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Different parts of *Solanum lycopersicum*, carotenoid: nutritional analysis and role in antimicrobial activity

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Abstract

Seeds contain many bioactive secondary metabolites, there has been an increase in research into using them as potential sources of therapeutics. Tomatoes contain significant amounts of carotenoids and flavonoids, as well as vitamins C and E and polyphenols. These compounds are also involved in disease prevention. Lycopene is assumed to be an active constituent in tomatoes that reduces the risk of various types of cancer. Numerous different prospective action mechanisms for lycopene have been proposed, such as gene function regulation, interaction via gap junctions, hormone and immunologic activity modulation, and carcinogen metabolism. Indeed, many possible treatment uses of tomatoes have been properly studied. Tomato seeds have not been widely used as a source of oils and proteins. Numerous tomato seeds and peels are discarded in industrial processing due to a lack of knowledge and awareness. Our experimental research was primarily concerned with comparing quantified phytonutrient estimations and evaluating the antioxidant and antibacterial properties of seed, peel and pulp of raw and ripe *Solanum lycopersicum*. Green tomatoes have good amount of carbohydrates and also show efficient scavenging activity; can act as reactive oxygen species (ROS) whereas ripe tomatoes show high vit b1 content that the raw one.

Key words : *Solanum lycopersicum*, carotenoids, nutritional analysis, antimicrobial activity.

Around 700 A.D., the Aztecs of Central America cultivated the *Solanum lycopersicum,* tomato plant known as xitomatl. It was named tomate by Spanish conquistadors. Tomato seeds were supplied, around 1520, from the Andes to Spain, and then to other European countries. Tomatoes were known as pompodoro or "golden apple" in Italy and "pomme d'amour" or "apple of love" in France. Thomas Jefferson mentioned growing tomatoes in Virginia in 1781; the use of tomato soups and sauces in the United States began

around 1830[1]. The green revolution was the first step toward reducing global hunger and starvation, after achieving some of this, the obvious next step is to combat malnutrition. With surplus food available, the emphasis should now be on providing a balanced diet with adequate micronutrients. More than two billion people worldwide are said to be suffering from "hidden hunger" at the moment (a lack of vitamins and minerals). Significant efforts are required to understand the nutritive potential of various crops and optimise their processing (from harvest to plate) to retain their nutritive value[16].

The current global output of tomato is estimated to be 24 million tonnes,they are grown and consumed on a massive scale all over the world, just because the tomato plant belongs to the Solanaceae plant family, members of which produce toxic alkaloids such as nicotine, the fruits were assumed to be poisonous and their consumption was discouraged. As a result, most tomato plants were grown as ornaments. Tomatoes became popular as a food in the United States during the second half of the nineteenth century. 9 (Tomato News 2001, 31, 1.).

They are high in micronutrients and minerals, making them an excellent candidate for nutrient enhancement. However, a thorough understanding of tomato nutritive aspects, food processing, and genetic regulation of its essential nutrients is critical to the efficient exploration of tomato as a nutritional supplement. Understanding the complex genetic regulations and effects of environmental factors on the expression of nutritional quality-related traits can be aided by a thorough understanding of the tomato transcriptome and metabolome. This level of comprehension will also aid in the targeted improvement of the tomato crop in terms of nutritional value and biochemical composition.

Carotenoids are isoprenoids with numerous health benefits, the most noteworthy of which is lycopene. Carotenoids are a vital ingredient of tomato nutritional content, and tomatoes contain all four major groups: a- and b-carotene (0.10 and 0.45 mg/100 g red tomatoes), lutein (0.12 mg/100 g), and lycopene (2.57 mg/100 g).[5] also accumulate a wide range of secondary metabolites such as phenolic compounds, phytoalexins, protease inhibitors, and glycoalkaloids.Carotenoids have 11 conjugated double bonds and 9 unconjugated double bonds, shows good amount of scavenging activity; can act as reactive oxygen species (ROS)[2]. It has been postulated that tomato carotenoids and vitamins (C & E) have synergistic antioxidant activity that is greater than their individual effects.Tomatoes contain significant amounts of carotenoids and flavonoids, as well as vitamins C and E and polyphenols. These compounds are also involved in disease prevention[6]. Lycopene is assumed to be an active constituent in tomatoes that reduces the risk of various types of cancer[3]. Numerous different prospective action mechanisms for lycopene have been proposed, such as gene function regulation, interaction via gap junctions, hormone and immunologic activity modulation, and carcinogen metabolism.[1] Indeed, many possible treatment uses of tomatoes have been properly studied. Tomato seeds have not been widely used as a source of oils and proteins. Numerous tomato seeds and peels are discarded in industrial processing due to a lack of knowledge and awareness.

