according to Fish *et al*., (2002). Samples were first chopped and homogenized in a laboratory homogenizer. Approximately 0.5g of each food sample was weighed and 5ml of 0.05% (w/v) BHT in acetone, 5ml of ethanol and 10ml of hexane were added. The recipient was introduced into ice and stirred on a magnetic stirring plate for 15min. after shaking, 3ml of deionized water was added to each vial and the samples were shaken for 5 minutes on ice. Samples were then left at room temperature for 5 minutes to allow for the separation of both phases i.e. the polar and non-polar phases. Lycopene content of foods and tomato fruits was measured spectrophotometrically at 503 nm after an extraction with hexane (Sadler *et al*., 1990, Perkins-vizier *et al*., 2001 and Fish *et al*., 2002) Concentration of lycopene was derived using the molar extinction coefficient of 17.2 x 104 in the theoretical method of Markoric *et al* (2006) and also by applying the following equation in the experimental method described by Ravelo-Perez *et al* (2008): Lycopene content (mg/kg) = (A503 – 0.0007) x 30.3/g tissue

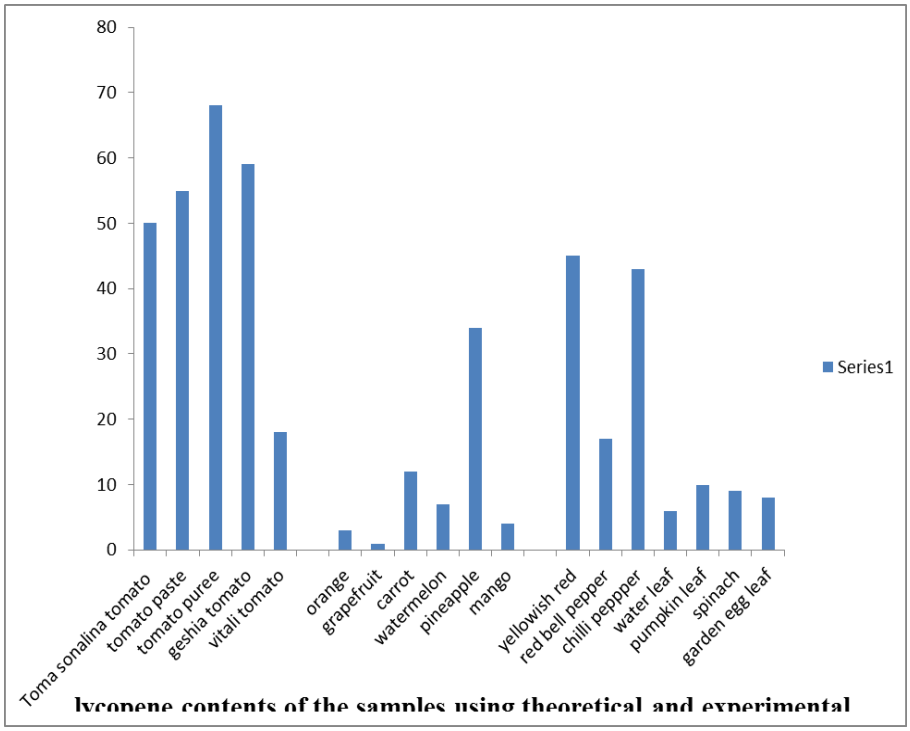
The Lycopene content of the selected food samples determined in this study was calculated using both the theoretical and experimental methods.

Lycopene estimation

The lycopene contentwas investigated by the methos of Saderet al (1990). The samples of raw andheated tomato slurrieswere mixed with 40ml of a mixture of n-hexane:acetone:ethanol (20:10:10) having 2.5% of ascorbic acid. The mixture was agitated continuously for half hour with a shaker. Then 10 ml water is added to the solution and again gitated for next 5 minn. The solution was separated into two polar and nonpolar layer in a seperating funnel and the polar phase was carefully drawn out. The organic layer was separated and filtered through dehydrated sodium sulphate. The hexane phase was collected into a 25ml flask and made up to mark with n-hexane. The optical density of the n-hexane extract was meadured spectrophotometrically at 502nm aainst an n-hexane blank. Concentration of lycopene was calculated using as extraction coeficirent of 3150.all analysis were carried out in triplicate from eacch other of the three replicatonns. Data was subjected to analysis of varience using the generalized linear model procedure of statisticl analysis software.

