Comparative analysis of biochemical and phytochemical characteristics of 'Abhinav' and 'Anand Roma' tomato varieties and their juice

ABSTRACT

Tomato (Lycopersicon esculentum) is the second most consumed vegetable globally, valued for its rich nutritional profile and diverse culinary applications. This study aimed to compare the biochemical and phytochemical characteristics of two popular tomato varieties, 'Abhinav' and 'Anand Roma,' to evaluate their suitability for dietary and processing purposes. Using standard analytical AOAC methods, ˚Brix, pH, total acidity, ascorbic acid, and lycopene content were assessed in both fresh tomatoes and their juices. The results showed that ˚Brix ranged from 4.68° to 4.81° in tomatoes and 4.77° to 5.09° in juices. pH values varied between 4.18 and 4.35, with total acidity ranging from 0.32% to 0.41% citric acid equivalents. Ascorbic acid content was 25.37 to 28.18 mg/100 g in tomatoes and 24.98 to 25.83 mg/100 g in juices, while lycopene levels ranged from 7.41 to 8.83 mg/100 g in tomatoes and 6.05 to 6.68 mg/100 g in juices. Significant differences ($p<0.05$) between the varieties were found in acidity, ash, ascorbic acid, and lycopene content. The findings emphasize the distinct nutritional attributes of these tomato varieties, providing insights into their optimal use for specific dietary needs and food processing applications.

Keywords: Tomato, Abhinav, Anand Roma, Ascorbic acid, Lycopene

1. INTRODUCTION

Tomatoes (*Solanum lycopersicum*) are widely recognized as one of the most popular and versatile vegetable consumed globally. It was originated in the lower Andes region of South America and were cultivated by the Aztecs in Mexico, forming a remarkable history over centuries (Bergougnoux et al., 1). The tomato, recognized as protective food, holds the distinction of being the second largest vegetable crop worldwide after the potato (Karniel et al., 2). The estimated area and production of tomatoes in India was about 8,45,000 ha and 21.181 million metric tonnes respectively, in the year 2021 and India is the second largest producer in the world after China (FAO, 3).

Tomatoes are commonly consumed raw in salads, cooked as a vegetable, and used in various dishes. Moreover, a significant portion of the global tomato crop is processed to produce products such as canned tomatoes, tomato juice, ketchup, puree, sun-dried tomatoes or dehydrated pulp (Meng et al., 4). Tomatoes are widely utilized for culinary purposes and are highly regarded for their nutritional and health benefits. They have a rich profile of vitamins, minerals, fiber, protein, carotenoids, and phytosterols (Ali et al., 5). Among these components, lycopene, beta-carotene, and phenolic compounds stand out and have been associated with numerous health-promoting properties, such as antioxidant, anti-inflammatory, and anticancer activities (Umara et al., 6). Additionally, these compounds play vital roles in neutralizing harmful reactive oxygen species, regulating enzymatic activities, and inhibiting cellular damage and proliferation (Devasagayam and Sainis, 7). The chemical composition of different

varieties has a moisture content ranging between 92.7 to 95.8% (Abdullahi et al., 8). The carbohydrate content is ranged from 3.92 to 5 g, 0.59 to 1.06 g, 0.2 to 0.8 g lipid content, 0.7 to 2 g fiber of 100 g tomatoes (USDA, 9). pH, TSS and titratable acidity of tomato ranges from 3.7 to 4.4, 4.07 to 5.5 ˚Brix and 0.39 to 0.55 %, respectively (Suárez et al., 10). Tomato also contains vitamins and phytochemicals especially vitamin C and lycopene. It differs according to the variety, cultivation type, processing methods. In tomatoes, vitamin C is in the range of 7.65 to 59.4 mg/100 ml and lycopene is 5.02 to 11.11 mg/100 ml (Sánchez-Moreno et al., 11; Ali et al., 5). The nutritional composition of tomatoes can vary significantly depending on factors such as variety, cultivation practice, ripeness, and storage condition.

