International Journal of Botany Studies
ISSN: 2455-541X; Impact Factor: RJIF 5.12
Received: 19-11-2020; Accepted: 04-12-2020: Published: 15-12-2020
www.botanyjournals.com
Volume 5; Issue 6; 2020; Page No. 664-668

Evaluation of changes in proximate compositions sugar profile and anti-oxidants markers of tomato (*Lycopersicon esculentum* L.) during unripe and ripe stages

Md. Ashikur Rahman[1*], Md. Parvez Hasan[2], Rakibul Hasan[3]

[1] Food Technology Division, Institute of Food and Radiation Biology, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh

[2, 3] Regional Agriculture Research Center, Bangladesh Agriculture Research Institute, Ishwardi, Pabna, Bangladesh

Abstract
A comparative study was carried out to investigate the changes of nutritional value, sugar content and antioxidant marker of unripe and ripe tomato in Bangladesh. The study was showed that moister content and protein content of ripe tomato significantly (p<0.05). higher compare to unripe tomato. On other hand, fat content and ash content of unripe tomato significantly (p<0.05). higher compare to ripe tomato. The highest amount (46.62mg/100g) of calcium was found in ripe tomato. Unripe tomato was contained the highest values (36.74mg/100g) and (1.86 mg/100g) of phosphorus and iron respectively. The highest amount (3.4 ±0.07%), (1.72 ± 0.02%) and (1.59 ±0.08%) of total sugar, reducing sugar and non-reducing sugar were found in unripe tomato compare to ripe tomato. The study was observed that ripe tomato contained highest values (27.5± 0.01 mg GAE/100g), (26.51 ±0.03 µg/ml) and (4.83 ±0.01 mg QUER/g) of total phenol. DPPH scavenging activity and total flavonoid respectively compare to unripe tomato. The study revealed that unripe tomato is not health beneficial to diabetic subject's due to high amount of sugar level compare to ripe tomato. On the other hand, ripe tomato is an excellent source of antioxidant that improve immune system of the human. The study was found that ripe tomato is the best for human consumption compare to unripe tomato.

Keywords: Tomato, proximate composition, sugar, antioxidant marker

Introduction
Fruits and vegetables are vital sources of nutrients for humans but in most developing countries like Bangladesh, their cultivation is seasonal [1]. The tomato (*Lycopersicon esculentum* L.) is usually consumed in Bangladesh also globally in raw-fresh or treated and cooking form [2]. Tomato cultivation in Bangladesh is of commercial significance, accounting for nearly 68,366 acres with the production of 388,725 metric tons [3]. Taste and nutritional content of tomatoes increases the intake of consumers. Tomato provide nutrients as well as phytochemicals that essential for the proper function of the human body [4].
Tomato has a good nutritive value contain high amount of water and excellent source of minerals such as calcium, iron, phosphorus [5]. More consumption of tomato that contains calcium, phosphorus, and iron, benefit to implicit in the natural activity of muscles and nerves [6]. Tomato is a significant source of antioxidants, when intake in adequate amount may inhibit some long-lasting diseases by preventing the detrimental properties of free radicals [7].
Chemically reactive molecules for example peroxide radicals ($ROO^{\cdot}$), superoxide ($O2^{-\cdot}$) and hydroxyl ($HO^{\cdot}$) called reactive oxygen species (ROS) are formed from oxygen metabolism [8]. Large amount of reactive molecules formation may instigate impairment to cells and tissues that cause loss of cellular activity as well as oxidative stress and finally, apoptosis or necrosis. Consequently, these damages may reduce numerous health problem, for example heart disease and carcinogenesis [9, 10]. With a view to counteracting the biomolecules in contradiction of a reactive oxygen species attack, antioxidants are essential to neutralize the extreme free radicals that defend the cells alongside their toxic properties and inhibit diseases as like arthritis as well as prolonged bronchitis [11]. Total phenol content and phenolic compounds such as flavonoids present in tomato act as an antioxidant [12].
Currently, use of tomato largely depend on morphological characteristics, nutritional value and antioxidant marker. The study of these compound and morphological characteristics was carried out many countries [13]. However, even now there is no details study on nutritional value, sugar profile and antioxidant marker in Bangladeshi tomato. Present research carried out to quantify of proximate composition, sugar profile and antioxidant of tomato to disseminate the knowledge among the consumers.

