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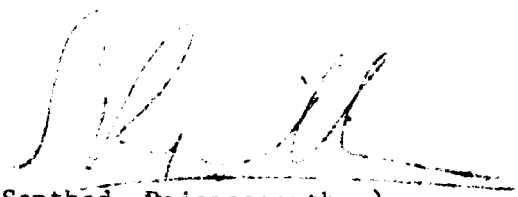

(Dr. Santhad Rojanasoonthon)

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ศึกษาการผลิตน้ำส้มเขียวหวานชนิดพร้อมดื่มและการทดลองตลาด

โดย รุจี วานิชยาการ, ศรีศักดิ์ ตรังวัชรกุล, วิวัธน์ ปฐมโยธิน,
อัจฉรียา แก้วม่วง และ อินทราวุธ ฉัตรเกษ

บทคัดย่อ

สถาบันวิจัยวิทยาศาสตร์และเทคโนโลยีแห่งประเทศไทย (วท.) ได้ทำการศึกษาการผลิตน้ำผลไม้จากส้มเขียวหวาน (tangerine) ชนิดพร้อมดื่มเป็นน้ำส้มเขียวหวาน 100% (natural tangerine juice) และชนิดที่เป็นน้ำส้มเขียวหวาน 50% (tangerine drink). ผลิตภัณฑ์น้ำผลไม้ทั้งสองชนิดนี้ได้ทดลองผลิตจากโรงงานต้นแบบของ วท.ที่มีกำลังการผลิตมากกว่า 1,000 กิโลกรัมต่อวัน (8 ชม.ทำการ).

ได้ศึกษาเปรียบเทียบการคั้นน้ำส้มด้วยเครื่อง automatic citrus press จากวัตถุดิบผลส้มที่มีขนาด 55-65 มม. ซึ่งได้ผลผลิตน้ำส้ม 42% กับเครื่องคั้นส้ม FMC ที่มีกำลังการผลิต 2-7 ตันต่อชั่วโมง ซึ่งเหมาะสมกับส้มที่มีขนาด 65-70 มม. และได้ผลผลิตน้ำส้มเขียวหวาน 56%.

การผลิตน้ำส้มเขียวหวานชนิด single-strength natural tangerine juice กับชนิดเจือจาง 50% (tangerine drink) ในระดับโรงงานต้นแบบจะมีต้นทุนการผลิตที่คิดจากการผลิต 30 ครั้ง. สำหรับ single-strength natural tangerine juice บรรจุในถังพลาสติกขนาด 20 และ 11.5 ลิตร และขวดแก้วขนาด 250 ซีซี จะมีต้นทุน 16.19-23.95, 17.05-24.07, 27.09-34.0 บาท ตามลำดับ ซึ่งคิดจากวัตถุดิบผลสดที่มีราคา 3 บาท ถึง 6.50 บาทต่อกิโลกรัม.

น้ำส้มเขียวหวานทั้งสองชนิดนี้ วท. ได้ทำการผลิตให้กับบริษัทเอกชนตามคำขอเพื่อนำไปทดลองตลาดหลายครั้ง. นอกจากนี้ยังผลิตเพื่อจำหน่ายในงานกาชาดและงานสัปดาห์วิทยาศาสตร์แห่งชาติหลายครั้งเช่นกัน โดยที่ได้รับการยอมรับจากผู้บริโภคเป็นอย่างดี.

STUDY ON PRODUCTION AND MARKET TRIAL OF TANGERINE JUICE

By Ruchie Wanichayakarn*, Srisuk Trangvacharakul*, Wiwat Pathomyothin*, Auchareeya Kaewmong* and Inthrawut Chatket*

ABSTRACT

The process of natural tangerine juice and 50% tangerine drink was developed by TISTR. The production equipments for pilot scale were also set up. Its production capacity is about 1,000 kg tangerine per day which yielded 42% of tangerine juice when extracted by the automatic citrus press extractor. The suitable tangerine size for the automatic citrus press extractor is 55-65 mm. The performance of the FMC citrus juice extractor which has the capacity of 2-7 tonnes tangerine per hour was also studied. The yield of juice extracted is 56%. The suitable tangerine size for the FMC citrus juice extractor is 65-70 mm.

The production costs of single-strength natural tangerine juice and 50% tangerine drink were calculated from pilot scale production data of more than 30 batches. The production cost of single-strength natural tangerine juice packed in 20 litres, 11.5 litres, and 250 cc glass bottle are 16.19-23.95, 17.05-24.07 and 27.09-34.0 baht per litre respectively when the price of fresh tangerine varies from 3.00 to 6.50 baht per kg.

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TISTR has occasionally sold tangerine juice and 50% tangerine drink packed in 20-litre plastic bottle and 250 cc glass bottle to private companies according to requests. Besides, TISTR has also sold natural tangerine juice with one-way bottles for take home in various fairs such as Red Cross Fair, Technology Fair, etc. Both natural tangerine juice and 50% tangerine drink are well accepted.

1. INTRODUCTION

Tangerine is mostly grown in the central part of Thailand. The fruit can be harvested at the maturity stage from 9 months to 10 months.

