EFFECT OF HARVESTING STATES ON THE QUALITY OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL CV. AVINASH-2, HYBRID)

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ABSTRACT

Tomatoes harvested at four maturity stages (viz. mature-green, breaker, turning and pink) were washed with 100 ppm chlorinated water, sorted and ripened at ambient conditions (20-23°C and 76-85% relative humidity (RH). The physico-chemical characteristics of unripe and ripe tomatoes were determined. Results indicated that total soluble solids and carotenoids increased while titratable acidity and total chlorophylls decreased with maturity. Vitamin-C remained unchanged regardless of the harvest maturity. Ripening time decreased significantly ($p<0.05$) with advancing harvest maturity. Physiological loss in weight, soluble solids and vitamin-C of ripe tomatoes harvested at breaker, turning and pink stages did not differ. Ripe tomato harvested at mature-green stage had minimum TSS (3.97°Bx) and vitamin-C (16.45 mg/100g) and maximum acidity (0.4%) of all the maturity stages studied. Tomato harvested at breaker stage showed the maximum carotenoids (5.82 mg/100g) in ripe tomato. Harvesting maturity had no significant effect on the visual color of the ripe tomato pulp but smell score was highest in breaker-harvested tomato. Breaker stage harvesting was found to be optimum based on the physico-chemical characteristics of ripe tomato.

Keywords: Chemical characteristics, harvesting stages, ripening, sensory quality.

INTRODUCTION

Avinash-2, a hybrid tomato (*Lycopersicon esculentum* Mill), is popular in the market for its high pulp content and rich red color. The post harvest life of tomato is largely influenced by the harvest maturity and post harvest treatments used. Most of the fruits are harvested when they are mature and allowed to ripen subsequently during transit, storage or when displayed in retail shops. In such cases the maturity standards should correlate the quality of the fruit when ripe. Harvesting depends upon the purpose. Fruits and vegetables are living entities and continue to respire for some time after harvest. Losses in quality and quantity occur in horticultural crops between harvest and consumption. The magnitude of post harvest losses in fresh fruits and vegetables is estimated to be 5-25% in developed countries and 20-50% in developing countries. Water loss can be one of the main causes of deterioration since it results in not only quantitative loss, but also causes loss in appearance, textural and nutritional quality (Kader, 1985). From the time of harvest until consumption, wilting occurs due to loss of water and texture changes due to ageing (Ranganna, 1997). The average post harvest losses of vegetable crops within the commercial production system in the hills of

Nepal range from 20-25% (Gurung et al., 1998). The principal causes of such losses are mechanical injuries, wilting, water loss, shriveling, bruising, over ripening and decay (Kader, 1980).

The maturity of harvested perishable commodities has an important bearing on the way in which they are handled, transported and marketed, and on their storage life and quality (Reid, 1985). Immature fruits are more subjected to shriveling and mechanical damage, and are of inferior quality when ripe. Any fruit picked either too early or too late in its season is more susceptible to physiological disorders and has a shorter life than furit picked at the proper maturity (Kader, 1994). The most important quality criteria for tomatoes are red color, firm but juicy textue, and good flavor. Tomatoes with high sugar and relatively high acid contents are the best flavored; low sugar and low acid contents result in poor flavored tomatoes (Cantwell, 1994). Therefore, harvesting them at optimum stage of maturity can have tomatoes with better quality and longer marketability. Information regarding the relationship between harvest maturity and quality and shelf life of this tomato variety is scarce. Hence, the objective of this work is to identify the otpimum harvest maturity resulting in better quality and longer marketability of ripe tomato.

MATERIALS AND METHODS

Tomatoes (*Lycopersicon esculentum* var. Avinash-2) at four progressive maturity stages (viz. mature-green, breaker, turning and pink) were harvested from farm at Guthitar, Dhankuta district on July-Aug, 2001 (20th Shrawan, 24th Bhadra and 6th Ashoj, 2058 BS). They were washed with 100 ppm chlorinated water, sorted and air dried to remove surface moisture. Tomatoes of each maturity stage were allowed to ripe at ambient condition (temperature: 20-23°C and RH: 76-85%). The physico-chemical quality characteristics of unripe and ripe tomatoes were determined. The organoleptic quality of ripe tomato was also evaluted.

ANALYTICAL PROCEDURE

Determination of Physiological Loss in Weight (PLW) and of Ripening Time

One kg tomatoes of each maturity stages were ripened at room temperature and the weight of ripe tomato was taken. The percent loss in weight was calculated as follows:

$$PLW\ (\%) = \frac{W_0 - W_r}{W_0} \times 100$$

Where,

W_O: Initial weight of tomato and
W_r: Weight of ripe tomato

In order to determine the ripening time, tomatoes were daily observed for their color and the time (days) required to reach fully red ripe stage (that is more than 90% of the tomato surface is red) was noted.

Determination of Total Soluble Solids (TSS), vitamin-C and acidity

The TSS was measured by using Abbe refractometer and the values were corrected to 20°C. The titratable acidity (as anhydrous citric acid) was determined by titrating the sample solution with 0.1 N NaOH using Phenolphthalein as

indicator. The vitamin-C content was determined by 2,6-dichlorophenol-indophenol visual titration method (Ranganna, 1997).

