Chelonian Conservation And Biology

Vol. 18 No. 2 (2023) | https://www.acgpublishing.com/ | ISSN - 1071-8443

DOI: doi.org/10.18011/2023.12(2).2372.2382

EVALUATION OF BIOCHEMICAL POTENTIAL IN TOMATO (*Solanum Lycopersicum* L.) GERMPLASM FROM MEGHALAYA, INDIA

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Abstract

Eleven tomato genotypes were evaluated for physical and biochemical parameters collected from different regions of Meghalaya, India during 2019-2023. Results revealed based on physical parameters, that the maximum value recorded for dry matter was 10.33% whereas the lowest was 7.39%.The maximum value recorded for moisture content was 92.54%. The maximum value recorded for TSS was 23˚Brix. The samples were analyzed based on eight biochemical parameters. The highest value recorded for ascorbic acid, carbohydrates, non-reducing sugar, phenol, protein, reducing sugar and total sugar was61.84mg, 3.61%, 5.21%, 3.01mg, 7.78%, 3.41% and 4.52% respectively. The lycopene content recorded was 1.69mg per 100g of dry weight. Based on the experimental results it has been concluded that out of eleven samples, the red color cherry shaped tomatoes of average diameter 2.0 cm collected from Williamnagar (Sample No. 6) was found to have a good nutritional value because of its highest content of antioxidant lycopene. It was observed that the red color egg-shaped tomatoes of 4.4cm diameter of Resubelpara (Sample No. 3) was a good source of another antioxidant Ascorbic acid. It was recorded that the round-shaped sample of diameter 4.9 cm collected from Baghmara (Sample No. 5) having 87.02% moisture content was the lowest in quantityand hasalonger shelf life than the rest of the collected samples.

Keywords: Tomato, Physical parameter, Biochemical parameter, Lycopene, Meghalaya

1.Introduction

Tomato (*Solanum lycopersicum* L.) is an important solanaceous vegetable and consumed both fresh and processed. It is a vegetable consumed through a diet that provides essential nutrients and bioactive compounds which help us to prevent many health problems including prevention of the risk of several types of cancer and coronary heart disease (Pernice *et. al.* 2010). Tomato is a rich source of vitamin A and C with low level of titratable acidity (Purkayastha 2011). Tomato-based products are also good sources of micronutrients (Siddiqui *et. al.* 2015). Tomato can detoxify our

body and the detoxification effect is probably due to the presence of chlorine and sulfur in tomatoes (Bhowmik *et. al.* 2012). It has been noticed that ripe tomatoes contain Rutin [quercetin 3-O-rutinoside; quercetin3-(6-rhamnosylglucoside)] as the major flavonoid compound (Selahle *et. al.* 2014). Lycopene accounts for up to 90% of the total carotenoids and has the maximum antioxidant activity and also responsible for red colour of tomato (Leyva *et. al.* 2014; Viskelis *et. al.* 2015).Nutrients such as vitamin A, Ascorbic acid, Potassium, and folate are found in considerable concentrations in tomatoes (Kara *et. al.* 2017; Kurek 2019). Kurina *et. al*. (2021) reported that the presence of lipophilic and hydrophilic compounds are responsible for the nutraceutical value of tomato fruits. Lycopene is one of the most important bioactive chemicals required by our body and the main sources of lycopene in our diet are carotenoids of tomatoes. The occurrence of bioactive compounds in tomato fruits have shown a broad range of physiological properties such as anti-inflammatory, antithrombotic, cardioprotective etc (Rasool and Ahmad, 2019).The main goal of this work was to evaluate the physical and biochemical parameters of tomato species available in Meghalaya.

2. Materials and methods

2.1. Study area

The composition of biochemical components of tomatoes from different parts of the Indian state of Meghalaya was selected for the experiment. The state of Meghalaya is an upland area formed by a detached part of the Deccan plateau with an altitude range of 1220 to 1830 m above sea level with geographical coordinates of latitude 20°1'N - 26°5'N and longitude 85°49'E - 92°52'E with an area of approximately 22,430 square kilometers. Generally, the ambient minimum and maximum temperature range from 4˚C to 33˚C in a year. The average rainfall is 12,000 mm a year.

2.2. Sampling locations and frequency of sampling

Tomato fruit samples were randomly collected from eleven locationsin Meghalaya during 2019-2023. The locations and physical descriptionsof the samples are given in Table 1.