This study aims to conduct a comprehensive nutritional and compositional analysis of two distinct tomato varieties (‘Abhinav’ and ‘Anand Roma’) commonly grown and consumed in middle Gujarat region to assess the change in the whole product and juice.

2. MATERIAL AND METHODS

Mature, fresh ‘Anand Roma’ and ‘Abhinav’ variety of tomatoes were procured from the Regional Research Station at Anand Agricultural University, Anand, Gujarat. The tomatoes were sorted, cleaned, and kept in the refrigerator (7±2 ˚C) for further processing and analysis. The tomatoes were washed with potable water to remove extraneous matter and spray residues which were adhering to the outer surface. Tomato juice was extracted by using a screw type juice extractor, which separates seeds and peels from the tomato pulp. It was stored in a PET bottle at refrigerated condition (7±2 ˚C) for further analysis.

Total soluble solids were measured using a digital refractometer at 20 ˚C, and values are expressed in ˚Brix. pH was determined using a microprocessor based digital pH meter model-102 and total acidity was estimated by titration method as per Ranganna (12). Moisture, protein, lipid, total fiber, ash content, and carbohydrate analysis was carried out using the standard method (AOAC, 13). Lycopene content was estimated by using Systronics UV-Vis spectrophotometer 119 as per standard method (Ranganna, 12) and ascorbic acid was estimated using 2, 6-dichlorophenol- indophenol by visual titration method (Ranganna, 12).

The data for all the samples of ‘Abhinav’ and ‘Anand Roma’ tomato varieties and their juices were compared using independent t-tests. The F test was used to assess the equality of variances between the groups. A significance level of 0.05 was chosen for all tests. Statistical analyses were performed using IBM SPSS 21.

3. RESULTS AND DISCUSSION

Table 1. Comparison of Physiochemical, proximate and phytochemical of Abhinav and Anand Roma variety tomatoes

Parameters	Abhinav var.	Anand Roma var.	t-test value	Significance
pH	4.18	4.35	-1.13	NS
TSS (˚Brix)	4.68	4.81	-0.61	NS
Total acidity (% of citric acid)	0.41[a]	0.32[b]	4.13	*
Moisture (%)	95.31	95.19	0.89	NS
Protein (g)	0.61	0.73	-3.40	NS
Lipid (g)	0.17	0.21	-2.75	NS
Carbohydrate (g)	3.55	3.38	1.73	NS
Total fiber (g)	0.31	0.37	-1.40	NS

Ash (g)	0.36[b]	0.49[a]	-5.63	**
Ascorbic acid (mg/100 g)	28.18[a]	25.37[b]	6.01	**
Lycopene (mg/100 g)	7.41[a]	8.83[a]	-2.83	*

Note: Results were expressed as mean ± SD. The rank symbols (a to b) were assigned based on the t-test values and significance level at α = 0.05. "NS" indicates a not significant, *significant and ** highly significant difference between the two varieties for the respective parameter.

The total acidity was found significantly (p = 0.05) higher in 'Abhinav' varieties as compared to the 'Anand Roma' variety. The mean values of pH, TSS and total acidity are in line with the previously reported values in the range of 3.7 to 4.4, 4.07 to 5.5 ˚Brix and 0.39 to 0.55 %, respectively (Boulbiga et al., 15; Suárez et al., 10). The moisture content of 'Abhinav' and 'Anand Roma' varieties were respectively 95.31% and 95.19%, which is consistent with the findings of Suarez et al. (10). The protein and fat content of tomatoes, were 0.61, 0.73 % and 0.17 and 0.21 %, respectively, for 'Abhinav' and 'Anand Roma' varieties and were not having significant difference. However, 'Abhinav' tomatoes contained 0.36 g of ash, while 'Anand Roma' tomatoes had 0.49 g which is similar to data reported in the literature (Oke et al., 16; Suárez et al., 10). The difference in ash content between the two varieties was highly significant (p = 0.01), with 'Anand Roma' showing a higher ash content. In fresh tomatoes, the 'Abhinav' variety exhibited a higher content of ascorbic acid (28.18 mg/100 g) compared to the 'Anand Roma' variety (25.37 mg/100 g), which is within the range of 7.65 to 59.4 mg/100 g (Sánchez-Moreno et al., 12; Shuaibu, 17). The vitamin C content in the two varieties of tomato juices were found highly significant (p = 0.05). In fresh tomatoes, the 'Abhinav' variety had a lower lycopene content (7.41 mg/100 g) compared to the Anand Roma variety (8.83 mg/100 g) which was statistically significant (p = 0.05), with Anand Roma tomato.