The ample number of tomato-based foods consumed globally, understanding the nutritional aspects of the tomato, nutrient losses during processing, and how these by-products can be efficiently utilised is of great value and importance. In this current study, we will discuss the nutritional aspects of most underrated parts (peel and seed) of red and green tomatoes as well as pulps and a basic understanding of microbial activity on *E. coli* bacteria.

Sample collection and preparation for the experiments :

Two types of *solanum lycopersicum* both red and green (fig. 1) were collected from various markets of Kolkata. Then three different portions were dried carefully, they were mechanically ground into a coarse powder. The powdery form of the solvent was derived using double distilled water (aqueous) and 100% ethanol[11] 1gm of each seed powder (raw and ripe seed) was added to 50 ml of solvent (ethanol and distilled water) to make seed extracts. Following that, an overnight extraction at ambient temperature was conducted by wobbling the conical flasks. The extracts were filtered using Whatman No. 1 filter paper and stored at 4 degree c for future biochemical analyses.

Chemicals required :

The chemicals were all of analytical grade. SRL supplied starch, iodine solution (KI + KIO3), and DPPH, Ninhydrin, Anthrone, sulphuric acid, BSA, Folin's reagent, potassium di chromate, Abbott provided a vitamin C chewing tablet, HIMEDIA provided Bradford Reagent, Nutrient Agar, and nutrient broth, Merck biological society of India provided ascorbic acid and a local medical store provided standard lycored.

Vitamin profiling :
Vitamin c :

The samples were tested for vitamin C using the potassium iodate, potassium iodine titration method[13]. The calculation was

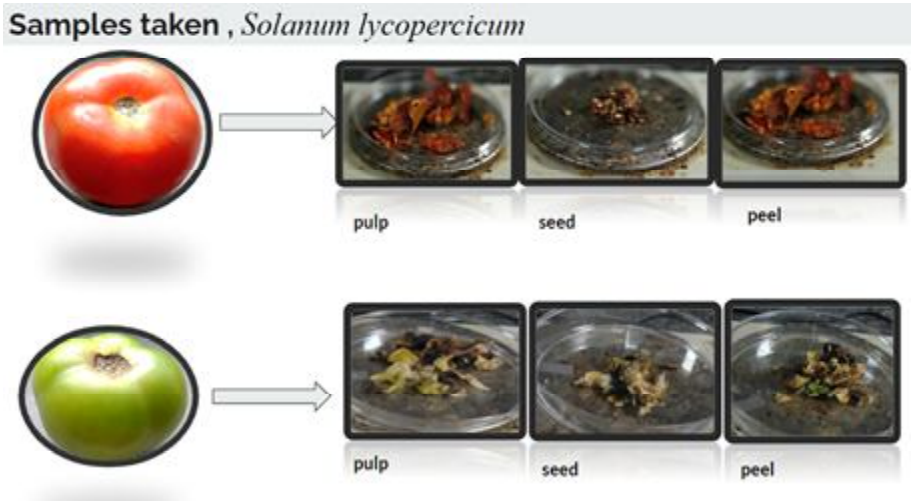

Fig. 1 shows both the samples.

performed by multiplying the number of iodine drops by the standard value of limcee tablet. The samples were collected using a standard iodine solution as an oxidising agent, starch as an indicator, and samples and controls (vitamin-c medical grade tablet and distilled water).

Vitamin B1 :

The thiamine content was quantified using standard method with only minor modifications.[14]

In vitro antioxidant assay :

The free 2, 2-diphenyl-2-picrylhydrazyl stability extracts' radical scavenging activity was assessed using the standard method for determining the presence of antioxidant capabilities in natural products[17]. Absorbance was measured at 517 nm. The calibration curve was altered by using ascorbic acid as the standard. This experiment is repeated thrice.