2.3.Methods of Biochemical analysis

Fruits were harvested at 7-10 intervals at the color break stage that was duly tagged. The physical parameters like fruit shape and average fruit diameter were recorded. Biochemical attributes viz, Ascorbic acid, Carbohydrate, Lycopene, Non-reducing Sugar, Phenol, Protein, Reducing Sugar, and Total Sugar content of fruits were determined. Standard methods of biochemical analysis as shown in Table 2 were followed.

2.4. Statistical analysis

The obtained data were analyzed statistically using SPSS software.

3. Results and discussions

3.1. Experimental results on physical parameters

The average results obtained for physical parameters of the tomato samples are given in Table 3. The CV values of physical parameters showed different trends. As such, there was high variability of the parameters for dry matter and total soluble solids. A few of the permissible/desired values of different physical parameters of tomatoes are placed in Table 4. Higher CV value (9.24%) for dry matter content in the samples indicated a high variability of the parameter. Highest dry matter content (10.33%) was found in the round-shaped sample of diameter 5.1 cm belongs to Dalu (Sample No. 2) and the lowest dry matter content (7.39%) was recorded in the egg-like sample of length 4.4 cm collected from Resubelpara (Sample No.3). The dry matter consists of structural and non-structural sugars, oil, pigments, carbohydrates, starch, and minerals. Tomatoes having less dry matter will have a watery texture and those containing high dry matter will be more dry meaty and will have comparatively longer storage life [7]. In the present work, it was recorded that all the eleven samples contain more quantity of dry matter than the permissible limit of 4.6-5.6 % (FAO). In the present work, it was recorded that all the eleven samples contain less quantity of moisture than the average limit of 94.2 to 95.2 g (USDA). As such, all these tomatoes have longer shelf life. The less CV value (0.78%) for moisture content indicated a low variability of the parameter. It was found that an egg-like sample of length 4.4 cm belonging to Resubelpara (Sample No. 3) has the highest quantity of moisture content (92.54%) and on the other hand the round-shaped sample of diameter 4.9 cm collected from Baghmara (Sample No. 5) has the lowest moisture content (87.02%). In the present work, the CV value (2.12%) for TSS indicated a high variability of the parameter. It was found that an egg-like sample of length 4.3 cm belonging to Khliehriat (Sample No. 11) has the highest TSS of 6.23˚Brix and on the other hand the egg-shaped sample of length 4.4cm collected from Resubelpara (Sample No. 3) has the lowest TSS of 3.97˚Brix. It was also observed that out of all the eleven samples, the sample from Resubelpara (Sample No. 3) contained the less quantity of TSS (3.97˚Brix) than the permissible limit of 4.15-6.62˚Brix (FAO), while the rest samples contained TSS within the said limit. The results were in accordance with the reports of Leyva *et. al.* (2014) and Siddiqui *et. al.* (2015) in tomato.

3.2. Experimental results on biochemical parameters

The average results obtained for the biochemical parameters of the tomato samples are given in Table 5. The higher CV values of all the biochemical parameters indicated high variability for the parameters. The highest variability among the biochemical parameters was found for total sugar and the lowest variability was found forthe protein content. A few of the permissible/desired values of different biochemical parameters of tomatoes were placed in Table 6.

Higher CV value (2.47%) for Ascorbic acid indicated a high variation for the parameter. It was found that the egg-shaped tomatoes of 4.4cm diameter of Resubelpara (Sample No. 3) contained the highest ascorbic acid (61.84mg), while the round-shaped sample from Mawkyrwat (Sample No.10) contained the lowest Ascorbic acid (56.28mg). The desired value of ascorbic acid is 12.3 to 25.9mg/100g as per USDA. All the experimental tomato samples have crossed this value with an average of 58.48mg per 100 g of dry powder. Thus, these tomato samples were very rich

sources of Ascorbic acid. Kara *et al*. (2017) reported that the ascorbic acid content of tomato ranged from 7.13 to 11.94 mg per 100 g fresh weight.

In the present work, it was recorded that all the eleven samples contain less quantity of carbohydrates than the average limit of 3.84% (USDA). The CV for Carbohydrates in these samples was 3.45%, indicated a high variability of the parameter. In this work, it was found that an egg-like sample of length 4.3 cm belonging to Khliehriat (Sample No. 11) has the highest quantity of carbohydrates (3.61%) and on the other hand the egg-shaped sample of length 4.2cm collected from Shillong (Sample no.7) has the lowest quantity of carbohydrate (1.58%). The result was in accordance with the report of Kurina *et. al.* (2021) in tomato.

