

## Quality Evaluation of Raw Tomato Fruits

— With special reference to color and puffiness —

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### Abstract

A simple spectrophotometric technique using sequential extraction of pigments was attempted to perform color evaluation of raw 'Taimuri' tomato (*Lycopersicon esculentum* Mill.) fruits. The difference between summed absorbance of 80% acetone and chloroform extract at 480 nm and 660 nm reflected the maturity of raw tomato fruits. The measurement system presented was regarded as a simple and reliable method for objective color evaluation of tomato fruits. It seems possible to predict the degree of puffiness by weight per volume w/v ratio of tomato fruits during various stages of maturity.

### Introduction

The increasing demand of tomatoes for fresh market or processing encourages researches on the quality evaluation of tomatoes and tomato products in Korea.

Color is very important in quality evaluation of tomatoes for both fresh market and processing. Acceptable surface color is desired for fresh market, while internal color is of major importance for processing.<sup>(1)</sup>

The extent of original natural color included in the processed products of tomatoes becomes an important criterion of high color quality.<sup>(2)</sup> Thus an accurate color measurement of raw tomatoes is prerequisite to successful color control.

Tomato color results from the composite of numerous carotenoid pigments. Lycopene is the most abundant carotenoid, comprising more than 80 % of total pigments.<sup>(2)</sup> Carotenoids are easily soluble in certain organic solvents, however, it appears that precise color measurement by extraction is rather complicated.

Watada *et al.*<sup>(3)</sup> developed an elaborate technique estimating pigment contents of whole tomato by light absorbance. Maturity of tomatoes was estimated on the basis of color manifested by both chlorophyll and carotenoids. At the present, the Agrtron spectrophotometers and Hunter colorimeters are widely used for objective color measurement of tomato fruits.

This investigation was undertaken to establish a simple spectrophotometric technique for color evaluation of raw tomatoes based upon destructive measurement, using sequential extraction of pigments with acetone and chloroform.

Puffiness is a common quality defect of tomatoes<sup>(4,5)</sup> for fresh market. Accordingly, an attempt was made to predict the extent of puffiness by the use of a nondestructive measurement.

### Materials and Methods

#### Raw material

Color classification of raw tomatoes was based on United States standards for grades of fresh tomatoes.<sup>(5)</sup> The terms included Mature Green, Breaker, Turning, Pink, Light Red and Red. Four uniform tomatoes of desired maturity stages were sorted out, by visual examination, from bulk lots of commercial 'Taimuri' tomatoes in the local market.

#### Color determination

In this study, filtered residue of blended tomato pulp was used as a source of chlorophyll and carotenoids. These pigments were sequentially extracted from individual tomatoes at several stages of maturity for a given period of time.

Individual tomatoes were homogenized for 1 minute at high speed in a Waring blender and filtered under vacuum through Toyo No. 2 filter paper. A 5g sample taken from filtered tissue residue was employed for the

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sequential extraction with acetone and chloroform.

Chlorophyll was first extracted from prepared sample with 20 ml of 80 % (v/v) acetone for 10 minutes. The chlorophyll extract was carefully decanted after centrifuging for 10 minutes at 4000 rpm. Then carotenoids were sequentially extracted from the sedimented residue with 20 ml of chloroform for 10 minutes.

Absorbance of 80 % acetone and chloroform extracts was read at 10 nm intervals over the visible wavelength range using a Hitachi model 101 spectrophotometer (Hitachi Ltd., Tokyo, Japan). The absorption spectrum is presented as the sum of absorbance of both the 80% acetone and chloroform extract at each specified wavelength.

### Puffiness

To estimate the defect of puffiness, individual tomatoes were weighed in grams and their volume was measured by the water displaced in milliliters. The proportion of open space between the tomato wall and the central pulp was visually examined with transverse section of tomato. The extent of puffiness was rated from 1-5, where 5 equalled no puffiness and 1 severe puffiness.

## Results and Discussion

### Color measurement

Results in Table 1 showed that a certain amount of chlorophyll or carotenoids could be extracted by the two different solvents.

Arnon<sup>(6)</sup> used the wavelength 652 nm for calculation of chlorophyll in 80 % acetone extracts. According to

our results, the summed absorbance of 80 % acetone and chloroform extracts at 660 nm was quantitatively related to maturity of tomato fruits. Their absorption spectra clearly show characteristic peaks between 420-450 nm or at 480 nm and 660 nm regardless of maturity stage (Fig. 1).

