

Location Effect on Strawberry Quality¹

Suraphong Kosiyachinda, Manit Kosittrakul, Peeradet Tongumpai,
Saichol Ketsa and Vichit Vangnai²

ABSTRACT

Tioga strawberries were harvested on March 19 – 22, 1983 from 3 different growing areas. They were Chang Kian, Intanon and Mae Sai. The study was conducted daily and shortly after harvest. Right after harvest strawberries of Intanon had over 2% SS higher than those of the other two areas with 5.65 and 5.14%. They were highly significantly different. The TA were 0.75 – 0.95% in both stages. It was not statistically different within the same stage. Similar pattern was found in full color fruits and SS/TA ratios. Flesh firmness of Intanon strawberries was 2.16 kg/cm² in the first day. It was firmer than that of Chang Kian and Mae Sai, but at full color stage their values were slightly different (1.04 – 1.29 kg/cm²).

Data indicate that Tioga strawberries from higher elevation areas tend to have slightly better quality. It was confirmed by organoleptic test. However the fruits have their own characteristic of low % SS and comparably high % TA. The taste is not palatable, if strawberries are eaten as they are without any seasoning.

INTRODUCTION

Different groups of people have different eating habits. Fresh strawberries are well known in the western markets, but are relatively new in Thailand, where the fruit is mainly sold in the form of finished products such as jam and jelly. It is used as an ingredient or a favoring item in ice cream, milk, jello syrup and cakes. When fresh strawberries were firstly placed in the market, after tasting the fruit the new Thai customers agreed on its aroma, but not the taste. It is due to the acidity, since the Thais are generally fond of sweet fruits. Though They are not very sweet, if acidless or slightly sour they are acceptable.

The eating quality of fresh strawberries should be publicized. To achieve introducing strawberry fruit to Thai customers, education and recipes of the western preparation must be given in conjunction with their adaptable methods. Furthermore, new Thai recipes on the utilization of the fruit should be created.

It was reviewed by Ting and Attaway (1971) that citrus growers have long recognized that weather conditions are a prime factor influencing fruit quality. The high solids years of the fruit had a lower rainfall and less cloudy days during the early fruit development period. On the contrary, the abundance of rainfall or excessive irrigation during the ripening period seemed to have a dilution effect on the total soluble solids (SS) and total acids (TA) of the fruit.

Wutscher (1976) reported that night temperature was somewhat influential on grapefruit quality. Fruits grown under a 32°/30°C day/night temperature regime had 10.4% SS, 1.16% TA and 8.96 SS/TA; a 32°/7° regime had 9.1% SS, 1.56% TA and 5.83 SS/TA; and 32°/24° resulted in 12.6% SS, 1.31% TA and 8.47 SS/TA. When root systems of Washington Navel and Valencia oranges were under constant day and night temperature, Cary and Weerts (1978) found that at 25°C juice yields

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2 Department of Horticulture, Faculty of Agriculture, Kasetsart University.

of both varieties were higher, skin thickness was less, SS and TA contents of juice were lower than at 17°C.

Reuther and Rios-Castano (1969) conclude in their paper that with some exceptions, fruits of orange, grapefruit and mandarin varieties produced in hot tropical locations in Columbia, in addition to maturing more rapidly, and attaining larger size, have greener rinds, paler flesh, higher juice content, and lower SS and TA in juice. Apparently, the combination of high night respiration losses and competition of vegetative growth with fruit for carbohydrates tends to produce lower SS. Reuther (1970) pointed out that information on the relation of temperature to SS in juice of the grapefruit and pummelo group is not sufficient to draw any conclusions beyond that there is a very wide difference among varieties in their reactions to the extremes of climate from cool to hot.

Strawberries are produced in Chiang Rai and Chiang Mai, the northern provinces of Thailand. Producing areas are located in different elevations and environments. Quality of the fruit from different areas has been an interesting subject; particularly the fresh market. This study is trying to elucidate whether the production site affects the strawberry quality.

