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### A Review on the Taxonomy, Ethnobotany, Chemistry and Pharmacology of *Solanum Lycopersicum* Linn

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#### Abstract

The Tomato is native to South America but growing in temperate climates worldwide. The tomato begins its colourful and varied history upon the coastal highlands of western South America, where it was being enjoyed by the native peoples for a long time. There are numerous vernacular names and a wide diversity of uses, it is chemically, genetically and geographically extremely variable and has been divided into three subspecies and several regional forms. The fruit is rich in lycopene, which may have beneficial health effects. Plants have been one of the important sources of medicines since the beginning of human civilization. There is a growing demand for plant based medicines, health products, pharmaceuticals, food supplements etc. The scientific basis for the statement that plants and their active constituents play an important role in the prevention diseases is continuously advancing. Recently, the leaves of tomato plant that contained several active compounds including alkaloid, steroid and flavanoid have been used for the treatment of variety of diseases and as anti-cancer, antioxidant and anti-gout. Because the wide traditional usage of *solanum lycopersicum* for treatment of diseases, in this review published scientific reports about the pharmacological properties of this plant were collected. Results of animal studies, as well as a phase I clinical study, have shown no indications of toxicity. Sufficient preclinical data are now available to justify controlled clinical studies.

**Key words:** *Solanum Lycopersicum*, Phytochemistry, Pharmacological Activity, Uses

#### Introduction

The tomato belongs to the family of nightshades or Solanaceae or nightshade family. The tomato is a popular and versatile food. Only the fruits of tomato plant can be eaten since the leaves contain toxic alkaloids. It is a fruit of good nutritive value as it is fairly rich in vitamins (vitamin C), and other minerals like calcium, phosphorus and iron. Tomato juice is used alone or in combination with lime, honey, buttermilk, yoghurt and avocado in several home made remedies to keep skin healthy. The species have been used in traditional medicine to cure human diseases including cancer diseases such as lung, prostate, stomach, cervical, breast, oral, colorectal, oesophageal, pancreatic, and many other types of cancer, high blood pressure, treat oedema, kidney and liver problems, antioxidant cathartic. Tomato is also good for liver health. Tomato has detoxification effect in the body. Probably it is due to the presence of chlorine and sulfur in tomatoes. Sulfur in tomatoes protects the liver from cirrhosis. Recently a variety of compounds that possess antimutagenic properties has been detected in vegetables and spices, and evidence is accumulating that their dietary intake decreases the risk of cancer and other malignant diseases in human. According to the literature, several compounds have been isolated from different fractions of *Solanum* species are a rich source of Lycopene,  $\beta$ -carotene, carotenoids, lutein, total phenols, polyphenols,  $\alpha$ -tocopherol, potassium and folate, flavonoids, ascorbic acid, dehydroascorbic acid and total vitamin C and vitamin E contents, fatty acids and carbohydrates as well as hydrophilic and lipophilic antioxidant activities were determined which have shown pharmacological relevance<sup>1-4</sup>.

#### Taxonomy<sup>5</sup>

The botanical Latin name for the tomato plant is "love plant". As the tomato belongs to the Solanaceae family, known as the "deadly" Nightshade family, it has in the past given it a false reputation of being toxic while, in fact, it

is the tomato leaf that is toxic and not the fruit or tomato. In 1753 the tomato was placed in the genus *Solanum* by Linnaeus as *Solanum lycopersicum* L. (derivation, 'lyco', wolf, plus 'persicum', peach, i.e., "wolf-peach"). However, in 1768, Philip Miller placed it in its own genus, and he named it *Lycopersicon esculentum*. This name came into wide use, but was in breach of the plant naming rules. Technically the combination of *Lycopersicon* and *lycopersicum* would be correct but this name has hardly ever been used. Therefore it was decided to conserve the well-known *Lycopersicon esculentum*, making this the correct name for the tomato when it is placed in the genus *Lycopersicon*.

