



Appropriate Tomato and Mandarin Ratios on Development of Blended Tomato Juice and Mandarin Juice Products

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Abstract

The objective of this research was to determine different ratios of tomato and mandarin on the qualities of blended tomato juice and mandarin juice products. This research was performed as five experiments: 1) tomato juice (control); 2) blended tomato juice and mandarin juice 90:10; 3) blended tomato juice and mandarin juice 80:20; 4) blended tomato juice and mandarin juice 70:30 and 5) blended tomato juice and mandarin juice 60:40. The physical qualities of mixed tomato juice and mandarin juice as brightness (L^* value), redness ($+a^*$ value), yellowness ($+b^*$ value), viscosity and sedimentation value were detected. The chemical properties as pH, percent of total acidity, vitamin C and lycopene were determined. The sensory evaluation as color, odor, taste and overall acceptability were done by 9-points hedonic scale. The results showed that brightness, redness, viscosity, sedimentation value, pH and percent of total acidity were significantly different. ($P < 0.05$), except for yellowness. The chemical properties revealed that vitamin C range and lycopene range values of 0.033-0.075 mg/ml and 1.134-1.835 mg/100g fresh weight, respectively. The sensory evaluation on overall liking revealed that panelists accepted with the highest scores of 7.23 on blended tomato juice and mandarin juice 60:40.



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Introduction


Nowadays, beverage products play a greater role in everyday life, with the ready-to-drink fruit juice market. Most of the drinks being derived from the ingredients of fruits or vegetables. Some consumers may not consume vegetables, but they can enjoy the

benefits of the various types of Thai herbs that can be processed in the form of health drinks. Because they help to quench thirst, they also receive various nutritional benefits in various types of ready-to-drink blended fruit and vegetable juices.¹ Tomato is the fruit of the plant botanically known as *Lycopersicon*

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esculentum. Tomato has widely been reported to be a good source of natural antioxidants including vitamins C, A and the B group, as well as flavonoids, and the carotenoid - lycopene. Lycopene has been implicated as an antioxidant and as a cholesterol lowering compound. A tomato is 95% water, contains 4% carbohydrates and less than 1% each of fat and protein. In a 100 gram amount, raw tomatoes supply 14 milligram of vitamin C and 449 microgram of β -carotene.² Tomato juices are attracting more attention due to the phytochemical value of many vegetables. Tomato products are increasing in popularity due to the scientific findings that lycopene, the major carotenoid pigment responsible for the red color in tomatoes, has anti-inflammatory and anti-carcinogenic properties. Unlike β -carotene and other closely related carotenoids, lycopene has no pro-vitamin A activity.³ Mandarin is prized for the delicious flavor of their fresh fruit, but relatively little information is available citrus, such as orange or lemon. Mandarin has an important chemical composition, consisting of 34 micrograms / 100 grams of vitamin A and 155 micrograms / 100 grams of beta carotene.⁴ Juicing is a great way to get adequate quantities of water, raw enzymes, vitamins, and minerals, all necessary for health. The citrus processing industry follows the demands of the market for processed products that have characteristics resembling the fresh product. Production of ready-to-serve citrus juices has become common in the last years; these juices are produced without the traditional passage through partial elimination of water and its following reconstruction at the moment of use.⁵ There are some researches related to the processing of tomato juice by preservation with and without seeds. The results indicated that proximate composition of the juice gave fat content for juice without seeds (0.79 ± 0.05 g/100 g) and juice with seeds (1.62 ± 0.02 g/100 g). There was significant ($p < 0.05$) increased in protein content in the juice without seed (11.89 ± 0.08 g/100g) and juice with seed (12.38 ± 0.06 g/100 g) when compared to the raw tomato (8.81 ± 0.09 g/100 g). The fiber content of the juice with seed (8.15 ± 0.04 g/100 g) was significantly ($p > 0.05$) higher than in juice without seed (4.26 ± 0.05 g/100 g) and the raw tomatoes (5.04 ± 0.08 g/100 g). Processing significantly increased the sugar content in tomato juice to 3.62 ± 0.01 g/100 g (without seed) and 3.39 ± 0.04 g/100 g (with seed) from 2.79 ± 0.01 g/100