The percentages of inhibition were calculated using the following formula: % inhibition = (Control OD- Sample OD)/ Control OD *100.

Proximate nutritional analysis :
Carbohydrate

The Anthrone method was used for quantification. The experiment's standard curve was created using glucose. At 610 nm, the absorbance was measured. The result was expressed as mg Glucose equivalents/g dry material (fig. 3a)[8].

Protein :

The Bradford assay was used for quantification. The experiment's standard curve was created using bovine serum albumin (BSA). At 595 nm, the absorbance was measured. The result was expressed as mg BSA equivalents/g dry material.[7]

Amino acid :

Each of the aquous extract (1ml) was treated with few drops of Ninhydrin reagent. Appearance of purple color indicated the presence of amino acids and measured through spectrophotometric assay quantified using standard method with only minor modifications[12].

In vitro disc diffusion assay :

Disc diffusion techniques were used to determine in-vitro antibacterial activity. Gram-positive bacteria E. coli was used in this study, which were obtained from the Microbiology Department's laboratory at Calcutta University. To create the sample extracts for this test, sterile Analytical grade water was used, which was then filtered through 0.2-m Whatman Filter paper. *E. coli* was sub-cultured in 100 l of sterile Luria broth, which was then incubated for 24 hours at 37°C. During the log phase of newly sub-cultured tubes, 20 l of test bacteria were smeared and seeded onto sterile LB Agar plates that had been preheated during the log phase. Using sterile forceps, sterile paper discs were placed on top of inoculated agar plates. The sample extracts were then pipetted out in 20 l aliquots onto the agar surface paper discs. The plates were allowed to dry for a few

minutes before being incubated at 37°C for 24 hours. The inhibition zone (in mm.) formed by the extracts surrounding the disc was used. The antibacterial activity was determined by using area of the inhibition zone (in mm.) created by the extracts surrounding the disc. Every test went well, done for three times.[15]

Vitamin profiling :
Vitamin C estimation :

Tomato products are rich sources of bioavailable vitamin C in addition to lycopene. Consuming tomato products on a regular basis can improve cells' resistance to DNA damage brought on by oxidant species. This result might result from the interaction of several antioxidants found in tomatoes.

Figure 2a depicts the results of this assay. The amounts range is given below in mg AAE/ml fresh weight.

Red Peel 137.38± 2.06	Green Peel 192.43± 2.08
Red Pulp 303.22± 3.13	Green Pulp, 275.35± 2.05
Red Seed 305.42± 2.61	Green Seed 288.61± 2.19

Vitamin B1 :

According to the result, the amount of total Vitamin B1 content (fig. 2b) in red or ripened tomato peel, pulp, seed was significantly higher than the green or raw tomato peel pulp and seed.

red		green	
Red Peel	38.231±0.337	Green Peel	7.293 ±0.035
Red Pulp	31.978±0.093	Green Pulp	5.801±0.232
Red Seed	34.226±0.162	Green Seed	4.450±0.324

Thiamine (vitamin B1), which can be found in many foods, is used to treat Wernicke-Korsakoff syndrome, low thiamine, beriberi, and a few other nerve illnesses (WKS).
Our bodies need thiamine to use carbohydrates properly. Furthermore, it helps support nerve performance can be found in foods including meat, beans, nuts, yeast, and cereal grains. It is included in many vitamins B complex preparations and is often used in conjunction with other B vitamins.

People take thiamine for illnesses associated to low levels of thiamine, including beriberi and inflammation of the nerves (neuritis) (neuritis). There is no reliable evidence to support its use for several other conditions, such heart disease, diabetic nerve pain, and digestive problems.[9]

Antioxidant estimation :

The inhibition percentage determined using the Ascorbic Acid standard curve (R2 =0.998) was higher in red peel, pulp, seed in ripe seeds than in raw peel, pulp, seeds in the case of aqueous extracts. Given the case of aqueous extract, the % inhibition is more in raw samples.