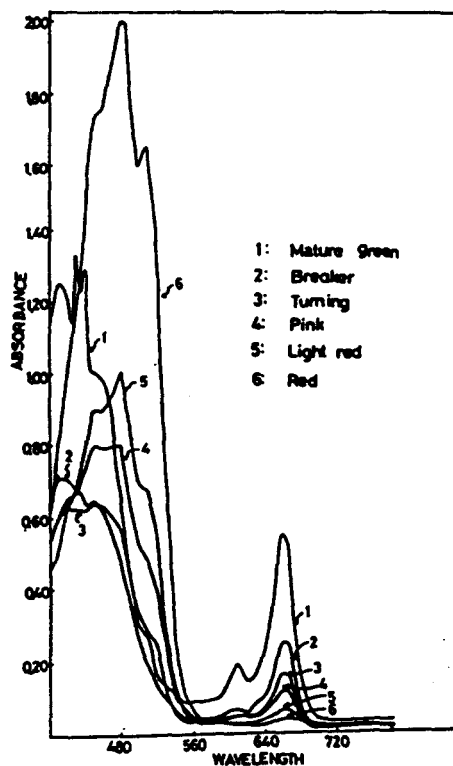


Fig. 1. The summed absorption spectra of 80% acetone and chloroform extract by sequential extraction of 'Taimuri' tomato fruits at various maturity stages

Table 1. Absorbance at 480 or 660 nm of 80% acetone or chloroform extract by sequential extraction of 'Taimuri' tomato fruits at various maturity stages

Stages of maturity	Absorbance at 480 nm		Absorbance at 660 nm	
	80% Acetone extract	Chloroform extract	80% Acetone extract	Chloroform extract
Mature Green	0.431 <sup>2</sup>	0.220	0.446	0.108
Breaker	0.270	0.208	0.215	0.039
Turning	0.257	0.313	0.153	0.015
Pink	0.273	0.531	0.112	0.011
Light Red	0.250	0.770	0.060	0.009
Red	0.240	1.815	0.037	0.005

<sup>2</sup>Values are means of 4 replications.

In a nondestructive quality evaluation of intact fruits by spectrophotometry,<sup>(7)</sup> the difference in optical density ( $\Delta OD$ ) at two wavelengths has been used to estimate the relative concentrations of the pigments. Two wavelengths are from the areas of maximum absorption and minimal effect on absorbance.

In this experiment, the summed absorbance of 80 % acetone and chloroform extract at 480 nm and 660 nm, probable lycopene,<sup>(2,8)</sup> and chlorophyll peaks<sup>(9,10)</sup> were plotted at various maturity stages of tomato fruits. As maturity of tomato fruits progresses, the magnitude of difference between absorbance at 480 and 660 nm remarkably increased because of the gradual decrease of chlorophyll content and drastic synthesis of carotenoids (Fig. 2).

The difference between absorbance at 480 and 660 nm plotted against maturity is shown in Fig. 3. Under the present measuring system, the difference between absorbance at 480 nm and 660 nm of around 0.10 signifies Mature Green stage of tomato fruit, 0.20

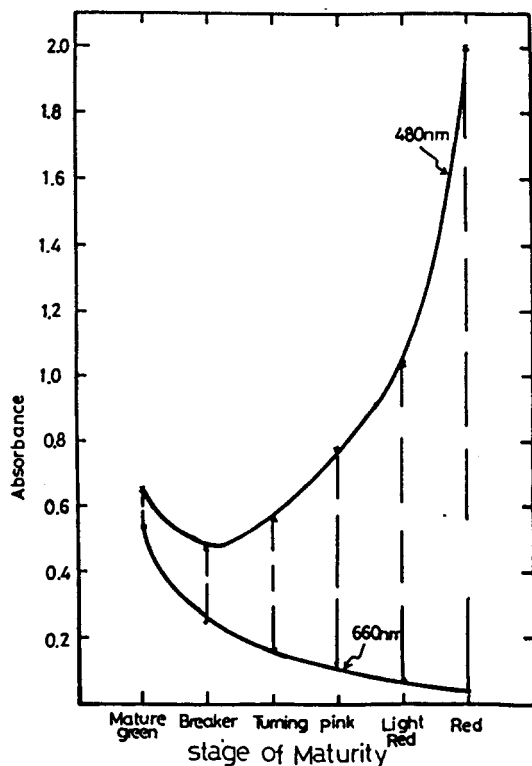


Fig. 2. The summed absorbance at specified wavelengths of 80% acetone and chloroform extract of 'Taimuri' tomato fruits at various maturity stages