g in raw tomatoes. Processing slightly decreased Vitamin C content in the processed juice (151.00 ± 1.00 mg/100 g without seed), and (154.67 ± 0.33 mg/100 g with seed), while Vitamin C concentration in the raw tomatoes was 157.33 ± 0.33 mg/100g. Vitamin A content decreased to 3954.67 ± 11.35 IU in juice without seed and 3943.67 ± 34.16 IU with seed, from 4126.00 ± 83.43 IU in raw tomatoes.⁷ The another research report involved about changes in orange juice color. This research focuses on natural way of improving the color of orange juices is by adding other juices, which provide a more intense coloration. The US legislation allows the addition of up to 10% of mandarin juice to the orange juice to improve its color. The first objective of this study was to compare the color characteristics of juices from 11 mandarin cultivars, currently being grown in Spain. The experimental results proved that only the green-red coordinate, a^* , of the orange juices can be improved by adding mandarin juice. The mandarin cultivar that provided a juice with the highest values of a^* . Once this selection was made, the effects of adding mandarin juice at different ratios, up to 10%, on the color characteristics of the orange juice were studied. Values of the a^* coordinate went from 5.50 for the pure orange juice up to 6.29 for the mixture of 90% orange juice plus 10% of mandarin juice. Finally, hedonic tests proved that regular juice consumers preferred the color of mandarin juice to that of orange juice and that they liked better the color of the juice mixture containing 10% mandarin juice than that containing 3% mandarin juice.⁸ The last research concerned about mandarin cultivar on quality of mandarin juice. Eight mandarin cultivars have been analyzed for their content of vitamin C, minerals (Ca, Mg, K, Na, Fe, Cu, Mn, and Zn), CIELab color coordinates (L^* , a^* , b^* , C^* , and h_{ab}), total volatile compounds content and sensory aroma intensity of juice. The experimental results proved that no important enough differences were found in the minerals contents to decide which mandarin cultivar was of higher quality. Clemenules provided the darkest juice with the highest vitamin C content and with the most intense mandarin aroma. On the other hand, Nova and Hernandina mandarin could be considered as the worst cultivars for juice production. Finally, if Clemenules mandarins were not available for juice processing, Orogrande, Clemenpons, Ellendale, and Marisol could also be good options.⁹ But there

was no information about the formulation of tomato mixed with mandarin. For this reason, of tomato and mandarin benefits, the researchers are interested in producing water-based tomato and mandarin with the healthy drink by studying appropriate amounts of tomato and mandarin ratios on the physical, chemical quality, sensory acceptance of the consumer and storage time towards the product in order to preserve the vitamin C and lycopene that was acceptable to the consumer, which help with the quenching of thirst and help relax or make the body. The data obtained from this research was an alternative to make tomato and mandarin as raw materials for beverage production to improve the nutritional quality and good health of consumers also solve the problem of bringing agricultural products that are processed with higher values.

Methodology

The research was carried out at the Division of Food Science and Technology, Faculty of Agricultural Technology, Rajamangala University of Technology Thanyaburi. (RMUTT) Pathum Thani Province Thailand. The samples used in this study were purchased from Rangsit Market which located in Pathum Thani Province Thailand.

Chemical Properties of Tomato Juice and Mandarin Juice

Preparation of tomato juice and mandarin juice (as raw materials) in the sample preparation process in order to analyze the chemical properties (some details appeared in Preparation of Blended Tomato Juice and Mandarin Juice) including pH, total soluble solid (TSS), percentage of total acidity, vitamin C and lycopene were recorded as values adapted from [10].