Red Peel	11.373±0.050	Green Peel	2.031±0.724
Red Pulp	7.286 ± 0.050	Green Pulp	2.429±0.848
Red Seed	19.789±0.093	Green Seed	2.454±0.804

Humans need to consume vitamin C in order to survive. All of vitamin C's recognised actions are explained by the fact that it is an electron donor.

In humans, vitamin C functions as an effective water-soluble antioxidant and electron donor. Numerous in vitro investigations have shown vitamin C's antioxidant benefits.

A portion of the development of human diseases including cancer and atherosclerosis may result from oxidant injury to tissues.

Specific oxidation products that can be quantified in the lab are produced when lipids, proteins, and DNA oxidise. Even though these oxidation biomarkers have been measured in humans, these assays have not yet been confirmed or standardised, and it is unclear how oxidant markers relate to human illness situations. Studies on epidemiology demonstrate that diets rich in fruits and vegetables.[4]

Proximate nutritional analysis :
Protein estimation :

The experiment's BSA standard curve (R2 =0.996) was used for quantification. The total protein content (Figure 3) is lower in red seed extracts (152.27±1.50 mg BSA/g fresh weight) than in green extracts (169.32± 0.56 mg BSA/g fresh weight). Higher amount of protein present in green tomato peel seed and pulp extract.

Red Peel	13.44±1.87	Green Peel	143.37± 0.33
Red Pulp	37.55±0.09	Green Pulp	158.62± 0.71
Red Seed	152.27±1.50	Green Seed	169.32±0.56

Food macromolecules called proteins are crucial for cellular structure and biological processes. Protein analysis is essential for defining the biological activities and functional aspects of food products, as well as for nutritional labelling. Another class of macromolecules called lipids is typically insoluble in water but is organic solvent-soluble in fact, a precise and reliable examination of the lipid content in food is essential for maintaining manufacturing specifications, the level of quality, and nutritional labelling[9].

Carbohydrate estimation :

Quantification was done using the Glucose standard curve of the experiment (R2 =0.995). It is observed that the total carbohydrate content (Figure 4a) is more in raw aq. peel extract (12.747 ± 0.366 mg GE/g of dry weight) as compared to ripe peel extract (7.227± 0.101mg GE/g of dry weight). Also, the carbohydrate content is more in ripe aqueous pulp extract (74.458 ± 0.466 mg GE/ g of dry weight) than in raw aqueous pulp extract (37.056±0.970 mg GE/g of dry weight)

Red Peel	7.227± 0.101	Green Peel	12.747±0.366
Red Pulp	74.458±0.466	Green Pulp	37.056±0.970
Red Seed	20.967±0.443	Green Seed	20.967±0.443

Amino acid estimation :

Amino acids are the components of proteins, which playing an important part bodily functions including such cellular structure maintenance, nutrient transport and storage, wound healing, and tissue repair. In tomato, 17 organic molecules have been reported. Essential amino acids are estimated to account for 39.75% of total protein in tomato. The most abundant was glutamic acid (approximately 10.13 g/100 g protein). Among the various essential amino acids found in tomatoes, leucine has the highest concentration, while methionine has the lowest. Among the non-essential amino acids, glutamic acid is the most common, followed by cysteine[9].

Red Peel	7.227± 0.101	Green Peel	12.747±0.366
Red Pulp	74.458±0.466	Green Pulp	37.056±0.970
Red Seed	20.967±0.443	Green Seed	20.967±0.443

In vitro Antibacterial assay

zone of inhibition (fig. 4a,4b) was observed in the case of the aqueous extracts; additionally, the raw sample extract (ethanolic) shows a lower antimicrobial property as compared to the ripe sample extract (ethanolic) which is clearly represented. Lycopene 16.89±0 and Water 5.33± 0.00 mmwas taken in this experiment.