### Scientific classification

Kingdom: Plantae  
 Phylum: Angiosperms  
 Order: Solanales  
 Family: Solanaceae  
 Genus: *Solanum*  
 Species: *lycopersicum*



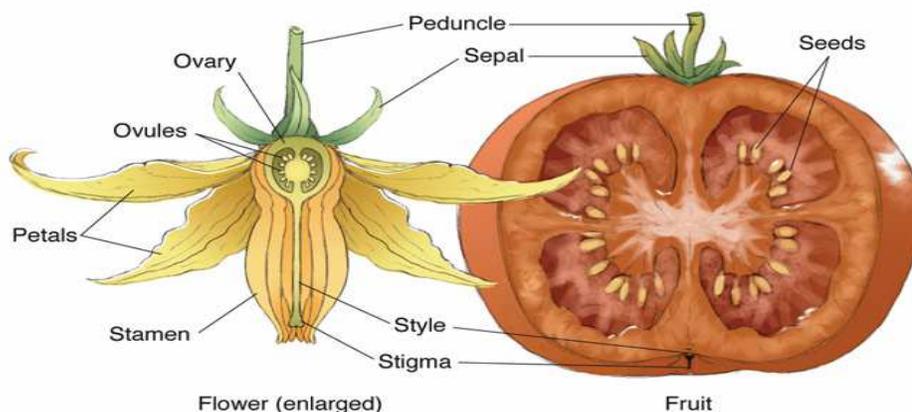
The current custom of giving plants Latin scientific names developed from early botanic treatises that were written in Latin. As early as the sixteenth century, the tomato received the name "Mala aurea" (golden apple). Some early writers described the tomatoes with phrases like "poma amoris fructu rubro" (apple of love with red fruit).

### Geographical Review<sup>6-8</sup>

Tomato is the world's largest vegetable crop and known as protective food both because of its special nutritive value and also because of its wide spread production. Tomato is one of the most important vegetable crops cultivated for its fleshy fruits. Tomato is considered as important commercial and dietary vegetable crop. Ten most promising States of the country for tomato crop have been identified and utilized for further study on various aspects of tomato crop. The maximum production and productivity have been shown by UP followed by Karnataka, Punjab, West Bengal and Assam. However, Maharashtra has increased area under tomato crop significantly as about 110% increase from years 90-91 to 95-96 and Bihar, UP with 72%, 44% respectively. Punjab is able to obtain about 114% increase in production for a considered period. About 8.3% increases has been achieved by UP followed by Assam (75%) and Karnataka (72%) in terms of the tomato production. It is produced from outside the India such as Mesoamerica, Britain, Spain, Middle East & North Africa and North America also. Tomato is protective supplementary food. As it is short duration crop and gives high yield.

### Morphological Review<sup>9-11</sup>

Leaves are lateral organs that are produced from the flanks of the shoot apical meristem (SAM). Leaf development can be divided into three continuous and overlapping phases: initiation, primary morphogenesis (PM), and secondary morphogenesis (SM) or histogenesis. *Solanum lycopersicum* has small, soapy-smelling green fruit with an unpleasant flavour and small compound leaves with thick, rounded leaflets. Leaflets are initiated from the marginal blastozone at the primary morphogenesis stage and go through similar developmental stages as leaves. The tomato is a short-lived perennial plant, grown as an annual plant, in the Solanaceae or nightshade family, typically growing to 1-3 m tall, with a weakly woody stem that usually scrambles over other plants. Tomatoes may be round, oblate are flattened at the top and bottom or pear shaped. The fruit is an edible, brightly coloured (usually red, from the pigment lycopene) berry, 1-2 cm diameter in wild plants, commonly much larger in cultivated forms. Though it is botanically a berry, a subset of fruit, the tomato is nutritionally characterized as vegetable.



The flower initiation was regularly recorded from the earlier tagged ten random plants. The 50 per cent flowering was noted when the flower initiation in five plants has started and days to 50 per cent flowering was worked out from the date of transplanting and expressed in days and grouped as early flowering and late flowering.

**Uses**<sup>12-13</sup>**1. Traditional Uses**

Tomato is a model species for classical genetic and genomic studies. It can be used in many places in which some are discussed below-

In marked symptoms of rheumatism and influenza.

In severe aching pains all over body.

In Hay-fever with marked aggravation from breathing the least dust.

In frequent urination and profuse watery diarrhoea.

*Solanum lycopersicum*, In treatment for Head, eye, nose, heart.

Half-ripe tomatoes are usually given in dyspepsia, summer diarrhea.

In homeopathic remedies.

**2. Medicinal Uses**

Englishman William Salmon in 1710 suggested using tomatoes to treat burns, itching, ulcers, running sores, back pain, headaches, gout, and sciatica.

Tomatoes provide essential antioxidants, good for kidney, hair, in diabetes, cell damage, helps to lower cholesterol, in lead toxicity, combating stroke, treatment of vasodilatation, proper functioning of brain, dysentery.

The other uses are treatment of aching back, dull pain in lumbar region, sharp pain of pectoral's muscles and in rheumatic pain.