Preparation of Blended Tomato Juice and Mandarin Juice

This research was performed as five experiments (three replications): 1) tomato juice (control); 2) blended tomato juice and mandarin juice 90:10; 3) blended tomato juice and mandarin juice 80:20; 4) blended tomato juice and mandarin juice 70:30 and 5) blended tomato juice and mandarin juice 60:40 The tomato was washed with clean water and slice into thin small pieces and peeled theirs to juice with a fruit juice extractor, then filtered through a cloth and mixed with water 1:3 ratio. The mandarin

was washed with clean water and halved theirs to juice with a fruit juice extractor with water 1:3 ratio. The blended aliquots were placed in a stainless steel pot and heated to 70°C for 10 minutes. Addition of some detailed ingredients (0.1 percent of salt and 0.05 percent of carrageenan powder), then, adjusted 14° Brix of final total soluble solid content by using white sugar and heated to 80°C for 10 minutes. The blended aliquots were placed in 250 ml of sterilize colored glass bottles by means of cooling immediately and storage at 4°C for 14 days.¹⁰

Effect of Storage on Vitamin C and Lycopene In Blended Tomato Juice and Mandarin Juice Products at Different Storage Day

The processed products from above steps. (Preparation of Blended Tomato Juice and Mandarin Juice) were stored at 4°C. Analysis of changes in the amount of vitamin C and lycopene were recorded values at the storage period of the day (0,7 and 14).¹⁰

Recording of Data

Data were collected and recorded from experiments (three replications) calculated and analyzed for statistical data. The experimental design for physical and chemical quality analysis were evaluated by using a completely randomized design (CRD). A randomized complete block design (RCBD) for sensory evaluation was used with analysis of variance. Analysis of the mean differences of experiments was performed by using Duncan's new multiple range test.¹¹

Physical Measurement

Prepare samples from the preparation process in the form of a solution, pour in a 50ml beaker to measure the color brightness (L*), color as red (+a*) and yellow (+b*) were measured by using Minolta CR-10 and recorded as values adapted from.¹² The viscosity was detected by Brookfield Viscosimeter. (500 ml of aliquot was placed in 1000 ml of beaker) for viscosity measurements and recorded as values adapted from.¹² The sedimentation value was recorded by using measuring cylinder (add 100 ml aliquot to the 100 ml measuring cylinder and leave at low temperature for 24 hours to observe and measure the level of sedimentation) as values adapted from.¹²

Chemical Measurement

Prepare samples from the preparation process in the form of a solution, pour in a 50ml beaker to measure the pH and percentage of total acidity were measured by using pH meter OHAUS ST3100-F and titration with 0.1N sodium hydroxide (phenolphthalein as indicator) as values adapted from.¹³ The vitamin C and lycopene were measured as values adapted from.¹⁴ Stored the products at 4°C for 14 days to study shelf life and observed the changes in the amount of lycopene and vitamin C.¹⁴

Sensory Evaluation

The sensory evaluation was carried out by 30 untrained panelists in Rajamangala University of Technology Thanyaburi, Thailand. Panelists were asked to analyze their levels of preference for each treatment by using a 9-point hedonic scale test based on the attributes of color, odor, taste and overall acceptability. A randomized complete block design was used with analysis of variance. Analysis of the mean differences of experiments was performed by using Duncan's new multiple range test.¹⁵

Results and Discussion

From the measurement of the initial chemical properties of tomato juice and mandarin juice that can be prepared. It revealed that tomato juice and mandarin juice had a low pH value of 4.32 and 3.58, respectively. The percentage of total acidity and total soluble solid in tomato juice and mandarin juice. (calculate as citric acid) were 0.60 and 5.11°Brix and 1.08 and 10.98°Brix, respectively. The vitamin C in tomato juice and mandarin juice were 0.30 and 0.32 mg / ml, respectively. The lycopene in tomato juice was 10.29 mg /100g. From the analysis of chemical property, tomato juice was found that had higher pH value than tangerine juice but gave lower percent of acid. The vitamin C content was similar, because the tomatoes consisted of 5-10 percent of solids and 10 percent of organic acids, which were less than mandarin. Organic acids are found as citric acid and malic acid form. The major pigment found in tomato juice and tangerine juice are lycopene, which is dark red crystals and is found during the maturation of tomatoes. This value was greater than the tangerine orange juice.^{7,8,9,16}

Table 1: Physical measurement of blended tomato juice and mandarin juice products