Processing of food results in a change or decrease in the nutritional and phytochemical compounds, those changes were evaluated for different biochemical characteristics of 'Abhinav' and Anand Roma varieties tomato juice as shown in Table 2.

Table 2. Comparison of Physiochemical, proximate and phytochemical of Abhinav and Anand Roma variety tomato juice

Parameters	Abhinav var.	Anand Roma var.	t-test value	Significance
pH	4.17	4.31	-2.19	NS
TSS (˚Brix)	4.77[b]	5.09[a]	-3.73	*
Total acidity (% of citric acid)	0.43[a]	0.35[b]	2.99	*
Moisture (%)	95.23	94.92	2.70	NS
Crude protein (g)	0.58	0.71	-3.15	NS
Crude fat (g)	0.15[b]	0.20[a]	-4.84	*
Carbohydrate (g)	3.71	3.78	-0.32	NS
Crude fiber (g)	0.27	0.31	-2.37	NS
Ash (g)	0.33[b]	0.41[a]	-9.81	**
Ascorbic acid (mg/100 g)	25.83	24.98	1.37	NS
Lycopene (mg/100 g)	6.05[b]	6.68[a]	-2.91	*

Note: Results were expressed as mean. The rank symbols (a to b) were assigned based on the t-test values and significance level at α = 0.05. "NS" indicates a not significant, *significant and ** highly significant difference between the two varieties for the respective parameter.

The TSS of Anand Roma was found higher compared to 'Abhinav' variety tomato juice, so the Anand Roma varieties juice might be suitable for the preparation of juices that will meet the FSSAI standards viz. TSS should be a minimum 5 ˚Brix. Whereas the 'Abhinav' varieties tomato can be utilized for the preparation of tomato crush, puree, paste, sauce, ketchup etc. However, the paired t test between the 'Abhinav' variety tomato before and after processing into juice shows not significant of TSS (Table 3). The lipid, ash content in 'Abhinav' variety juice were shown a significant difference between the varieties.

Table 3. Paired sample t test for Abhinav variety tomato before and after processing into juice

Pair	Parameters	Paired Differences				t value	Sig. (2-tailed)
		Mean	SD	95% Confidence Interval of the Difference			
				Lower	Higher		
Pair 1	pH BP - pH AP	0.01	0.27	-0.66	0.67	0.04	0.970^{NS}
Pair 2	TSS BP - TSS AP	-0.22	0.18	-0.66	0.21	-2.20	0.159^{NS}
Pair 3	Titratable acidity BP - Titratable acidity AP	-0.02	0.08	-0.22	0.18	-0.43	0.707^{NS}
Pair 4	Moisture BP - Moisture AP	0.08	0.09	-0.13	0.29	1.56	0.259^{NS}
Pair 5	Protein BP - Protein AP	0.03	0.06	-0.13	0.19	0.90	0.464^{NS}
Pair 6	Fat BP - Fat AP	0.02	0.01	0.00	0.03	5.00	0.038*
Pair 7	Carbohydrate BP - Carbohydrate AP	-0.16	0.19	-0.63	0.31	-1.45	0.284^{NS}
Pair 8	Crude fibre BP - Crude fibre AP	0.03	0.01	0.02	0.05	10.00	0.010**
Pair 9	Ash BP - Ash AP	0.03	0.05	-0.08	0.15	1.22	0.346^{NS}
Pair 10	Ascorbic acid BP - Ascorbic acid AP	2.35	0.20	1.85	2.85	20.28	0.002**
Pair 11	Lycopene BP - Lycopene AP	1.36	0.60	-0.13	2.85	3.92	0.049*