Respiratory treatment such as pain in chest, husky voice

**3. Nutritive Value of Tomato**

Tomato is a Rich source of vitamin C. Moisture, energy, carbohydrate, protein, fat, fibre, vitamin A, thiamine, riboflavin, niacin, ascorbic acid, magnesium, oxalic acid, phosphorus, sodium, potassium, copper, sulfur, chlorine, iron and calcium, these are also present in tomato.

**Chemical Constituent**<sup>14-25</sup>**1. Steroidalalkaloid**

Green and unripe parts contain steroid glycosides, in form of glycoalkaloids. Total contents of steroid alkaloids differ from 0.1 up to 0.5 %. It is found in highest amount in fruits and seeds. In the genus *Solanum* they are important, both ecologically and commercially. The main steroid alkaloids are **Solanin** and **Solasodine**. Both consist of an aglycone and are connected mostly with 3 sugar parts like a chain. So they are called **solatrioses**. The content of solasodine found in young leaves.

**2. Steroidal saponines**

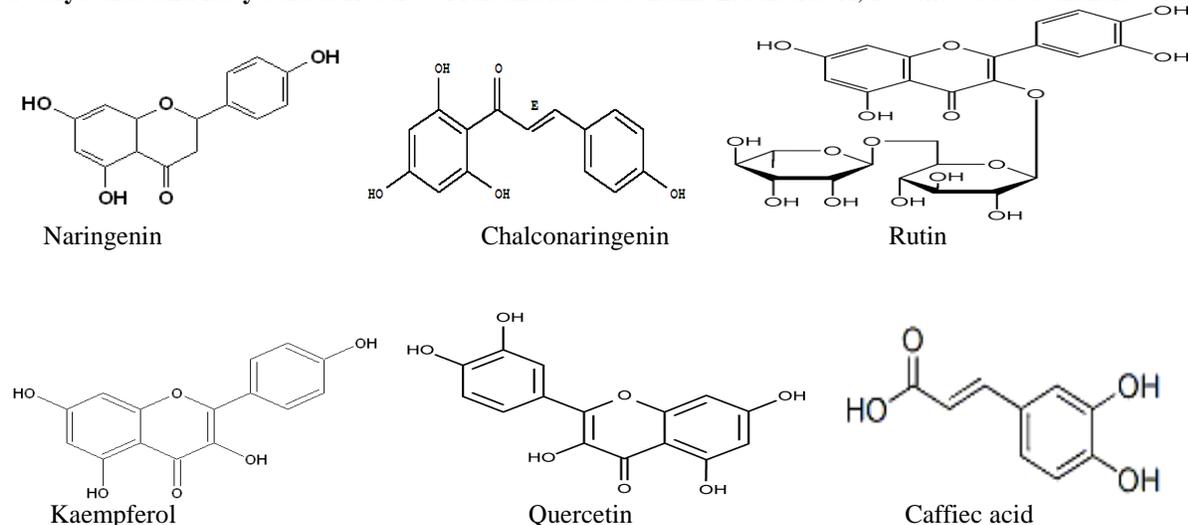
In most species steroid saponines were found, additionally. Their sapogenines are diosgenin, hispigenin, neochlorogenin, solagenin, tigogenin, yamogenin. From *S. lycopersicum* following saponines are isolated, such as solanigrasides 2-7, degalactotigonin. On human tumour cell line their cytotoxicity is tested. Only degalactogonin is toxic with IC 50 values 0.25. 4.49 $\mu$ M. In some other *Solanum* species, like *S. malacoxylon* and *S. verbascifolium* glycosides of dihydrocalciferol could be detected.