Red Peel	8.44± 0.29	Green Peel	26.33± 0.15
Red Pulp	7.23± 0.38	Green Pulp	7.00 ± 0.03
Red Seed	5.23±0.71	Green Seed	20.33± 0.05

Graphical presentations :

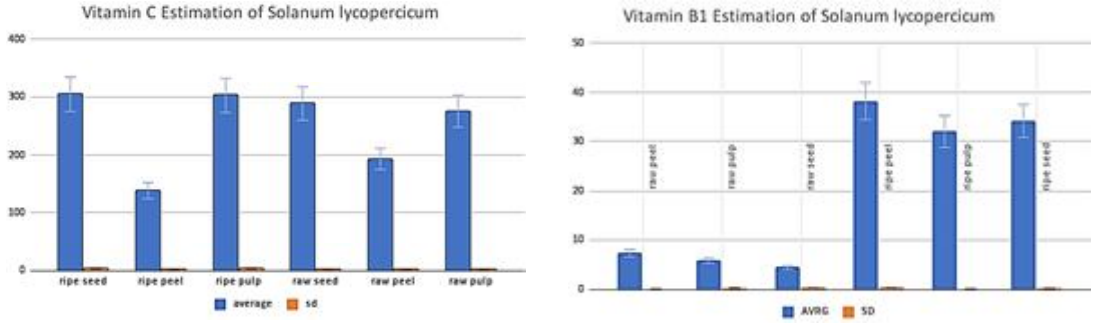

Fig. 2a, 2b shows the vitamin profiling contents of different parts of both *Solanum lycopersicum*

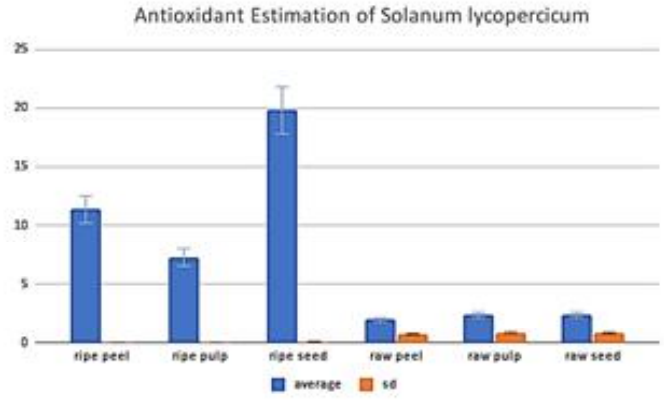

Fig. 3 shows the antioxidant contents of different parts of both *Solanum lycopersicum*