Materials and Method
Sample and chemicals
Unripe tomato and ripe tomato were collected at tow harvesting stages. Tomatoes were in spotless and uniform for analysis. Their morphological characteristics presented in table 1.

Table 1: Morphological characteristics of unripe and ripe tomato

Maturation	Color	Firmness	Height (nm)	Weight (gm)	Diameter (nm)	Shape
Unripe	Green	Slightly soft	47.88	95	67.45	Uniform
Ripe	Red	Soft	51.83	102	72.30	Uniform

The collected samples sorted, washed and stored at refrigerator temperature for further analysis. Analytical grade chemicals were used in this study.

Proximate Analysis

Ten grams of sample was taken into a dried petri-dish. The sample in petri-dis was placed in an oven at 105 ° C for 4 h. Desiccator was used to cool the sample. After cooling weight of the sample was taken and calculated of moisture content according the method of AOAC (2002). Ash content was determined using the method of AOAC (2002). Protein content of sample was measured by Micro- Kjeldahl method as per description of Foss Analytical manual. Soxlet apparatus was used to measure fat content of sample using the method of AOAC (2002) [14].

Analysis of mineral content

Iron and calcium content were determined by the method as per description of Raghuramula *et al*., [15]. Phosphorus content was measured by the method of Fiske and Subbarow [16]

Total sugar

Total sugar content was estimated by Anthrone reagent method described by Hansen and Moller (1975) [17]. In brief, 0.1 ml extract was mixed with 1.9 ml distilled water and kept in ice bath for 15 min. Next, 3.5 ml anthrone reagent was added following heated in boiling water for 20 min. After cooling at room temperature, the absorbance was measured at 620nm using GENESYS 150 UV-visible spectrophoto-meter.

.

Reducing sugars

Total reducing sugar was measured using the method of Nelson-Somogyi, 1944 [18]. Briefly, tomatoes were blended with benzoic acid solution (0. 2%).The blended sample centrifuge at 2500rpm for 3 min following filtration. The copper reagents (a mixture of alkaline Rochelle salt and acidic CuSO4) were mixed with the previously filtrate. Solution was heated in boiling water (15 min) then cooling at room temperature. Blue color was developed after addition of arseno molybdate color reagent. Finally, the optical density was recorded at 520 nm.

Non-reducing sugar

Non-reducing sugar of tomatoes were calculated by subtracting the reducing sugar content from total sugar content [19] using the following formula:

Percentage of non-reducing sugar = (Percentage of total sugar- percentage of reducing sugar) × 0.95

Measurement of total phenols content

Fifty µl extract of sample was mixed with 0.5 ml distilled water (pH =7.00) to measure the total phenol content. Then,0.5 ml diluted Folin-Ciocalteu reagent was added to sample solution. Sample solution was incubated for 7 minutes following the addition of 0.5 ml of 7% sodium carbonate. The optical density was recorded at 765 nm using a spectrophotometer (GENESYS 150 UV-visible spectrophoto-meter). The results were calculated using the gallic acid standard curve and expressed as mg of gallic acid equivalent/hundred gm [20].

DPPH radical scavenging activity assay

Hundred ml of ethanol (95%) was used to dissolve 5 mg DPPH. Briefly, 100 µl extract was added in previously made 5 ml DPPH. Addition of 5 ml DPPH in 5 ml distilled water for the perpetration of control sample. At the same way, blank sample was made by using extract of sample and ethanol (95%). The optical density was measured at 517 nm following 40 minutes incubation at dark. The results were calculated based on Trolox standard curve using formula IC_{50} value [21].