Determination of total chlorophyll and carotenoids

The total chlorophyll (chlorophyll a and b) and carotenoids contents were determined as per Bajracharya (1998) with slight modification. Five hundred milligram of the blended tomato pulp was extracted with acetone in a mortar and pestle till the residue is colorless. The extract was filtered and the volume was made up to 50 ml with acetone. The absorbances of the extract were taken at 440, 654 and 663 nm in a spectrophotometer (Systronic, India) using acetone as blank. The chlorophyll and carotenoid contents in the samples were calculated as follows:

Chlorophyll a: $3.78 \times A_{663} - 0.99 \times A_{645}$
Chlorophyll b:$21.4 \times A_{645} - 4.65 \times A_{663}$
Carotenoids: $4.69 \times A_{440} - 0.268\ (20.2 \times A_{645} + 8.02 \times A_{663})$

Sensory evaluation

Ripe tomatoes were blended to pulp and were subjected for sensory evaluation in terms of taste and smell according to 9 points hedonic rating using 15 semi-trained panelists as per Ranganna (1997).

Data analyses

The experiment was performed in Completely Randomized Design with 3 replications. The data were analyzed by using one way ANOVA at 5% level of significance using excel program. The means were compared using LSD method as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

CHEMICAL COMPOSITION OF TOMATO AT DIFFERENT MATURITY STAGES

Tomatoes of different harvesting stages were analyzed for acidity, vitamin-C, total soluble solids, total chlorophyll and carotenoids and the results are shown in Table 1.

Table 1: Chemical characteristics of tomato at different maturity stages (n = 3)

Parameters	Maturity stages*			
	Mature green	Breaker	Turning	Pink
Titratable acidity (%, wb)	0.44^a	0.41^b	0.40^c	0.35^d
Vitamin C (mg/100 g)	16.75^a	17.95^a	15.76^a	16.61^a
Total soluble solids °Bx)	2.38^a	2.80^b	3.47^c	3.84^d
Total chlorophyll (mg/100 g)	1.78^a	0.93^b	0.76^c	0.59^d
Total carotenoids (mg/100 g)	0.33^a	0.41^b	0.50^c	1.37^d

* : Means with the same superscripts in a row do not differ significantly ($p>0.05$) by LSD.

Acidity decreased significantly ($p<0.05$) with advancing harvest maturity. Maximum acidity (0.44%) was found in mature green tomato, which declined with advancing maturity. Harvesting stages had a significant effect on the acidity of tomato and the values were significantly different from each other. Analogous results were also reported by Rick (1987) and Cantwell (1994). Vitamin-C contents did not differ significantly with tomato maturity. The values were similar to those reproted by Cantwell (1994). TSS increased with increasing tomato maturity and the values were significantly different. According to Wills et al. (1996) the increase in TSS during successive stages of maturation and ripening could be due to the degradation of polysaccharides (starch, hemicelluloses and pectin) to simple soluble sugars, which increases the level of TSS.

Total chlorophyll content of mature green tomato was 1.78 mg/100g while that of pink tomato was 0.59 mg/100g. It decreased with successive stages of maturation. Statistical analysis revealed that the chlorophyll contents were significantly different. On the other hand, total carotenoid contents increased with advancing harvesting stages. Pink stage tomato had about four times higher carotenoids than that of mature green tomato.

EFFECT OF HARVESTING STAGES ON THE RIPENING TIME AND CHEMICAL CHARACTERISTICS OF RIPE TOMATO

The time required to ripe for tomato of each maturity and their chemical characteristics were determined and the values are presented in Table 2.

Table 2: Ripening time and chemical characteristics of ripe tomato (n = 3)

Parameters	Maturity stages*			
	Mature green	Breaker	Turning	Pink
Ripening time (days)	10.33^a	9^b	7.33^c	4.7^d
PLW(%)	4.5^a	4.01^b	3.52^b	3.17^b
Total soluble solids (°Bx)	3.97^a	4.33^b	4.53^b	4.59^b
Titratable acidity (%)	0.40^a	0.34^b	0.31^b	0.30^b
Vitamin-C (mg/100g)	16.45^a	21.51^b	18.42^b	19.63^b
Carotenoids (mg/100g)	3.24^a	5.82^b	4.80^c	5.04^c

* : Means with the same superscripts in a row do not differ significantly ($p>0.05$) by LSD.

Ripening times of tomato were significantly affected by maturity at harvest. It decreased with advancing harvest maturity. Mautre green tomato

ripened in 10.33 days while that of pink stage took 4.7 days (Table 2). Physiological loss in weight (PLW) of ripe tomato harvested at mature green stage was significantly higher than those of breaker, turning and pink stage tomatoes, but the PLWs of the later three stages were not different. Joshi and Khandekar (1993) reported that the PLW increased with duration irrespective of tomato varieties under ambient, cool chamber and cool storage conditions. Tomato harvested at mature green stage resulted in the lowest TSS (3.97°Bx) in ripe tomato of all the samples. Ripe tomato harvested at pink stage had the maximum TSS (4.59°Bx), however, the value did not differ from those of breaker and turning stage-harvested tomatoes. Ripe tomato harvested at mature green stage contained significantly higher acidity (0.40%) compared to other samples. LSD indicated that the acidity of ripe tomatoes harvested at breaker, turning and pink stages were not different from each other.