Experiment	physical values*				
	L*	a*	b*ns	viscosity* (cps)	sedimentation* (cm)
tomato juice (control)	15.47 ^b	-0.82 ^e	5.37	1.68 ^a	4.90 ^a
blended tomato juice and mandarin juice 90:10	16.30 ^b	-1.12 ^d	5.80	1.37 ^b	4.60 ^b
blended tomato juice and mandarin juice 80:20	18.67 ^a	-1.24 ^c	6.47	1.23 ^c	4.41 ^{bc}
blended tomato juice and mandarin juice 70:30	18.80 ^a	-1.36 ^b	6.80	1.19 ^d	4.37 ^{bc}
blended tomato juice and mandarin juice 60:40	18.90 ^a	-1.58 ^a	6.87	0.82 ^e	4.28 ^c

Each value in the table are represented as physical values. Statistically significant at $p < 0.05$, where $a < b < c < d$ in each column and ns non significant difference ($P > 0.05$)

Physical Measurement

The results showed that all of L* and color as +a* and +b* values, viscosity and sedimentation depending on different ratios of tomato and mandarin. The results showed that all values were significantly different (except b* value). The brightness tended to increase with increasing mandarin proportion. According to the experimental method, because the mandarin juice are a bright yellow color,^{8,17} while the measured green value tended to increase

when the tomato ratio decreased. Because naturally, tomato color is red, but tangerine has a light orange color. When the mandarin juice was increased, the red color value was reduced, but the trend of the brightness and the yellowness value were increasing. As for the yellow color, the color of mandarin juice increased when the mandarin juice ratio increased. The viscosity measurement used 100 rpm needle number 1. Increasing the amount of mandarin juice ratios while decreased tomato juice ratios had a

greater effect on viscosity. Which is an important component in the tomato juice, has opaque fibers and suspended more than mandarin juice. Resulting in a high viscosity of the measured value, consistent with the volume measurement mentioned the occurrence of sedimentation and the occurrence

of the appearance. It revealed that Experiment 1 produced the highest volume of sediments. Possible reasons were that the increasing of sediments contained sediment could have resulted in proportion in more tomato juice¹⁸ as shown in Table 1.

Table 2: Chemical measurement of blended tomato juice and mandarin juice products

Experiment	chemical values*			
	pH*	% of total acid ^{ns} (citric acid)	vitamin C ^{ns} (mg/ml)	lycopene* (mg/100g)
tomato juice (control)	4.41 ^a	0.144	0.033	1.835 ^a
blended tomato juice and mandarin juice 90:10	4.37 ^b	0.160	0.044	1.497 ^B
blended tomato juice and mandarin juice 80:20	4.29 ^c	0.183	0.051	1.400 ^{bc}
blended tomato juice and mandarin juice 70:30	4.21 ^d	0.184	0.060	1.279 ^{cd}
blended tomato juice and mandarin juice 60:40	4.13 ^e	0.193	0.075	1.134 ^d

Each value in the table are represented as chemical values. Statistically significant at $p < 0.05$, where $a < b < c < d < e$ in each column and ns non significant difference ($P > 0.055$)

Chemical Measurement

The results indicated that the pH and percentage of total acidity in tomato juice products with mandarin juice, depended on the different ratios (Table 2). The result showed that the pH and lycopene were statistically significant differences while the percent of total acid and vitamin C were not statistically different. This value depended on the increasing appropriate mandarin juice ratio, resulting in lower pH values (more acidity). The results indicated that a tendency for the percent of total acidity and vitamin C to increase values in comparison with the control samples. The values analyzed were consistent with the percentage of total acid content in the form of citric acid that is higher with the increase in vitamin C. Because mandarin is a good source of vitamin C. There was a tendency toward increased mandarin juice ratios when compared to the control samples due to the increasing in the amount of analyzed vitamin C.^{7,8,9} There was a tendency for lycopene values to decrease compared to the control sample due to the reduction of tomato juice mixed with mandarin juice. Organic acids (as citric acid) naturally occurring in many foods including citrus, such as orange and lime. Because of tomato and mandarin contains carotenoids as important pigment.¹⁹ In addition, tomato juice also contains more