Measurement of total flavonoid content

Two ml extract was added in 5 ml methanol. The sample solution was mixed with 300 µl of 1M potassium before adding 250 µl of 10% aluminum solution. The solution was incubated for 40 minutes following the addition of 6 ml distilled water. The absorbance was recorded at 415 nm. Quercetin was used for standard curve preparation and results expressed as mg/gm quercetin equivalent [22].

Statistical analysis

The results are expressed as a mean and standard deviation of three replicates. The independent t-test was carried out using MINITAB software and significant level considered as the value $p<0.05$.

Results and Discussions

The comparison of proximate composition of unripe tomato and ripe tomato presented in table 2. Moister content of ripe tomato is scientifically ($p<0.05$) higher than unripe tomato. Moisture content of unripe tomato and ripe tomato was found lower compared previous study carried by Sulbaran *et al*. [23] who stated moister content of 93.5% and 94.60% respectively. Harvesting time and cultivation process may influence the variation of moister content. It is clear that with the increase of harvesting time moister content increases. Ripe tomato is more perishable than unripe tomato at room temperature due to high moisture content [24]. Ripe tomato was found in highest amount (2.14 ±0.02 %) of protein content than unripe tomato. The values are scientifically difference. The values are not line with the findings of Korkalo *et al*. who reported the protein values 15.79% [25]. There is far difference between present and previous study. Protein content of unripe tomato and ripe tomato because of using small amount of urea for harvesting and soil condition.

Table 2: Proximate composition of Tomato

Sample	Moisture (%)	Protein (%)	Crude Fat (%)	Total Ash (%)
Unripe Tomato	90.5± 0.3[a]	1.52± 0.03[a]	0.88 ±0.01[a]	1.06± 0.02[a]
Ripe Tomato	93.31± 0.01[b]	2.14 ±0.02[b]	0.08 ±0.004[b]	0.80 ±0.02[b]

The fat content of ripe tomato is significantly ($p<0.05$) lower than unripe tomato. Ripe tomato was found negligible amount of fat content (0.08 ±0.004 %). Previous findings reported in FAO [26] that fat values 3.51% of tomato that

higher than present study values. The variation of fat content might be due to origin of tomato is plant. Plant product have a low amount of fat content. The highest value (1.06± 0.02) of ash was found in unripe tomato compare to ripe tomato with significant difference (p<0.05). The values of ash content are below to those obtained by Gupta *et al.* [27] findings values 7.21% and 7.24% respectively.

Three essential minerals were assessed in the study such as calcium, phosphorus and iron were shown in figure 1. The ripe tomato was found in highest value (45.62 mg/100g) of calcium with significant difference (p<0.05) compared to unripe tomato. The highest amount of phosphorus and iron was found (36.74 mg/100g) and (1.86 mg/100g) respectively in unripe tomato compared to ripe tomato with significant difference (p<0.05). The previous study stated by Srivastava R. P., and Sanjeev, K *et al.* [28]. that the values of calcium, phosphorus and iron of unripe tomato were (20mg/100g), (36 mg/100g) and (1.8 mg/100g) respectively of unripe tomato on the other hand calcium, phosphorus and iron were found (48mg/100g),(20mg/100g) and (0.4 mg/100g) respectively of ripe tomato. These values are in line with present study.