The higher CV value (5.12%) for lycopene indicated high variability of data. It was recorded that the cherry-shaped tomatoes of an average diameter of 2.0 cm collected from Williamnagar (Sample No. 6) contained the highest quantity of lycopene (3.98mg) per 100g of dry weight. It was found that an egg-shaped sample withan average diameter of 5.0cm collected from Ampati (Sample No. 1) containedthe lowest quantity of lycopene (1.69 mg) per 100g of dry weight. The lycopene content of Sample No. 1, 7, 8, and 11 was found to be less than the desirable level as per USDA. The results are in accordance with the report of Gujral (2018).

In the present work, it was recorded that out of eleven samples, Samples No. 6, 10 and 11 contained more quantity of non-reducing sugar than the permissible limit of 0.011-1.425 g% (FAO/WHO), while the rest samples contained more quantity of non-reducing sugar that the said permissible limits of FAO/WHO. The higher CV value (6.37%) for non-reducing sugar indicated a high variability of the parameter. The round-shaped sample of diameter 4.6 cm collected from Mawkyrwat (Sample No.10) has the highest non reducing sugar content (5.21%), while the egg-like sample of length 3.8 cm collected from Nongpoh (Sample No. 9) has the lowest non reducing sugar content (0.49%).

In this work, it was found that an egg-like sample of length 3.8cm belonging to Nongpoh (Sample No.9) has the highest quantity of phenols (3.01mg) and on the other hand the egg-like sample of 5.0 cm diameter collected from Ampati (Sample No. 1) has the lowest quantity of phenols (1.23mg).

Proteins are large bio-moleculesthat play a significant role in growth and development. The CV for proteins (2.26%) indicated a high variability of the parameter. The egg-like sample of length 3.8cm belonging to Nongpoh (Sample No. 9) has the highest quantity of protein (7.78%) and on the other hand the round-shaped sample of 4.9cm diameter collected from Baghmara (Sample No.5) has the lowest quantity of protein (5.02%).

In the present work, it was recorded that out of eleven samples, Sample No. 10 and 11 contained the less quantity of reducing sugar than the permissible limit of 1.130- 2.273 g % (FAO/WHO), while the rest tomato samples contained more quantity of reducing sugar than the said permissible limit. Higher CV value (9.67%) for reducing sugar indicated a high variability of the parameter. It was found that the cherry-like sample of diameter 1.9 cm belongs to Tura (Sample no. 4) has

the highest quantity of reducing sugar (3.41%) and on the other hand the round-shaped sample of diameter 4.6 cm collected from Mawkyrwat (Sample No.10) has the lowest quantity of reducing sugar (0.49%). Tadesse *et. al.* (2012) remarked that the sweet taste of tomatoes was attributed to reducing sugars.

In the present work, it was recorded that out of eleven samples, Sample No. 10 has less quantity of total sugar than the permissible limit of 1.67 to 5.52 % (FAO), while the rest tomato samples contained more quantity of total sugar than the said permissible limit. The higher CV value (6.79%) for total sugar indicated a high variability of the parameter. It was found that the cherry-like sample of diameter 2.0 cm belongs to Williamnagar (Sample No.6) has the highest quantity of total sugar (4.52%) and on the other hand the round-shaped sample of diameter 4.6 cm collected from Mawkyrwat (Sample No.10) has the lowest quantity of total sugar (1.41%). *Sugars* impart a flavor to *tomatoes,* particularly glucose and fructose mainly responsible for the growth, ripening, composition, and taste *of tomato* fruits (Kanayama 2017).

4. Conclusion

Based on the experimental results it has been concluded that out of eleven tomato samples, the red color cherry shaped tomatoes of average diameter 2.0 cm collected from Williamnagar (Sample No. 6) was found to have a good nutritional value because of its highest content of antioxidant lycopene which can reduce the risk of heart disease and cancer (Gujral 2018). It was observed that the red color egg-shaped tomatoes of 4.4cm diameter of Resubelpara (Sample No. 3) was a good source of another antioxidant Ascorbic acid which is required for healing wounds, and for repairing and maintaining bones and teeth. It was recorded that the round-shaped sample of diameter 4.9cm collected from Baghmara (Sample No. 5) having 87.02% moisture content was the lowest in quantity and has a longer shelf life than the rest of the collected samples.

Acknowledgment

The authors are thankful to the farmers who helped the study by providing their plant samples.