SENSORY EVALUATION

Ripe tomato pulps were subjected to organoleptic quality evaluation in terms of smell and color and the results are depicted in Fig. 1.

The mean sensory scores for color of ripe tomato pulp were 7.47, 6.80, 6.87 and 6.93 for mature-green, breaker, turning and pink stage harvested tomatoes, respectively. Similarly, the smell scores were 6.80, 8.07, 6.80 and 6.33 for the respective harvesting stages.

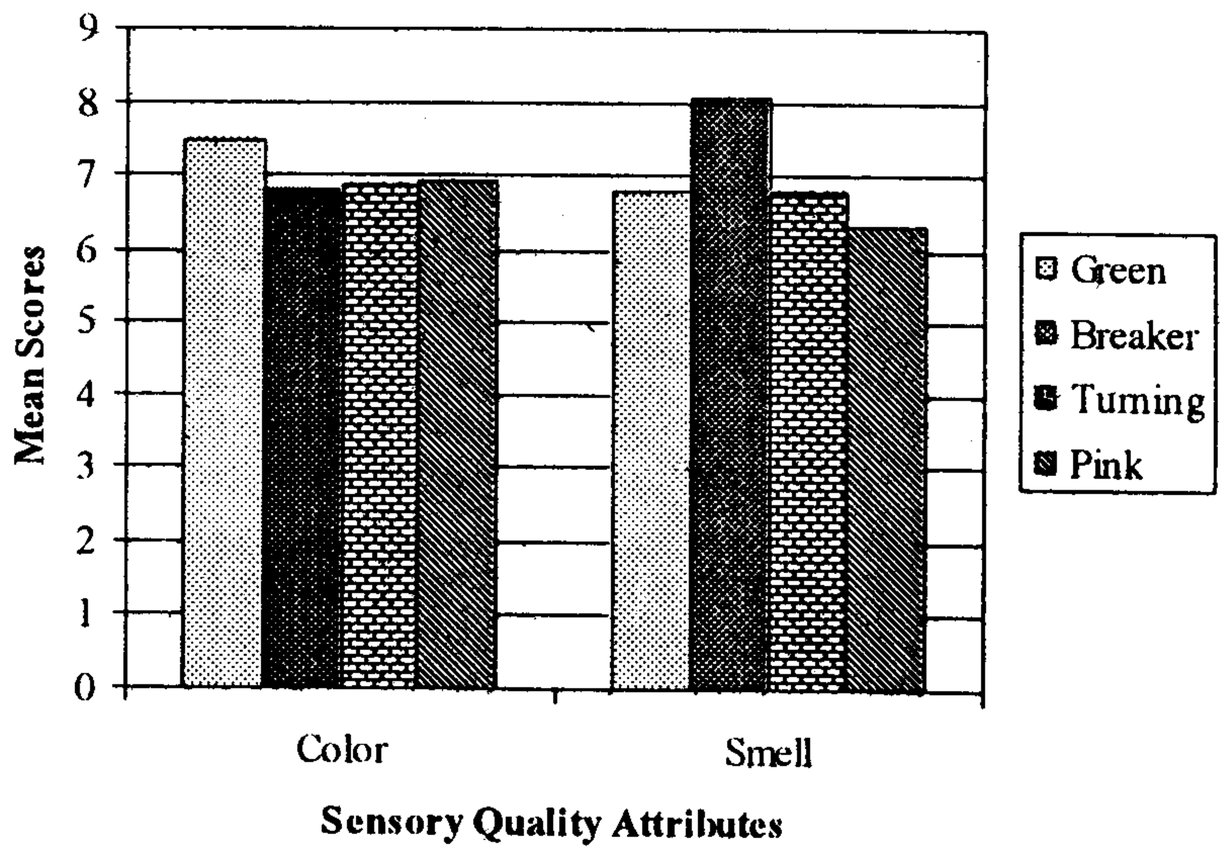

Fig. 1: Effect of harvesting stages on the color and smell of ripe tomato pulp

Statistical test did not indicate any significant difference in color but the smell score of breaker stage harvested tomato was significantly higher of all the samples. Harvesting stages giving longer ripening time; lower physiological loss in

weight; higher total soluble solids, titratable acidity, vitamin-C and carotenoids as well as higher sensory scores could be regarded as an optimum maturity. Although, ripe tomato harvested at mature green stage had longer ripening time, it had higher physiological loss in weight and poor in other quality attributes except acidity. Ripe tomatoes harvested at breaker stage contained higher vitamin-C, carotenoids and smell scores. Hence, breaker stage could be regarded as the optimum harvesting maturity as it reduced physiological loss in weight substantially and increased carotenoids, vitamin-C and total soluble solids significantly.

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