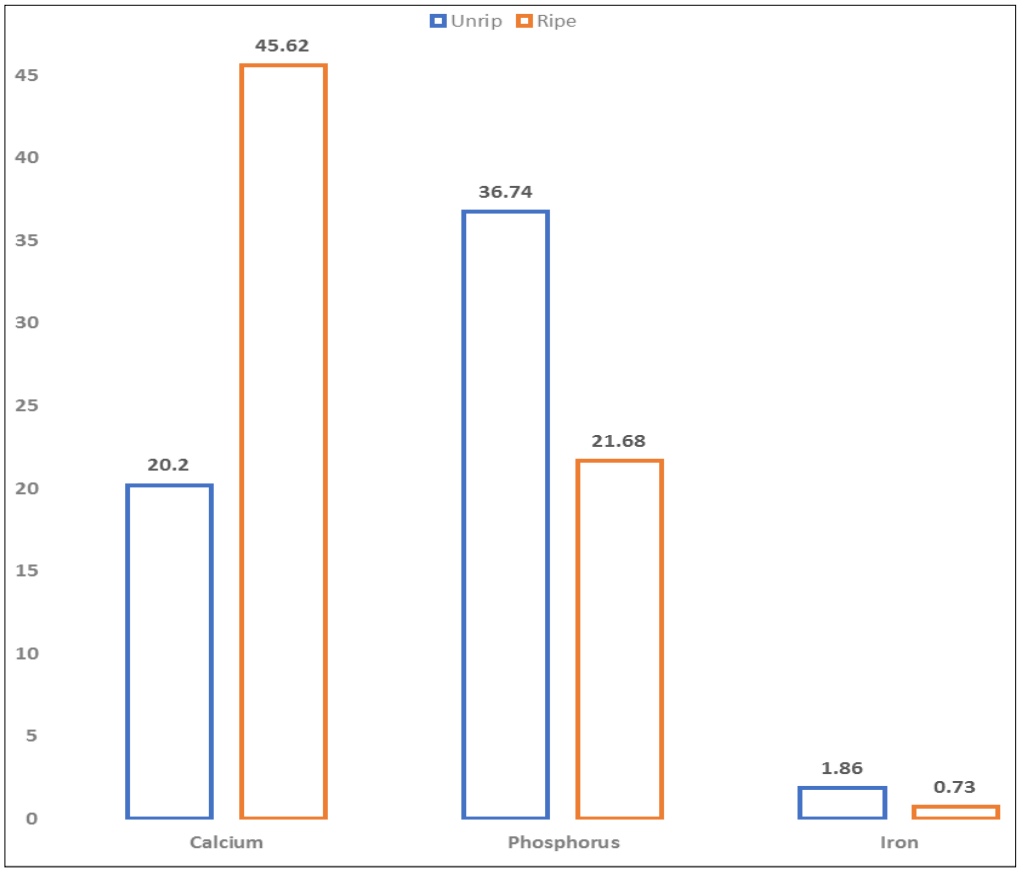

Fig 1: Comparison of selected mineral content of unripe tomato and ripe tomato

Total sugar, reducing sugar and non-reducing sugar were analyzed that presented in table 3. The highest amount of total sugar, reducing sugar and non- reducing sugar were found (3.4 ±0.07 %), (1.72 ± 0.02%) and (1.59 ±0.08) respectively in unripe tomato compared to ripe tomato. These values are not line with those of Bernal *et al.* [29] who reported the highest level of values 6.62% sugars in tomato. Sugars play vital role for body energy. High amount of sugar harmful for diabetic patients. People consume tomato as a fruit and vegetable but do not know large amount of consumption may badly effect on health especially for diabetic subjects due to present of sugars.

Table 3: Sugar content of tomato at unripe and ripe stages

Sample	Total Sugar (%)	Reducing Sugar (%)	Non-Reducing Sugar (%)
Unripe Tomato	3.4 ±0.07	1.72 ± 0.02	1.59 ±0.08
Ripe Tomato	2.42± 0.02	1.31 ±0.02	1.03± 0.01

Data expressed as mean± standard deviation of three replicates

Antioxidant marker of tomato at unripe and ripe stages were determined that presented in table 4. The highest total phenol, DPPH scavenging activity and total flavonoid (27.5± 0.01 mg GAE/100g),(26.51 ±0.03µg/ml) and(4.83 ±0.01 mg QUER/gm) respectively were found in ripe tomato compare to unripe tomato. These results are in line with those of Mechlouch *et al.* [30]. Phenolic compounds are considered as antioxidants that inhibit oxidative damage to fatty substances also reduce rancidity thus enhancing shelf life as well as the nutritive value of fruits and vegetable These compounds have a wide range of biochemical actions for example antioxidant, antimutagenic and anticarcinogenic [31]. Flavonoids are a set of phenolic compounds that are small amount existent in tomatoes compare to other fruits and vegetables [32].