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Table 1. Sample collection and physical descriptions of tomato germplasm

Sample No.	Collection point	District	Fruit Shape	Average Fruit Diameter (cm)
1	Ampati	Southwest Garo Hills	Egg like	5.0±0.2
2	Dalu	West Garo Hills	Round	5.1±0.2
3	Resubelpara	North Garo Hills	Egg like	4.4 ±0.2
4	Tura	West Garo Hills	Cherry like	1.9 ±0.1
5	Baghmara	South Garo Hills	Round	4.9±0.2
6	Willaimnagar	East Garo Hills	Cherry like	2.0±0.1
7	Shillong	East Khasi Hills	Egg like	4.2±0.2
8	Jowai	WestJaintia Hills	Round	5.1±0.2
9	Nongpoh	Ri-bhoi	Egg like	3.8±0.1
10	Mawkyrwat	South West Khasi Hills	Round	4.6 ±0.2
11	Khliehriat	East Jaintia Hills	Egg like	4.3 ±0.2

Table2. Parameters/Compounds and their methods of determination

Parameters/ Compounds	Methods ofDetermination/Reference	Particulars
Ascorbic acid (Vitamin C)	Ranganna (1997)	Ascorbic acid (mg/100g) = $\frac{\text{D.F.V x Titrate value x Volume made up x 100}}{\text{The volume of the aliquot x weight of the sample}}$ Here D.F.V. is Dye Factor Value = 0.5/ Titrate reading (mL) ,
Carbohydrate	Anthrone method	Absorbance reading was taken at 630 nm in a Spectrophotometer.
Dry matter	Gravimetric method	Dry matter percentage = $\frac{\text{Weight of dry matter}}{\text{Weight of original sample}}$ X 100
Lycopene	Spectrophotometric method	Lycopene (mg/100g) = $\frac{31.206 \times \text{Absorbance}}{\text{Weight of sample}}$
Moisture content	Gravimetric method	Moisture percentage = $\frac{Wi-Wd}{Wi}$ X $1oo$, here Wi is the fresh weight of the fruit sample (g) and Wd is the dry weight of fruit powder(g).
Non Reducing Sugar	calculation	Non-reducing sugar(%) = (Totals sugar-reducing sugar) x 0.95

Phenol	Folin-ciocalteau method	The absorbance was measured at 650nm against a reagent blank.
Protein	Lowry method (Lowry *et al*. 1951)	The optical density (OD) value was observed at 660nm in the spectrophotometer.
Reducing Sugar	Fehling's solution (Copper reduction) suggested by Lane and Eynon (1923)	Reducing Sugar (%) = 20 / Titrate value (mL.)
Total Soluble Solids	Hand Refractometer.	The main principle involved in refractometry is the refraction based on the speed of the light that passes in the different mediums.
Total Sugar	-do-	Total Sugar (%) = 20/Reading (ml.)

Table3. Average values of different physical parameters of the tomato germplasm

Sample No.	**Collection point**	**Dry Matter (%)**	**Moisture Content (%)**	**Total Soluble Solids (^{0}Brix)**
1	Ampati	7.69±0.01	90.67±0.03	4.78±0.02
2	Dalu	10.33±0.03	92.12±0.03	5.98±0.03
3	Resubelpara	7.39±0.01	92.54±0.03	3.97±0.01
4	Tura	8.02±0.02	90.19±0.03	5.02±0.03
5	Baghmara	8.89±0.02	87.02±0.02	4.77±0.02
6	Willaimnagar	9.61±0.03	91.79±0.03	4.79±0.02
7	Shillong	8.61±0.02	91.88±0.03	6.01±0.03
8	Jowai	10.02±0.03	89.01±0.02	6.11±0.03
9	Nongpoh	8.00±0.02	91.58±0.03	6.02±0.03
10	Mawkyrwat	9.45±0.03	91.39±0.03	5.77±0.03
11	Khliehriat	9.57±0.03	90.98±0.03	6.23±0.03
Average	-	8.87	90.83	5.40

CV	-	9.24	0.78	2.12
SEM	-	0.45	0.32	0.12
CD (1%)	-	1.12	1.24	0.28
CD (5%)	-	0.41	0.78	0.17
Range(minimum)	-	7.39	87.02	3.97
Range(maximum)	-	10.33	92.54	6.23

1^0Brix = 1 gram of sucrose in 100 grams of solution.