RESULT

A good straight line with the correlation coefficient of 0.995; P<0.05 was obtained for the calibration graph of the absorbance versus the lycopene concentration (mg/l) in hexane (ranging between 0 and 5mg/l). The mean values of lycopene contents of the food samples using both the theoretical and the experimental methods are presented in Fig. 1.



Although the value obtained from the experimental method were generally higher than the theoretical method, the values obtained for each food sample using the two methods were not significantly different (P>0.05). Gino tomato paste had the highest lycopene content followed by Tomasonia tomato paste while Vital tomato paste had the lowest lycopene content. Geisha tomato sauce had less lycopene content than all of the tomato pastes analysed. Lycopene varied widely among the various fresh fruits ranging from (0.47 ± 0.04 mg/kg) in grapefruits (white) to (32.15 + 0.70 mg/kg) in red watermelon. The lycopene content in watermelon was significantly higher than the other selected fresh fruits (p<0.05). Among the yellowish-red and green leafy vegetables fresh Tomato had the highest lycopene content followed by fresh chilli pepper. The lycopene content of red bell pepper was significantly lower than in chilli pepper or fresh tomato (p<0.05). Among the green leafy vegetables, bitter leaf had the highest lycopene content followed by pumpkin leaf while water leaf had the lowest lycopene content.

DISCUSSION

Lycopene is known to be one of the most potent antioxidant among dietary carotenoids (Argarwaland, 2000). Knowing the lycopene content of commonly consumed foods is useful in planning dietary strategies to satisfy the reference daily intake for antioxidant and also as useful indices of potential health benefits, of individual plant-based foods. The result presented in the study has shown that lycopene content varied widely among tomato based products, fruits and vegetables indicating the need of different servings of these foods. Among the food samples analysed, tomato and tomato derived products had the highest content of lycopene. This observation is similar to the reports of Grossman *et al.*, (2004) which indicates that tomatoes and tomato based sauces, juice and ketchup account for more than 85% of the dietary intake of lycopene of most people

who include them in their diet. Khan *et al*., (2008) also reported that, lycopene in tomato pastes was four times more bioavailable than in fresh tomato According to report of Khan *et al*., (2008), cooking and crushing of tomatoes (as in canning process) and with addition of serving oil, greatly increases the assimilation of lycopene from the digestive tract, into the bloodstream. Lycopene is fat soluble thus oil helps its absorption (Khan, et. al., 2008). Regular intake of fruits and vegetables, with inclusion of tomato based products, may result in regular intake of 20mg lycopene or more /day (EPSA, 2005). The report of Perkins Veatie *et al*., 2006 indicates variability in the lycopene content of the different fruits. Among the fresh fruits analysed in this study, red watermelon had the highest content of lycopene. The lycopene value obtained for the red watermelon is within the range stated in the literature. This indicates that red watermelon is rich in lycopene. Within the yellowish-red vegetable group fresh tomato had the highest concentration of lycopene content. The value obtained is also within the range reported by Ravelo-Perez *et al*., (2007) and Khachick *et.al*., (1992). However, all the tomato based products had higher amount of lycopene content than the fruits and vegetables analysed. According to Silaste *et al*., (2007), a diet rich in lycopene cut the risk of prostate cancer by 45%. Lycopene is also known to lower the risk of colorectal cancer, stomach cancer and it also inhibits the growth of other types of cancer cells. In conclusion, this study

ACKNOWLEDGMENT

The Research work has been done at Dr. D.Y. Patil Arts, Commerce & Science College, Pimpri, Pune. We would like to pay my sincere gratitude to Dr. F. V. Dandwate and Mr. M.V. Gaikawad for giving and opportunity to work on such an exciting work. Our sincere thanks also for Department of Chemistry and Microbiology.