β -carotene and lycopene than mandarin juice, which are derived from fruits that are yellow. When the body consumes tomato juice and mandarin juice, the body will be converted to β -carotene and carotenoids as vitamin A, containing organic acids such as citric acid, high malic acid, resulting in a sour taste.²⁰ The experiment with a large amount of mandarin juice has a high percentage of total acid content and low pH.²⁰ When considering the vitamin C obtained in each experiment, it indicated that the value was very similar and the value decreased from the initial value of 0.30-0.32 mg / ml. It was found that the measured value was in the range of 0.033-0.075 mg / ml, which there was not much lower value. This reduced value due to vitamin C is a water-soluble vitamin. With low stability, easy decomposition when exposed to light and air, heat, certain metal ions. The decomposition of L-ascorbic acid during the storage period causes oxidation of oxygen left in the headspace between the filling process, but the value is not much different, possibly due to the ratio between carrot juice and water.^{7,8,9,21} The lycopene showed a value of 1.134-1.835 mg / 100. The values decreased but not much. This is due to the heat used in the production process, resulting in the lycopene forming a thermal isomer, when natural carotenoids are in the form of trans. When heated or radiation

is changed a cis form which is more active in the reaction than trans form and will absorb light at a lower wavelength,²² resulting in a lower value. In addition, degradation due to oxidation reactions

as well as vitamin C changes. This loss depends on the amount of oxygen and light. The vitamin C decomposition can be left for a long time. It can be formed by trans-isomer.²³

Table 3: Mean score of preference for sensory properties of blended tomato juice and mandarin juice products

Experiment	scores*			
	color*	odor ^{ns}	taste*	overall acceptability*
tomato juice (control)	5.30 ^c	5.50	5.76 ^b	5.83 ^c
blended tomato juice and mandarin juice 90:10	6.43 ^b	5.90	6.27 ^{ab}	6.43 ^{bc}
blended tomato juice and mandarin juice 80:20	6.60 ^{ab}	5.93	6.30 ^{ab}	6.80 ^{ab}
blended tomato juice and mandarin juice 70:30	6.93 ^{ab}	6.07	6.93 ^a	6.97 ^{ab}
blended tomato juice and mandarin juice 60:40	7.33 ^a	6.17	6.93 ^a	7.23 ^a

Each value in the table are represented as scores. Statistically significant at $p < 0.05$, where $a < b < c < d$ in each column and ns non significant difference ($P > 0.05$)

Table 4: Effect of storage on vitamin C in blended tomato juice products and mandarin juice at different storage day

Experiment	vitamin C (mg/ml)/day		
	0 ^{ns}	7 [*]	14 [*]
tomato juice (control)	0.033	0.028 ^c	0.0038 ^c
blended tomato juice and mandarin juice 90:10	0.044	0.040 ^b	0.0081 ^b
blended tomato juice and mandarin juice 80:20	0.051	0.042 ^b	0.0086 ^b
blended tomato juice and mandarin juice 70:30	0.060	0.059 ^a	0.0089 ^{ab}
blended tomato juice and mandarin juice 60:40	0.075	0.063 ^a	0.0096 ^a

Each value in the table are represented as scores. Statistically significant at $p < 0.05$, where $a < b < c < d$ in each column and ns non significant difference ($P > 0.05$)

Sensory Evaluation

The tomato juice products mixed with mandarin juice in five Experiments (Table 3) were analyzed by using statistical methods. Based on the color, odor, taste and overall acceptability values. The results of the sensory analysis presented that there were differences in color, taste and overall acceptability (except taste). Therefore, to make the product of tomato juice mixed with mandarin juice mixed with aroma and taste more sour according to the increasing mandarin juice ratio.^{7,8,9,24} It can be seen that the ratio of tomato juice mixed with

mandarin juice in different ratios affected on the acceptance score in all aspects: color, taste and overall acceptability but did not affect on the smell. When considering the taste test scores, it can be seen that tomato juice mixed with mandarin juice 50:50 and 60:40 ratio, had the greatest acceptance from panelists, due to the addition of tomato juice and mandarin juice were appropriate scales. One possible reason might be due to the suitable proportion of tomato juice and mandarin juice was balance in taste and the taste is not too sour. But considering the overall acceptability, it can be

concluded that tomato juice mixed with mandarin juice at 60:40 ratio, the panelists had the highest total acceptance. This may have been due to the consumers preferred the tomato juice proportion more than a little mandarin juice. The sourness of both tomato juice and mandarin juice are not too much and give good taste. The flavor changes of both tomato juice and mandarin juice are very little.^{7,8,9,25}