Table 4: Antioxidant marker of unripe tomato and ripe tomato

Sample	Total Phenol (mg GAE/100g)	DPPH scavenging activity(µg/ml)	Total Flavonoid (mg QUER/gm)
Unripe Tomato	25.48± 0.01	24.04 ±0.01	3.36± 0.05
Ripe Tomato	27.5± 0.01	26.51 ±0.03	4.83 ±0.01

Data expressed as mean± standard deviation of three replicates

Conclusion

The study concludes that sugar content decrees and antioxidant markers increase with the increase of ripening of tomato. The proximate composition of tomato also changes with ripening stages. The variation of tomato component may be due to use of fertilizer, cultivation process and time. The study suggested that find out the reason behind the composition change at different harvesting stages. The results of this study may aware the consumer to select the best quality of tomato.

Acknowledgement

The authors express their gratitude to their colleagues and laboratory members for the encouragement to complete the work. The authors would like to express acknowledge to Food Technology Division, Institute of Food and Radiation Biology. The authors express immense gratitude to the Ministry of Agriculture for funding this research.

References

1. Beckles DM. Factors affecting the postharvest soluble solids and sugar content of tomato (*Solanum lycopersicum* L.) fruit. Postharvest Biology and Technology. 2012; 63:129-140.
2. FAOSTAT Access from http://faostat.fao.org/site/339/default.aspx [Accessed June 10, 2018], 2017.
3. Bangladesh Bureau of Statistics Yearbook of Agricultural Statistics-2017, 29th Series: access from http://www.bbs.gov.bd/bbs report. [Access online 17 April 2018], 2019.
4. Canene-Adams, Campbell K, Zaripheh S, Jefferey E H, Erdman JW Jr. The Tomato as a Functional Food. The Journal of Nutrition. 2005; 135:1126-1130.
5. United States Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory USDA National Nutrient Database for standard reference, Release, 2016, 28.
6. Bhowmik D, Sampath Kumar KP, Paswan S, Srivastava S. Tomato - a natural medicine and its health benefits. Journal of Pharmacognosy and Photochemistry. 2012; 1(1):33-43.
7. Mostapha BB, Louaileche H, Mouhoubi Z. Antioxidant activity of eight tomato (*Lycopersicon esculentum* L.) varieties grown in Algeria. Journal of Food Technology Research. 2014; 1(2):133-145.
8. Rahal A, Kumar A, Singh V, Yadav B, Tiwari R, Chakraborty S, *et al*. (2014). Oxidative stress, prooxidants and antioxidants: The interplay. BioMed Research International, 2014: 1-19.
9. Iqbal E, Salim KA, Lim LBL. Phytochemical screening, total phenolics and antioxidant activities of bark and leaf extracts of *Goniothalamus velutinus* (airy shaw) from Brunei Darussalam. Journal of King Saud University - Science. 2015; 27:224-232.
10. Nordberg J, Arnér ESJ. Reactive oxygen species, antioxidants and the mammalian thioredoxin system. Free Radical Biology and Medicine. 2001; 31(11):1287-1312.
11. Pham-Huy, L A, He H, Pham-Huy, C. Free radicals, antioxidants in disease and health. International Journal of Biomedical Science. 2008; 4(2):89-96.
12. Vallverdú-Queralt A, Medina-Remón A, Martínez-Huélamo M, Jáuregui O, Andres-Lacueva C, Lamuela-Raventos RM. 2011. Phenolic profile and hydrophilic antioxidant capacity as chemotaxonomic markers of tomato varieties. J Agric Food Chem. 2011; 59:3994-4001.
13. Juroszek P, Lumpkin HM, Yang RY, Ledesma DR, Ma, CH. Fruit quality and bioactive compounds with antioxidant activity of tomatoes grown on-farm: comparison of organic and conventional management systems. J Agric Food Chem. 2009; 57:1188-1194.
14. Association of Official Analytical Chemists. Official Methods of Analysis of AOAC International (17th ed). Gaithersburg, Md, 2002.
15. Raghuramalu N, Nair MK, Kalyanasundaram SA. Manual of laboratory techniques, second edition, National Institute of Nutrition, KMR, Hyderabad, 2003, 201.
16. Fiske CJ, Subarrow Y. The colorimetric determination of phosphorus. J Biol Chem. 1935; 66:375-400.
17. Hansen J and Moller I Percolation of Starch and Soluble Carbohydrates from Plant Tissue for Quantitative Determination with Anthrone. Analytical Biochemistry. 1975; 68:87-94.
18. Nelson S. Analytical procedure No.1, School of Biological Technology, Australia. 1944; 2033:37.
19. Banik AK. Studies on pre and postharvest treatments on shelf life of mango with special reference to major diseases. Ph.D. Thesis, BCKV, West Bengal, 1995, 52.
20. Musa KH, Abdullah A, Jusoh K, Subramaniam V. Antioxidant activity of pink flesh guava (*Psidium guajava* L.). Effect of extraction techniques and solvents Food Analytical Methods. 2011; 4:100-107.
21. Mendes L, Freitas VD, Baptista P, Carvalho M. Comparative antihemolytic and radical scavenging activities of strawberry tree (*Arbutus unedo* L.) leaf and fruit. Food and Chemical Toxicology. 2011; 49:2285-3229.
22. Jiao H, Wang SY. Correlation of antioxidant capacities to oxygen radical scavenging enzyme activities in blackberry. Journal of agricultural and food chemistry. 2000; 48(11):5672-5676.
23. Sulbarn B, Sierra E, Ojeda de Rodrguez G, Berradre M, Fern.ndez V, Pea, J. Evaluaci.n de la actividad antioxidante del tomate crudo y procesado. Revista de La Facultad de Agronomia. 2011; 28: 273-291.
24. Agassounon M, Tchibozo D, Gomez S, Tchobo FP, Soumanou MM. Essai de conservation de la tomate par la technique de la d.shydratation impr.gnation par immersion (DII). International Journal of Biological and Chemical Sciences. 2012; 6: 657-669. http://ajol.info/index.php/ijbcs