REFERENCE

1. Agarwal Sand Rao V. A. Tomato lycopene and its role in human health and chronic diseases. Canadian Medical Association Journal, 2000; 163: 739-744.
2. Basu A, Imrhan V. "Tomatoes versus Lycopene in oxidative stress and carcinogenesis: conclusion from clinical trials". Eur J Clin Nutr, 2007; 61(3): 295-303.
3. Blum, A., Merei, M., Karam, A. *et al*. Effect to tomato on the lipid profile. Clin invest med, 2006; 29-298-300.
4. Chio E, Seddon JM, Resoner B, Willett WC, Hankinson SE. Prospective study of intaske of fruits, vegetables, vitamins, and carotenoids and risk of age-related maculopathy. Arch Ophthalmol, 2004; 122(6): 883-92.
5. Collins AR: Oxidative damage, antioxidants and cancer. BioEssays, 1999; 21: 238-256.
6. Cox BD, Whichelow MJ & Prevost AT Seasonal consumption of salad vegetables and fresh fruit in relation to the development of cardiovascular disease and cancer. Public Health Nutrition, 2000; 3: 19-29.
7. EPSA Journal, Opinion of the Scientific Panel on the Dietetic Products, Nutrition and allergies on the request from the commission related to an application on the use of α-Tocopherol containing oil suspension of Lycopene from Blakesleatrispora as a novel food ingredient, 2005; 212: 1-29.
8. Etminan M, Takkouche B, Caamano-Isorna F. The role of tomato products and lycoene in the prevention of prostate cancer: a metal-analysis of observational studies. Cancer Epidermiol Biomarkers Prev., 2004; 13(3): 340-345.
9. Fish W. W., Perkins-Veazie P, Collins J. K. j. Food Compos. Anal, 2002; 15: 309–317.
10. Giovannucci E. Tomatoes, tomato-based products, lycopene, and cancer: Review of the epidemiologic literature. J Natl Cancer Inst., 1999; 91: 317-331.
11. Hasler, C.M. Functional Foods: then role in disease prevention and health promotion Food Technol, 1998; 52: 63-69.
12. Heinrich U, Gartner C, Wiebusch M, *et al*. (2003) Supplementation with beta-carotene or a similar amount of mixed carotenoids protects NGUYEN, M. L. and SCHWARTZ, S. J. Lycopene: chemical and biological properties. *Food Technology*, 1999; 53: 38–45.
13. ODED, A. and UZI, K.. Enhanced performance of processing tomatoes by potassium nitrate based nutrition. *Acta Horticulturae*, 2003; 613: 81–87.
14. PETERSEN, K.K.,WILLUMSEN, J. and KAACK, K.. Composition and taste of tomatoes as affected by increased salinity and different salinity source. *Journal of Horticultural Science & Biotechnology*, 1998; 73: 205–215.
15. RUIZ, J. M. and ROMERO, L. Relationship between potassium fertilisation and nitrate assimilation in leaves and Fruits of cucumber (*Cucumis sativus*) plants. *Annals of Applied Biology*, 2002; 140: 241–245.
16. SADLER, G., DAVIS, J. and DEZMAN, D. Rapid extraction of lycopene and _-carotene from reconstituted tomato paste and pink grapefruit homogenates. *Journal of Food Science*, 1990; 55: 1460–1461.
17. SANTAMARIA, P., CANTORE, V., CONVERSA, G. and SERIO, F. Effect of night salinity level on water use, physiological responses, yield, and quality of tomato. *Journal of Horticultural Science & Biotechnology*, 2004; 79: 59–66.
18. SERIO, F., SANTAMARIA, P., ELIA, A., PARENTE, A. and ZILLI, P.(2001). Conducibilità elettrica della soluzione nutritiva, asportazioni e produzione del pomodoro allevato con la tecnica della canaletta a scorrimento. *Italus Hortus*, 8: 55–60.