The Vitamin C Contents In Blended Tomato Juice Products and Mandarin Juice at different Storage Day

Based on the results of the study, the storage time of the products at 4°C on the amount of vitamin C for a period of 14 days and analyzed vitamin C every 7 days. The products were stored until the day 14. The results indicated that the amount of vitamin C was less than 0.001 mg / ml. Vitamin C

content was decreased due to vitamin C is a water-soluble vitamin with low stability, can decompose easily when exposed to sunlight, heat, oxygen and some metal ions. In addition, the process of heat or pasteurization destroys vitamin C, resulting in faster decomposition if it is in the form of L-ascorbic acid. In addition, due to the duration of storage of the product, oxidation reactions may occur and may come from the remaining oxygen gas in the container during the filling process. Vitamin C is the main cause of many degradation. In addition, from the research results, it was found that during the day 0-7 of storage, the amount of vitamin C decreased rapidly in all storage temperatures. After that, the amount of vitamin C tended to decrease slowly. The cause due to vitamin C decomposition is associated with increased oxygen content and storage time significantly.^{7,8,9,26}

Table 5: Effect of storage on lycopene in blended tomato juice products and mandarin juice at different storage day

Experiment	lycopene (mg/100g)/day		
	0*	7*	14*
tomato juice (control)	1.835 ^a	10.821 ^a	10.386 ^a
blended tomato juice and mandarin juice 90:10	1.497 ^b	7.028 ^b	5.555 ^b
blended tomato juice and mandarin juice 80:20	1.400 ^{bc}	4.468 ^c	4.734 ^c
blended tomato juice and mandarin juice 70:30	1.279 ^{cd}	3.743 ^{cd}	1.279 ^d
blended tomato juice and mandarin juice 60:40	1.134 ^d	3.115 ^d	1.134 ^e

Each value in the table are represented as physical values. Statistically significant at $p < 0.05$, where $a < b < c < d < e$ in each column and ns non significant difference ($P > 0.05$)

Lycopene Contents in Blended Tomato Juice Products and Mandarin Juice at Different Storage Day

From the results of the study of the storage time of products at 4°C. On the amount of lycopene for 14 days each, the analysis of lycopene every 7 days showed that the amount of lycopene had the trend increased during the first 7 days of storage. After that it tended to decrease until the day 14. Possible reasons were tomatoes are bright red, have a high amount of lycopene, may turn into a dark red product, and the amount of lycopene found in concentrated tomatoes is usually lower than it actually is due to the loss during the production of lycopene has a large number of double bonds, which can predict

that there are two changes in the processing and storage of lycopene: isomerization. From isomers that are in all trans is in the form of mono-cis or poly-cis and oxidation reactions. Both of these reactions can occur simultaneously. Isomerization during heat processing, trans-cis isomerization of carotenoids can occur with the relationship between time and temperature in the storage period. There is no increased trans-cis isomerization reaction, but will have only the reaction of the reverse change trans and the reaction that can occur firstly, after which oxidation is the decomposition of lycopene from the oxidation reaction, which is a non-reversible reaction and will lead to degradation. Is the part of a small molecule, formed as acetone, methyl- heptinone,

levulinic acid, aldehyde, and it may be caused glyoxal, which causes the dilution of the visible color. With a smell like straw or grass, gradually appearing. This reaction depends on many factors, both physical and chemical, including the conditions of processing, moisture, exposure to oxygen, conditions with metal ions such as copper and iron. The presence of substances that activate or inhibit oxidation and fat compositions under strong acid-base conditions.²⁷

Conclusion

- The results of the physical properties and the chemical analysis showed that values (except +b value) and the pH and the lycopene were statistically significant differences ($P < 0.05$)
- Blended tomato juice and mandarin juice 60:40 gave the most taste and overall acceptability of 6.93 and 7.23 values, respectively from the panelists.
- Storage time had affected on quantity levels of vitamin C and lycopene values
- The researchers will be able to launch new

health drink products in the future by selecting the appropriate Thai local vegetables and fruits that are beneficial for antioxidants, an option for health-conscious consumers.

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Conflict of interest

The author declares that I do not have any conflict of interest.

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