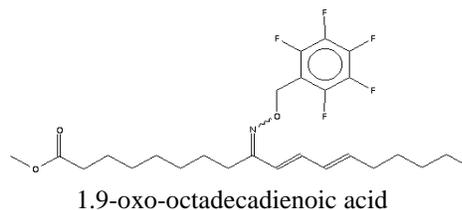
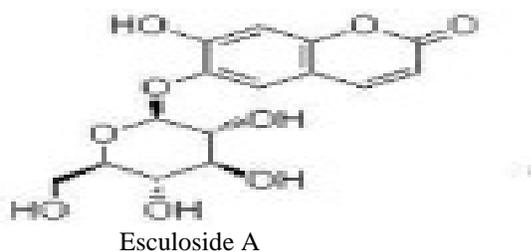
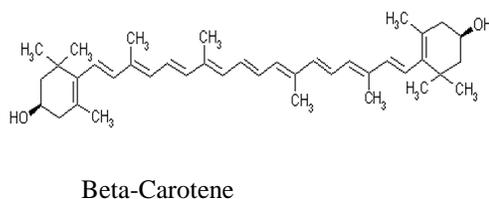
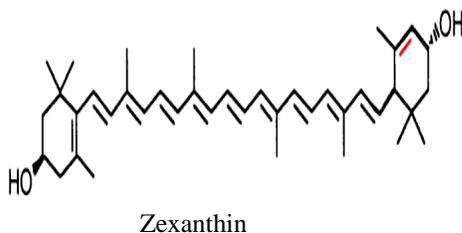
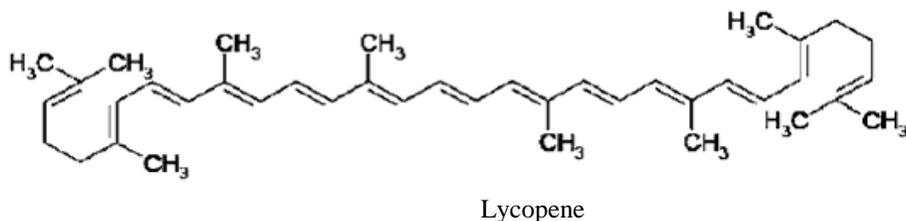
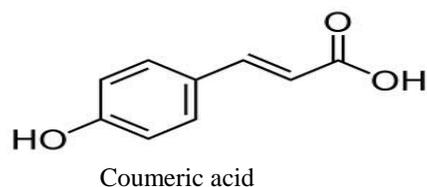
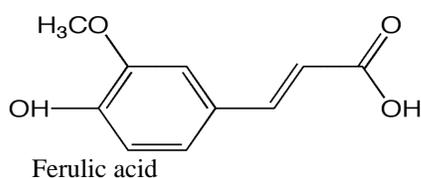
**3. Flavonoids**

Leaves of *S. lycopersicum* contain flavonones such as Neringenin, Calconaringenin and flavonols such as Rutin, Quercetin, Kaempferol,  $\alpha$ -tocopherol, polyphenols. Leaves also contain hydroxycinnamic acid such as Caffeic acid, Ferulic acid, Coumeric acid.

**4. Carotenoids**

Fruits contain Lycopene (in red tomato), Lutein, Zexanthin, and  $\beta$ -carotene.

**5. Glycoside and fatty acid derivative:** Fruit and leaves contains Esculoside A, 1,9-oxo-octadecadienoic acid



### Pharmacological Activities<sup>26-36</sup>

*Solanum lycopersicum* plant is anthelmintic, anti-inflammatory, anticarcinogenic, oxidative stress and antioxidants, platelet anti-aggregation activity, antifungal, biological activities and isolation of gene, bypassing kinase activity, enzymatic activity, high invertase activity, chromosome aberrations etc. It is used in the treatment of rheumatism and influenza, hay-fever, watery diarrhoea, treatment for Nose, eyes, head, respiratory, decreased risk of breast cancer, head and neck cancers, protective against neurodegenerative diseases, help lower urinary tract symptoms, reducing cardiovascular risk associated with type 2 diabetes.

#### 1. Anthelmintic activity of tomato leaf:

The methanolic extract of the tomato leaves showed significant anthelmintic activity. The methanolic extract of the tomato leaves was more effective even at lower concentrations in causing paralysis and death of earthworms than the Standard drug, Albendazole. It can be concluded that active constituents responsible for anthelmintic activity are present in the methanolic extract of leaves of *Solanum lycopersicum*.

#### 2. Antiinflammatory Activity of tomato leaf:

Methanolic extract of tomato leaves (0, 20, 50 and 100 µg/ml) showed significant antiinflammatory activity. PGE2 is also known to be pro-inflammatory mediator in many different acute and chronic inflammatory diseases as well as in normal defense reactions. In general, prostaglandin E2 is considered as one of the strongest inflammatory mediators in inflammatory response. It was transformed from arachidonic acid via the cyclooxygenases 2 catalytic reactions. The anti-inflammatory action of *Solanum lycopersicum* extract on lipopolysaccharide (LPS)-stimulated macrophages, its inhibitory and inflammation activity was investigated by observing the prostaglandin E2 production. At the highest concentration of tomato leaves extract tested, the PGE2 production is reduced.