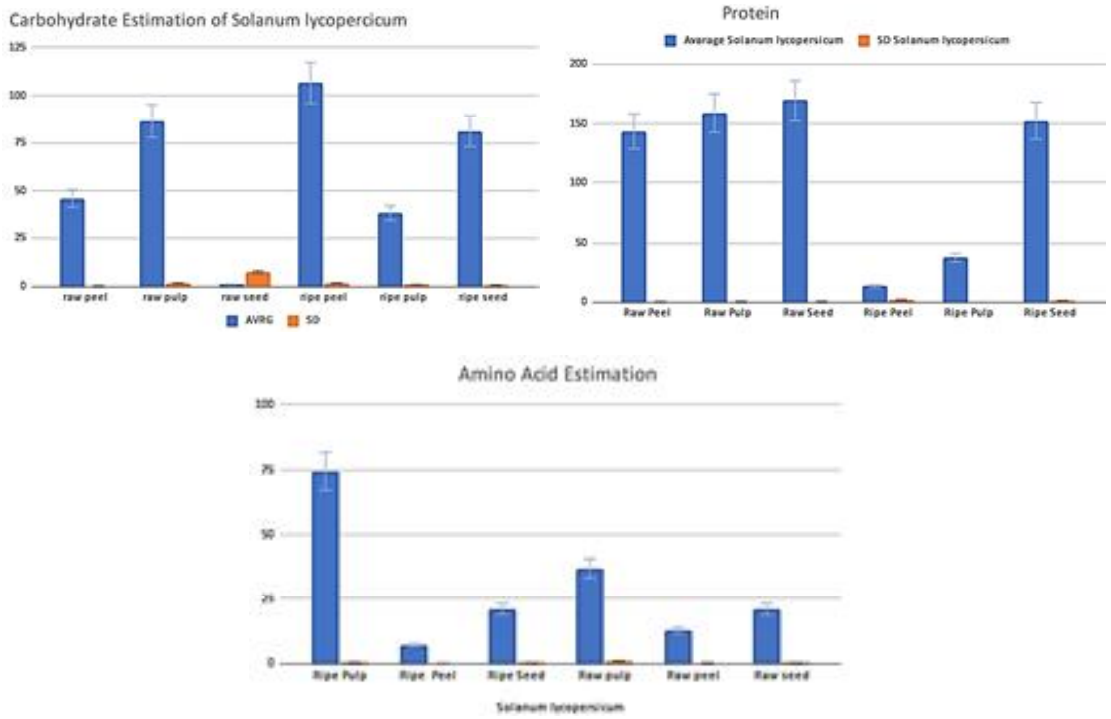

Fig. 4a,4b,4c shows the carbohydrate,protein and amino acid contents of different parts of both (green and red) *Solanum lycopersicum*

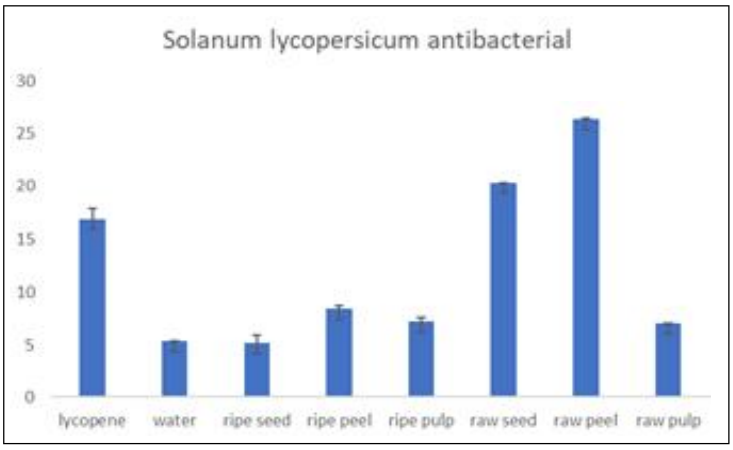

Fig. 4a shows the invitro microbial activities of different parts of both (green and red) *Solanum lycopersicum*

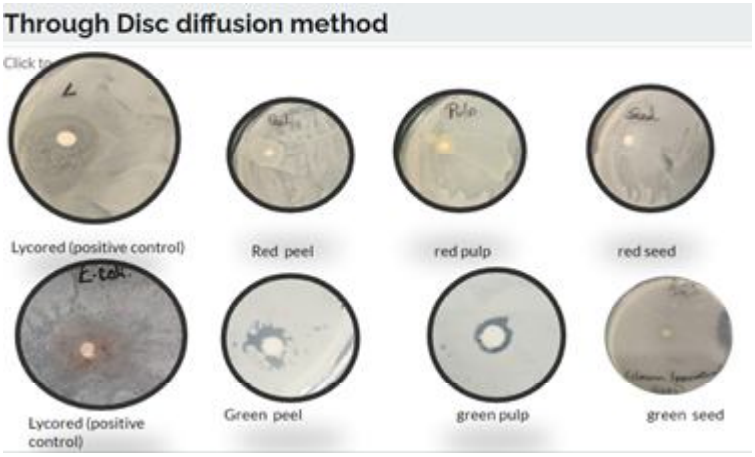

Fig 4b shows the disc diffusion images.

This special issue has a number of articles that highlight some of the most recent developments in the study of carotenoids, lycopene and antioxidant qualities. These research on this intriguing class of natural products have covered a wide variety of topics. According to the results of the experiment, red and green tomato pulp, peel and seed extracts (aqueous) have antimicrobial activity against *E. coli*. Although the phytochemical and nutritional content of raw and ripe samples differed, both were effective in inhibiting bacterial growth. Further research can be conducted in the future to isolate the various phytochemicals and other compounds that could be used to prepare hydro-alcoholic solutions of potential therapeutics more cost-effectively.

Thus, the study explains that different parts of tomato can be of different values and most importantly green tomato can be a new choice of discussion, development of herbal drugs with health-promoting effects, thereby transforming them into nutraceutical.

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