(BP: Before processing; AP: After processing; SD: Standard deviation; Sig.: Significance; *Significant; ** Highly significant; ^{NS} Not significant)

The ascorbic acid content in 'Abhinav' and Anand Roma variety were 25.83 and 24.98 mg/100 g, respectively. The t test showed a not significant ($p = 0.05$) difference between these varieties of tomato juice. However, paired t test shows that the highly significant difference for 'Abhinav' variety, that is interesting to note that the ascorbic acid content decreased in the tomato juices compared to fresh tomatoes, similar decrease in ascorbic acid while juicing was reported by Adubofuor et al. (18). This reduction could be attributed to the processing and storage of the juice, and while extracting juice, oxygen comes in to contact with the ascorbic acid which might change the ascorbic acid into dehydroascorbic acid, which might lead to a slight degradation of ascorbic acid in tomato juice (Mills et al., 19; Koh et al., 20). The lycopene content was 6.05 and 6.68 mg/100 g in 'Abhinav' and Anand Roma varieties tomato juice, the independent t-test showed a significant ($p = 0.05$) difference between the two variety and

paired t test shows that the lycopene content was not changed even after processing (Table 3 and 4).

A high amount of lipid, ash and lycopene content and a similar range of other characteristics as 'Abhinav' was depicting that the Anand Roma varieties was having comparatively good nutritional value as compared to 'Abhinav' varieties tomato juice. The Anand Roma varieties tomato juice also has a high amount of total soluble solids that might be useful for industrialists look the varieties for particularly juicing purposes and whereas 'Abhinav' varieties had a comparatively higher amount of ascorbic acid. These findings could be valuable for consumers and processors looking to incorporate specific nutrients, such as ascorbic acid or lycopene, into their processed food products such as juices, purees, ketchup etc.

Table 4. Paired sample t test for Anand Roma variety tomato before and after processing into juice

Pair	Parameters	Paired Differences				t value	Sig. (2-tailed)
		Mean	SD	95% Confidence Interval of the Difference			
				Lower	Higher		
Pair 1	pH BP - pH AP	0.04	0.24	-0.54	0.63	0.32	0.78^{NS}
Pair 2	TSS BP - TSS AP	-0.11	0.15	-0.49	0.27	-1.20	0.35^{NS}
Pair 3	Titratable acidity BP - Titratable acidity AP	-0.03	0.01	-0.05	-0.01	-3.20	0.14^{NS}
Pair 4	Moisture BP - Moisture AP	0.29	0.23	-0.29	0.86	2.16	0.16^{NS}
Pair 5	Protein BP - Protein AP	0.02	0.07	-0.16	0.20	0.56	0.63^{NS}
Pair 6	Fat BP - Fat AP	0.01	0.03	-0.06	0.07	0.44	0.70^{NS}
Pair 7	Carbohydrate BP - Carbohydrate AP	-0.40	0.41	-1.42	0.62	-1.70	0.23^{NS}
Pair 8	Crude fibre BP - Crude fibre AP	0.06	0.06	-0.09	0.21	1.80	0.21^{NS}
Pair 9	Ash BP - Ash AP	0.08	0.02	0.03	0.14	6.24	0.03*
Pair 10	Ascorbic acid BP - Ascorbic acid AP	0.40	1.22	-2.63	3.42	3.56	0.08^{NS}
Pair 11	Lycopene BP - Lycopene AP	2.15	0.99	-0.30	4.61	3.77	0.06^{NS}

(BP: Before processing; AP: After processing; SD: Standard deviation; Sig.: Significance, *Significant; ^{NS} Not significant

4. CONCLUSION

The comparison between the 'Abhinav' and Anand Roma tomato varieties observed notable distinction in the total soluble solids, acidity, ash and phytochemical contents, where Anand Roma exhibited significantly higher levels compared to Abhinav in both fresh tomatoes and their respective juices except in ascorbic acid where Abhinav varieties had slightly higher amounts than 'Anand Roma'. The high levels of TSS, lycopene and ascorbic acid is useful for

making good quality tomato based processed products such as canned tomatoes, juices, purees, ketchup, sauce and other tomato based products.

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