#### 3. Oxidative Stress and Antioxidant activity of tomato leaf:

Tomato leaf biomass and relative leaf growth rate decreased as a result of higher concentration in the root medium. Both cultivars also showed an increase in the total and free concentration, a reduction in growth and increase of concentration in the plant tissues as a consequence of toxicity has previously been observed in tomato. The malondialdehyde (MDA) and H<sub>2</sub>O<sub>2</sub> concentrations were measured in leaves as an indicator of oxidative stress.

**4. Antifungal activity of tomato leaf:** Tomato leaves extract using the Porapak Q method possess antifungal activity. The antifungal activity of tomato leaf volatiles (TLV), was investigated against three types of plant pathogenic fungi of *Botryotinia fuckeliana*, *Glomerella cingulata* and *Fusarium oxysporum* f. sp. *melonis*. The growth of *B. fuckeliana* and *G. cingulata* was completely inhibited by TLV extract volumes corresponding to 12 and 17 g of tomato leaves, respectively. These results suggest the presence of a defense response against plant pathogenic fungi in tomato plants and that TLV are efficacious as a biological control agent.

**5. Bypassing Kinase Activity of the *Solanum lycopersicum* leaf:** The tomato protein kinase confers resistance to *Pseudomonas syringae* tomato bacteria expressing the AvrPto and AvrPtoB effector proteins. Activity of Ptoas Kinase is specifically and potently inhibited by ATP-competitive Small Molecules. The current study results that Pto kinase activity plays an important role through autophosphorylation in the stabilization of the Pto molecule in the proper conformation for interacting with bacterial effectors, but not in Pto-mediated signal transduction. Finally, the chemical-genetic strategy used here to develop small-molecule inhibitors that specifically target the kinase activity of Pto.

**6. Biological activities and isolation of genes in tomato fruit:**  $\alpha$ -tomatine is a steroidal saponin, constituted by a tetrasaccharide group attached to the aglycone tomatidine. This compound is especially abundant in leaves and immature fruits of tomato, and has been found to inhibit the growth of various plant pathogens. The main objectives of the present work are the study of biological activities of  $\alpha$ -tomatine and the isolation of genes involved in the pathway. All the tomato genotypes tested significantly inhibited the growth of *Rhizoctonia solani*, *Fusarium solani*, *Fusarium oxysporum*, and *Xanthomonas axonopodis* pv. *vesicatoria*. Other genes involved in anabolism and catabolism of  $\alpha$ -tomatine have been investigated utilizing similar cloning strategies.

**7. Anticarcinogenic activity of tomato fruit:** R.C. Agrawal et al used Croton oil to induce carcinoma in mice. When *S. lycopersicum* extract is given one hour before the each treatment of croton oil, the incidence and the number of skin papillomas are significantly decreased. The appearance time of papillomas was also prolonged in the *S. lycopersicum* experimental groups in comparison to the carcinogen treated animals. The reduction in tumor counts may be due to effect in the promotional phase of *tumorigenesis* which prevents the reduction of free radicals. This result is important because the tomato is an important vegetable in Indian diet and considerable importance has been given for the role of tomato and lycopene in prevention of prostate and other type of cancers.

**8. Cryptic Introgression in Tomato green fruit:** Introgression is the transfer of genes of one species into the gene pool of another via hybridization. In plants, introgression is a key concept in studies of the risks of contamination of natural populations by genetically modified (GM) crops. Genotyping of populations sampled from these regions would provide evidence to re-examine whether introgression from these wild tomato species into *S. lycopersicum* has played a role in the crop's evolutionary history.

**9. Endo-beta-mannanase Activity in Tomato fruit:** Endo-mannanase is present in the seeds of monocots, dicots, and gymnosperms, often in numerous isoforms. It is an *endo* enzyme that hydrolyzes mannans, galactomannans and glucomannans, and may be involved in the germination of some seeds. During extraction of the fruit enzyme, the presence of a protease inhibitor results in only the additional pI isoform, whereas, in its absence, there was a third isoform. We presume that this additional isoform was the result of limited proteolysis during extraction, and was not present within the fruit.

**10. Enzymatic Activity in Tomato fruit:** Adaptation of plants to several types of stress depends upon a complex cellular signaling system where reactive oxygen species (ROS), salicylates and cellulose and chitin oligomers intervene. Presence of these elicitors, activate the antioxidant and cellular defense systems against abiotic and biotic stress, as well as fulfilling some development regulation functions and tomato fruit ripening. Highest values of activation of the enzymatic activity were obtained when fruits were treated with chitosan.