MATERIALS AND METHODS

Tioga strawberries of 3 color stages (21–40%, 41–60% and 61–80% color) were harvested on March 19–22, 1983 from 3 different locations (Fig. 1). They were Mae Sai of Chiang Rai which is some 10 Km. from Burmese–Thai border; Chang Kian of Chiang Mai which is in the city vicinity; and Intanon, the high elevation of mountainous area in the South West of Chiang Mai.

Twelve berries of each color stage and each location were analysed on the day of harvest at the farms or in the hotels wherever

it was appropriate. Subsequent daily study after harvest was made at the hotels and the Postharvest Horticulture Laboratory of the Department of Horticulture, Faculty of Agriculture, Kasetsart University, Bangkok. Analysis or study was conducted on % total soluble solids (SS) with hand refractometer, % titratable acids (TA) expressed as citric acid with NaOH solution, flesh firmness with fruit hardness tester (Model UB), color development by estimation of % fruit color, weight losses and organoleptic test. Weather data during the fruit growth and development period of the 3 locations were also compared.

RESULTS AND DISCUSSION

Losses :

Weight loss due mainly to water loss in strawberries was determined when the fruits became fully red. Intanon had the greatest weight loss of 7.10%, Chang Kian and Mae Sai had 5.88 and 6.08% (Table 1). The weight loss may have slight effects on SS and TA. Certainly it causes shrinkage of the berries. If it is severe, the fruits are shrivelled and becoming loose in the tray. Postharvest losses can be reduced to a certain extent. It is impossible to have the loss equal to zero.

At room temperature after the strawberries became fully red, those infected were highly susceptible to fungi and were decaying. Fruits from Chang Kian were loaded with mycelia one day after fully red color. The similar phenomenon also occurred in fruits from other areas. Besides pathogenic–damaging senescent strawberries, a few insect–damaged fruits were accidentally found in the batch of Chang Kian.

Total soluble solids and titratable acids :

Within a few hours after harvest SS of strawberries at the 3 color stages were slightly different within each location. The difference was only about 1%. However, the