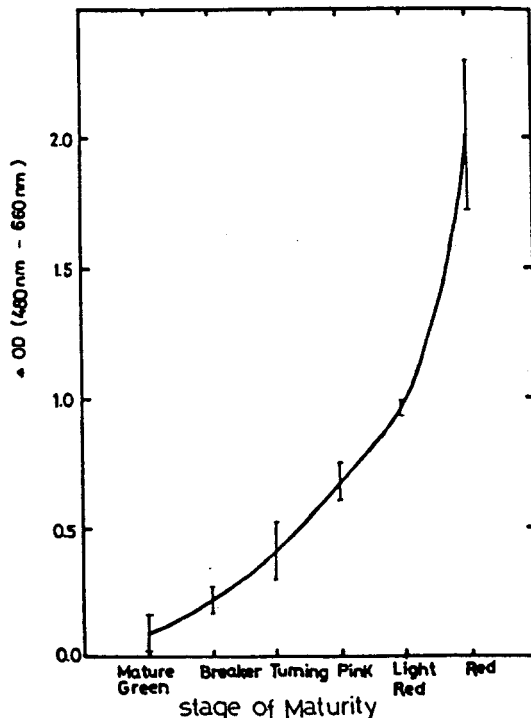


Fig. 3. The difference between absorbance at 480 nm and 660 nm of 80% acetone and chloroform extract by sequential extraction of 'Taimuri' fruits at various maturity stages. Vertical lines show SD

Breaker, 0.40 Turning, 0.70 Pink, 1.0 Light Red and 2.0 Red.

At present, Agtron spectrophotometers and Hunter colorimeters are commonly used instruments for objective color measurement of cut tomatoes or prepared tomato sample.<sup>(2)</sup> In the present study using an ordinary spectrophotometer, the measurement of difference between absorbance at 480 and 660 nm by sequential extraction procedure is shown to be a simple and reliable method for objective color measurement of tomato fruits.

**Correlation of w/v ratio with the degree of puffiness**

Puffy fruits are frequently encountered when growth regulators such as para-chlorophenoxyacetic acid<sup>(11)</sup> are applied for increased fruit setting under forcing structures. As a rule, severe puffiness of tomato fruits can be nondestructively detected only by visual examination of ribbed shape.

In the present study, the correlation of w/v ratio with the extent of puffiness was investigated to establish objective evaluation method on a universal scale.

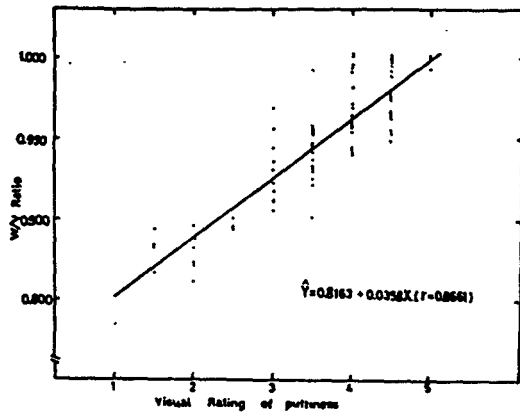


Fig. 4. Correlation of weight per volume ratio with the degree of puffiness, with 1 as severe puffiness and 5 as no puffiness

The w/v ratio or relative density is highly correlated with total solids content in fruits and vegetables.<sup>(1)</sup> It is probable that the difference of solids content due to maturity stage<sup>(12)</sup> would somewhat affect the value of w/v ratio.

As shown in Fig. 4, the great w/v ratio indicated high solids content or little air void in tomato fruits. The w/v ratio above 0.970 reflected little or negligible amount of puffiness and a ratio below 0.900 serious damage. The w/v ratio was highly correlated with the degree of puffiness. The correlation coefficient was 0.8661(df = 99), significant at the 1 % level.

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## 토마토의 품질평가에 관한 연구

—색 및 공동(空洞) 현상을 중심으로—

이미순 · 김건희

덕성여자대학 식품영양학과

토마토의 색도를 측정하기 위해 색소의 sequential extraction을 이용한 spectrophotometric technique을 시도하였다. 파장 480nm와 660nm에서 각기 80% acetone과 chloroform으로 추출된 용액의 흡광도를 합한 다음 두

과장에서의 총 흡광도 차이를 구한 결과 토마토의 숙성(ripening) 정도가 잘 반영되었다. 이러한 측정방법은 토마토 색소의 객관적 측정을 위한 간단하고 신뢰성 있는 방법으로 간주된다.