**11. Cyclophosphamide-induced chromosome aberrations in tomato fruit:** The clastogenic effect of *Solanum lycopersicum* fruit extract has been evaluated against cyclophosphamide (CP)-induced chromosomal aberrations in the bone marrow cells of the mice. The present observation supports the mutagenic potential of *S. lycopersicum* extract in mammalian test system.

**12. High invertase activity in tomato fruit:** In tomato, fruit number, fruit weight, and seed number per fruit were markedly decreased at daily mean temperatures of 29°C compared with those at 25°C. The data provide correlative evidence that a high capacity for sucrose import and INV activity could contribute to heat tolerance in young tomato fruit possibly through increasing glucose signalling activities repressing the PCD pathway. In conjunction with previous work these findings indicate that the INV mediated PCD pathway through sugar signalling is conserved in reproductive organs between the eudicotyledonous species of tomato and the monocotyledonous maize in response to heat and water stress, respectively.

**13. Metabolic engineering of flavonoids in tomato fruit:** Flavonoids comprise a large and diverse group of polyphenolic plant secondary metabolites. In plants, flavonoids play important roles in many biological processes such as pigmentation of flowers, fruits and vegetables, plant-pathogen interactions, fertility and protection against UV light. Building up and exploiting prior knowledge of pathway control mechanisms opens up new possibilities for metabolic engineering of the tomato flavonoid pathway.

**14. Platelet anti-aggregation activity and endothelial protection from tomato fruit:** It has been observed that the tomato has platelet anti-aggregation activity *in vitro* and *in vivo* by inhibiting platelet aggregation induced by

ADP and collagen. The platelet anti-aggregation activity of aqueous and methanol extracts of tomatoes *in vitro* were similar. Both types of extract showed inhibition of platelet aggregation induced by ADP. In the study by aqueous and methanol extracts under various temperature maintained their platelet anti-aggregation activity, indicating that the active compounds with platelet anti-aggregation activity present in the two extracts were not affected by heat treatment.

**15. Antiobesity activity of *Solanum lycopersicum* fruit:** Ethanolic extract of *Solanum lycopersicum* used for antiobesity activity Obesity is increasing at alarming rates in industrialized and „industrializing“ world and is considered to be a disorder of energy balance. *Solanum lycopersicum* is known to have lipid-lowering effects and antioxidant activities. The *Solanum lycopersicum* paste also decreased the plasma levels of malondialdehyde and increased the activities of superoxide dismutase, catalase and glutathione peroxidase in hamsters. Tomatine, a major component of green tomato, decreased serum LDL cholesterol through the formation of tomatine-cholesterol complex. *Solanum lycopersicum* (250mg/kg/day, 500mg/kg/day) significantly decreases the food intake (kcal), body weight, body mass index (BMI), lee index, weight of the adipose tissue. The antiobesity effect of various doses of ethanolic extract of *Solanum lycopersicum* is produced due to the antioxidant effect produced from the plants.

**16. Effects of a tomato extract on the labelling of blood constituents with technetium-99m:**

Blood constituents labeled with radionuclides have been used in procedures in nuclear medicine. This study suggests that the aqueous tomato extract, in a concentration that is found in human diet, has the ability to reduce the radiolabeling on plasma proteins. Probably this occurs due to chemical substances of the tomato extract that could have action on reducing agent (stannous ion) used in the labeling process and/or the ability to interact with plasma proteins, occupying its binding sites. Although these experiments were performed in rats, the results suggest that caution should be taken with the interpretation of the data obtained from nuclear medical diagnosis and tests when patients consume tomato extracts or its derivatives in food.

**17. Suboptimal-temperature tolerance of *Solanum lycopersicum* seed:** The vegetative growth rate of tomato at suboptimal temperature is for a significant part limited by its poor root development. Root-zone heating and grafting onto a low-temperature tolerant rootstock appeared to be useful tools for tomato to increase shoot growth at suboptimal cultivation temperatures by stimulation of the leaf expansion rate. Such new rootstocks may help to broaden the temperature optimum of elite tomato cultivars and so to increase the energy efficiency of tomato green house cultivation in the temperate climate zone.

## Conclusion

*S. lycopersicum* is wonderful plants having enormous range of medicinal activity in this article have assembled almost all information related to different research activity of plant. Although it is mentioned as a component in several popular polyherbal formulations in the form of alcoholic or hydroalcoholic extracts, it is an attractive candidate plant for formulating targeted drugs. It will help to researchers & scholars to go deep in this area as plant indicate vast range of phytochemical related to origin so it can be suggested the further work can be done on *S. lycopersicum*.

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