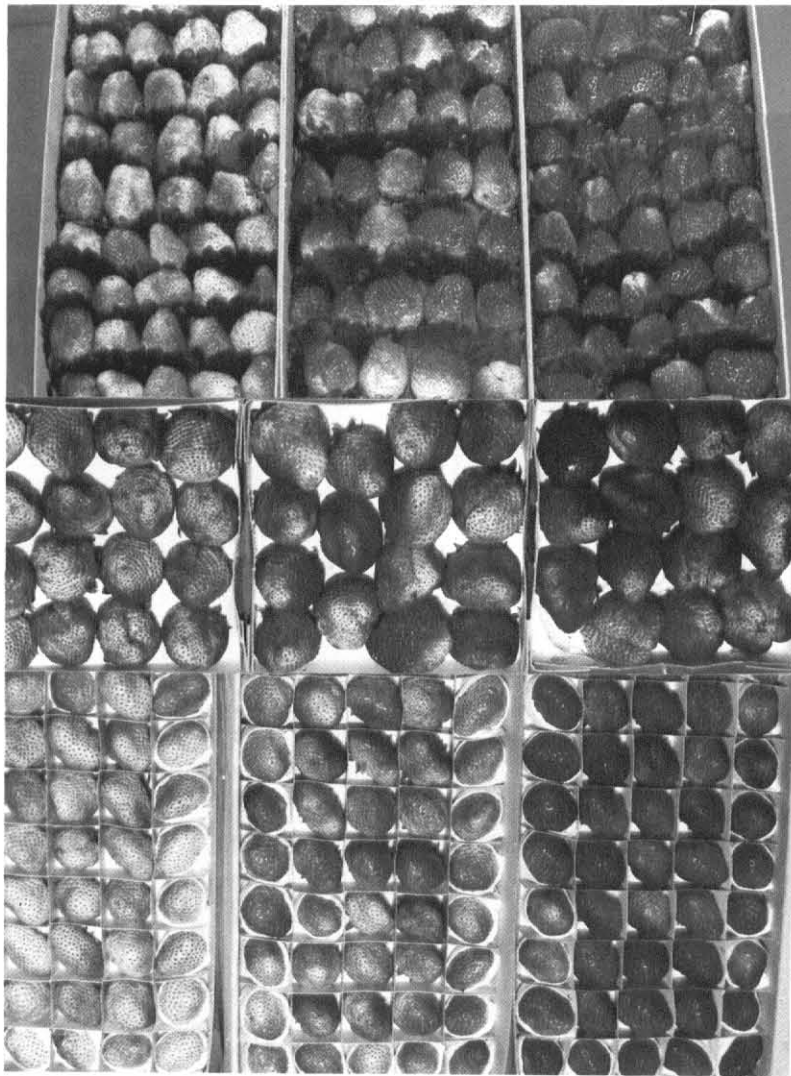


Fig. 1. Tioga strawberries from a : Chang Kian, b : Intanon and c : Mae Sai. They were d : 21–40, e : 41–60 and f : 61–80% color; and harvested on March 19, 20 and 22, 1983.

Table 1 Mean of weight loss (%), SS and TA of Tioga strawberries shortly after harvest (X) and when the fruits were fully red (Y) from 3 production sites.

Mean Values	Weight loss (%)	SS (%)		TA (%)	
		(X)	(Y)	(X)	(Y)
Production Sites					
Chang Kian	5.66	5.65 b ¹	5.92 b	0.75 a	.82 a
Intanon	7.16	7.76 a	7.23 a	0.79 a	.90 a
Mae Sai	6.06	5.14 b	5.12 c	0.77 a	.95 a

¹ Mean separation within columns by Duncan's multiple range test at 1% level.

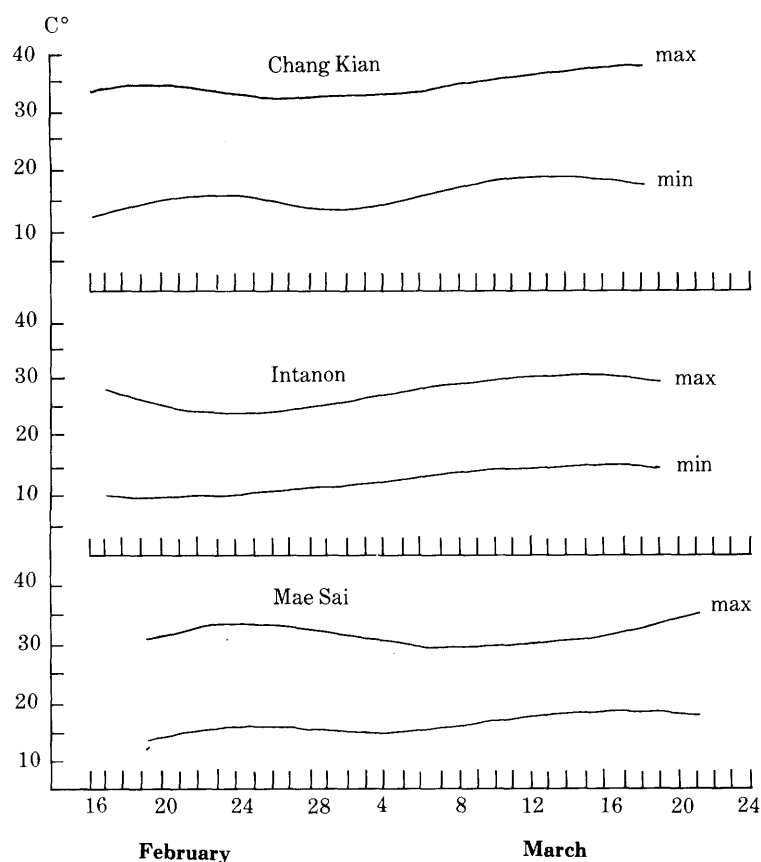


Fig. 2. Maximum and minimum temperatures of Chang Kian, Intanon and Mae Sai during fruit growth and development period.

Table 2 Ratio of SS/TA, organoleptic test score and flesh firmness of Tioga strawberries shortly after harvest (X) and when the fruits were fully red (Y) from 3 production sites.