25. Korkalo L, Hauta-alus H, Mutanen M. Food Composition Tables for Mozambique. University of Helsinki, Finland, 2011.
26. FAO West African Food Composition Table; Table de composition des aliments d' Afrique de l' Ouest. Rome, Italie, 2012, 148.
27. Gupta A, Kawatra A, Sehgal S. Physical-chemical properties and nutritional evaluation of newly developed tomato genotypes. African Journal of Food Science and Technology. 2011; 2(7):167-172.
28. Srivastava RP, Sanjeev K. Fruit and vegetable preservation principles and practices: Important methods for the analysis of fruits and vegetables and their products (3rd edition). International Book Distribution Co. Lucknow. 2003; 383.
29. Bernal J, Mendiola JA, Ibáñez E, Cifuentes A. Advanced analysis of nutraceuticals. J Pharm Biomed Anal. 2011; 55: 758-774.
30. Mechlouch RF, Elfalleh W, Ziadi M, Hannachi H, Chwikhi M, Ben Aoun A, *et al*. Effect of different drying methods on the physico-chemical properties of tomato variety 'Rio Grande'. International Journal of Food Engineering. 2012; 8(2):4.
31. Nakamura Y, Watanabe S, Miyake N, Kohno H, Osawa T. Dihydrochalcones: evaluation as novel radical scavenging antioxidants. Journal of Agricultural and Food Chemistry. 2003; 51(11):3309-3312.
32. Lammerts van Buerena ET, Jonesc SS, Tammd L, Murphyc KM, Myerse JR, Leifert C, *et al*. The need to breed crop varieties suitable for organic farming, using wheat, tomato and broccoli as examples: A review. NJAS - Wageningen Journal of Life Sciences. 2011; 58:193-205.