Table4. Average values of different physical parameters in tomatoes per 100g as per different agencies

SL. No.	Parameters	Minimum	Maximum	Source/Reference
1	Dry matter	4.6 mg	5.6 mg	FAO, WHO
2	Moisture content	94.2 g	95.2 g	USDA, NDB No. :100261
3	TSS (˚Brix)	4.15	6.62	FAO, WHO

TSS: Total Soluble Solids

Table5. Average values of different biochemical constituents of the tomato germplasm per 100g of sample

Sample No.	Collection point	AA(mg)	Carbohydrate (g)	LC (mg)	NRS (g)	PN (mg)	PR (g)	RS (g)	TS(g)
1	Ampati	58.40± 0.02	2.21±0.02	1.69± 0.01	0.60± 0.01	1.23± 0.01	5.13± 0.01	1.48± 0.02	1.87± 0.01
2	Dalu	59.92± 0.02	1.71±0.01	2.69± 0.02	1.40± 0.02	1.97± 0.01	5.21± 0.01	2.77± 0.02	3.76± 0.03
3	Resubelpara	61.84± 0.03	2.61±0.02	3.45± 0.03	1.20± 0.02	1.52± 0.01	6.33± 0.02	2.94± 0.02	3.68± 0.02
4	Tura	58.32± 0.02	3.42±0.03	3.69± 0.03	1.40± 0.02	1.76± 0.01	6.20± 0.02	3.41± 0.03	4.31± 0.03

5	Baghmara	59.76±0.02	3.01±0.03	2.83±0.02	0.76±0.01	2.12±0.02	5.02±0.01	1.34±0.01	1.81±0.01
6	Willaimnagar	57.02±0.02	1.86±0.01	3.98±0.03	2.40±0.02	1.45±0.01	5.23±0.01	2.83±0.02	4.52±0.03
7	Shillong	57.11±0.02	1.58±0.01	2.01±0.02	0.79±0.01	1.25±0.01	5.88±0.01	1.58±0.02	2.14±0.02
8	Jowai	56.32±0.01	2.69±0.02	1.78±0.01	0.70±0.01	2.08±0.02	5.04±0.01	1.38±0.01	1.86±0.01
9	Nongpoh	58.27±0.02	3.12±0.03	3.91±0.03	0.49±0.01	3.01±0.03	7.78±0.03	1.41±0.02	1.71±0.01
10	Mawkyrwat	56.28±0.01	2.11±0.02	2.79±0.02	5.21±0.03	2.11±0.02	5.12±0.01	0.49±0.01	1.41±0.01
11	Khliehriat	60.00±0.03	3.61±0.03	2.45±0.02	5.13±0.03	2.06±0.02	5.28±0.01	0.98±0.01	1.83±0.01
Average		58.48	2.54	2.84	1.83	1.87	5.66	1.87	2.63
CV		2.47	3.45	5.12	6.37	5.58	2.26	9.67	6.79
SEM		0.51	0.06	0.11	0.15	0.07	0.07	0.18	0.14
CD (1%)		1.67	0.16	0.31	0.44	0.21	0.17	0.78	0.43
CD (5%)		1.12	0.12	0.18	0.31	0.12	0.10	0.49	0.27
Range(min.)		56.28	1.58	1.69	0.49	1.23	5.02	0.49	1.41
Range(max.)		61.84	3.61	3.98	5.21	3.01	7.78	3.41	4.52

AA: Ascorbic acid; LC: Lycopene ; NRS: Non-reducing Sugar; PN: Phenol; PR: Protein; RS: Reducing Sugar;
TS: Total Sugar.

Table6. Average values of different biochemical parameters in tomatoes per 100g sample as per different agencies

SL. No.	Parameters/ Compounds	Minimum	Maximum	Source/Reference
1	Ascorbic acid (Vit. C)	12.3 mg	25.9 mg	USDA, NDB No.: 100261
2	Carbohydrate	-	3.84 g	USDA, NDB No. :100261
3	Lycopene	1830 µg	4340 µg	USDA, NDB No. :100261
4	Non Reducing Sugar	0.011 g	1.425 g	FAO, WHO
5	Phenols	-	4.9 mg	MDPI
6	Protein	0.56 g	0.88 g	USDA, NDB No. :100261
7	Reducing Sugar	1.130 g	2.273 g	FAO, WHO
8	Total Sugar	1.67 g	5.52 g	FAO, WHO

MDPI: Multidisciplinary Digital Publishing Institute
NDB Number: National Nutrient Database Number
USDA: United States Department of Agriculture