Mean Values	SS/TA		Organoleptic test	Flesh firmness (kg/cm ²)	
	(X)	(Y)		(X)	(Y)
Production sites					
Chang Kian	7.53 b ^{1/}	7.22 a	1.78 ^{2/}	1.15 b	1.04 a
Intanon	9.82 a	8.03 a	2.50	2.16 a	1.29 a
Mae Sai	6.68 b	5.39 b	1.83	1.32 b	1.18 a

^{1/} Mean separation within columns by Duncan's multiple range test at 1% level.

^{2/} Means of organoleptic test are ranking score with 1 = dislike, 3 = like and 5 = like very much.

average SS of the berries from Intanon were 7.76% (Table 1) which was highly significantly different from those of Chang Kian (5.65%) and Mae Sai (5.14%). It is interesting to observe that higher SS of strawberries were produced (Fig. 2) under the lower maximal and minimal temperatures of Intanon (Fig. 2). The Mae Sai fruits had lower SS. It may be due to the fruit growth period which was under 28 hazy-sky days out of 30 growing days in Mae Sai area.

The fruits are normally consumed when they are fully red. It took 3 days for Intanon and 2 for Chang Kian and Mae Sai for all berries to become fully red. At this stage, SS of the 3 locations were in similar pattern as they were shortly after harvest. Intanon strawberries had the highest SS of 7.23%, followed by Chang Kian and Mae Sai of 5.92 and 5.12%. The different SS were highly significant among them.

It was found that TA of strawberries right after harvest or at full color were not significantly different among production sites.

Their mean values were 0.75–0.79 and 0.82–0.95%. Chang Kian strawberries had the lower TA, whereas Intanon and Mae Sai fruits had higher acids content (Table 1). It should be noted that during the 30 days of fruit growth period, the average maximal/minimal temperature of Intanon, Mae Sai and Chang Kian was 27.6/12.2, 32.3/15.9 and 34.6/15.6°C (Fig. 2). It indicates that higher maximal and minimal temperatures of Chang Kian tend to result in lower SS and TA in strawberries, and it may be similar in Mae Sai fruits.

Higher SS of Intanon strawberries (7.76%) shortly after harvest yielded higher SS/TA ratio (9.82) as compared with the other 2 ratios (Table 2). They were also significantly different at 99% level. When the berries were fully red, the ratios decreased. It is due to the increase of TA and slightly change of SS. Strawberries of over-mature stage at harvest were slightly astringent.

Flesh firmness :

Shortly after harvest although lighter color fruits were firmer, the flesh firmness among 3 color stages was not statistically different within each production site. But Intanon strawberries with the average of 2.16 kg/cm² were firmer than those of Chang Kian and Mae Sai (Table 2). The difference was highly significant. When all strawberries were fully red, their flesh firmness decreased along with color development. The firmness was 1.04, 1.29 and 1.18 kg/cm² for Chang Kian, Intanon and Mae Sai of which they were not statistically different at this stage.

It is essential that at harvest and handling after harvest strawberries should be as firm as possible in conjunction to good consuming quality later on. It does not matter whether the fruit firmness is statistically different.

Organoleptic test :

As mentioned in the previous report (Kosiyachinda *et al.*, 1983) that strawberries are considerably new. It may not absolutely be able to extract the exact score of the organoleptic test of the fruit. This is perhaps due to its exotic flavor, and its unusual eating quality for the Thai. All fruits from any locations did not get the passing score of 3 (Table 2). The highest score was given to Intanon fruits which received 2.50. It is generally not easy to agree that Intanon strawberries are slightly better in taste and flavor than those of other areas, since the degree of difference is small and the rate of changes of strawberries is quite rapid (Kosiyachinda *et al.*, 1983).

CONCLUSION :

Water loss of Tioga strawberries of 5–7% was the major weight losses in the 3 production areas provided that good pest control was practiced. Intanon berries were higher in both % SS content and SS/TA ratio than those from

Chang Kian and Mae Sai either right after harvest or at full color stage. The difference is highly significant.

Flesh firmness at after harvest was slightly higher than those at full color. The Intanon strawberries which were firmer than others should have good shipping quality. Regarding taste test, the Intanon was slightly better due to its better flavor.

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