The harvesting seasons will be divided into two periods, i.e., November to January as yearly peak season and during March to May as late season. During late season, the produces are quite low because it is a summer time of Thailand. But, at present some growers can control their tangerine production by irrigation, hormones and fertilizer usage. They can also control their production at suitable time to get higher price of their produces.

Nowadays, Pathum Thani province is the biggest tangerine cultivated area in Thailand. During peak season in November to January, the estimated tangerine production in this area is about 1,000 tonnes per day. Therefore, the cultivated area in Pathum Thani province was surveyed as the potential raw material source for commercial production. The quantity, the quality, the price and the characteristics of tangerine were examined and analyzed as the basic information for natural juice production.

The production equipments for pilot scale were set up at the capacity of 1,800 kg tangerine fruits. The process of natural tangerine juice and 50% tangerine drink was developed by TISTR. The production cost of single-strength natural tangerine juice and 50% tangerine drink packed in various package was estimated. At the same time, the acceptability test and premarket test were also conducted.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Tangerine (Citrus recticulata)
2.1.2 Sodium hydroxide solution
2.1.3 Refractometer
2.1.4 Automatic burette
2.1.5 pH meter
2.1.6 Colour identification equipment
2.1.7 Tangerine juice extractors
2.1.8 Strainer
2.1.9 Plate heat exchanger
2.1.10 Mixing and holding tanks
2.1.11 Automatic filling and capping machine
2.1.12 Shrink-film wrap tunnel

2.2 Methods

2.2.1 Survey of tangerine orchards. The sampling plan is as follows:

2.2.1.1 One hundred and seventy tangerine orchards in Pathum Thani province were surveyed by random from four districts.

2.2.1.2 Sixty of the large tangerine orchards were selected as the representative samples to cover the whole cultivated area in Pathum Thani province. The tangerine fruit samples at the age of 6-7, 8-9, 10-11 and 11-12 months were separately collected at the same period from the selected orchards. The samples were analyzed for their total titratable acidity, total soluble solids, and colour for the whole year.

2.2.1.3 Determination of total titratable acidity in tangerine juice.

2.2.1.4 Colour identification of tangerine fruit juice.

2.2.2 Natural tangerine juice and 50% tangerine drink are produced as following steps:

2.2.2.1 Washing and grading
2.2.2.2 Extraction
2.2.2.3 Finishing
2.2.2.4 Sweetening and blending
2.2.2.5 Sterilization
2.2.2.6 Filling/capping and packing

2.2.3 Acceptability and premarket test

2.2.3.1 Acceptability test: The tangerine juice samples were distributed free of charge to TISTR's staff and also customers in Red Cross Fairs. Those taste panels were asked to fill their comments and organoleptic score in the hedonic scale.

2.2.3.2 Premarket test: TISTR sold the products to private sectors and requested for the results of acceptance by the public. Besides, TISTR also sold the products directly to consumers.

3. RESULTS AND DISCUSSIONS

From the preliminary survey of tangerine orchards in Pathum Thani province, the tangerine juice from 170 samples were analyzed. The total soluble solids content, total titratable acidity and its pH value are shown in Table 1.

After the preliminary survey, sixty of the large tangerine orchards had been selected for chemical properties analysis of tangerine production for the whole year in order to see the seasonal and the fruit maturity effects on tangerine juice quality.

The results of juice analysis were shown in Figures 1, 2 and Table 2. It can be concluded that in summer the tangerine juice samples are higher in Brix and acid ratio than in rainy harvesting season. The total soluble solids content of the juice in summer is mostly in the range of higher than 10^{o} Brix, and the total titratable acidity is in the range of 0.3-0.9 percent as citric acid. However, in the rainy harvesting season, the total soluble solids content of the juice samples are mostly in the range of lower than 10^{o} Brix, and the total titratable acidity is in the range of 0.2-0.45 per cent as citric acid. For the colour identification (Table 2), in the rainy harvesting season, the colour pigment is lower than the tangerine juice sample in summer harvesting season due to higher yield of the juice.

Most of the tangerine from Pathum Thani province will be bought by the middle men from the Rangsit wholesale market. They will come to buy the fruit at the orchards. The whole fruit will be graded by a sizing machine into 6 sizes according to its diameter (Table 3).

TABLE 1. PROPERTIES OF TANGERINE JUICE IN PATHUM THANI PROVINCE FROM THE PRELIMINARY SURVEY

District	Total soluble solids content	Total titratable acidity	Average pH value	Colour identification
	Average value (^{o}Brix)	Average value (% as citric acid)		Range of colour[1/] (hue)
Nong Sua (70 samples)	10.8	0.39	4.4	6.0-8.49 YR
Klong Luang (38 samples)	10.5	0.38	4.6	6.0-8.49 YR
Tanyaburi (26 samples)	10.5	0.43	4.5	5.5-8.49 YR
Lam Luk Ka (36 samples)	9.8	0.35	4.6	5.5-8.49 YR

[1/] Value = 7.6-8.0, Chroma = 11.9-13.0

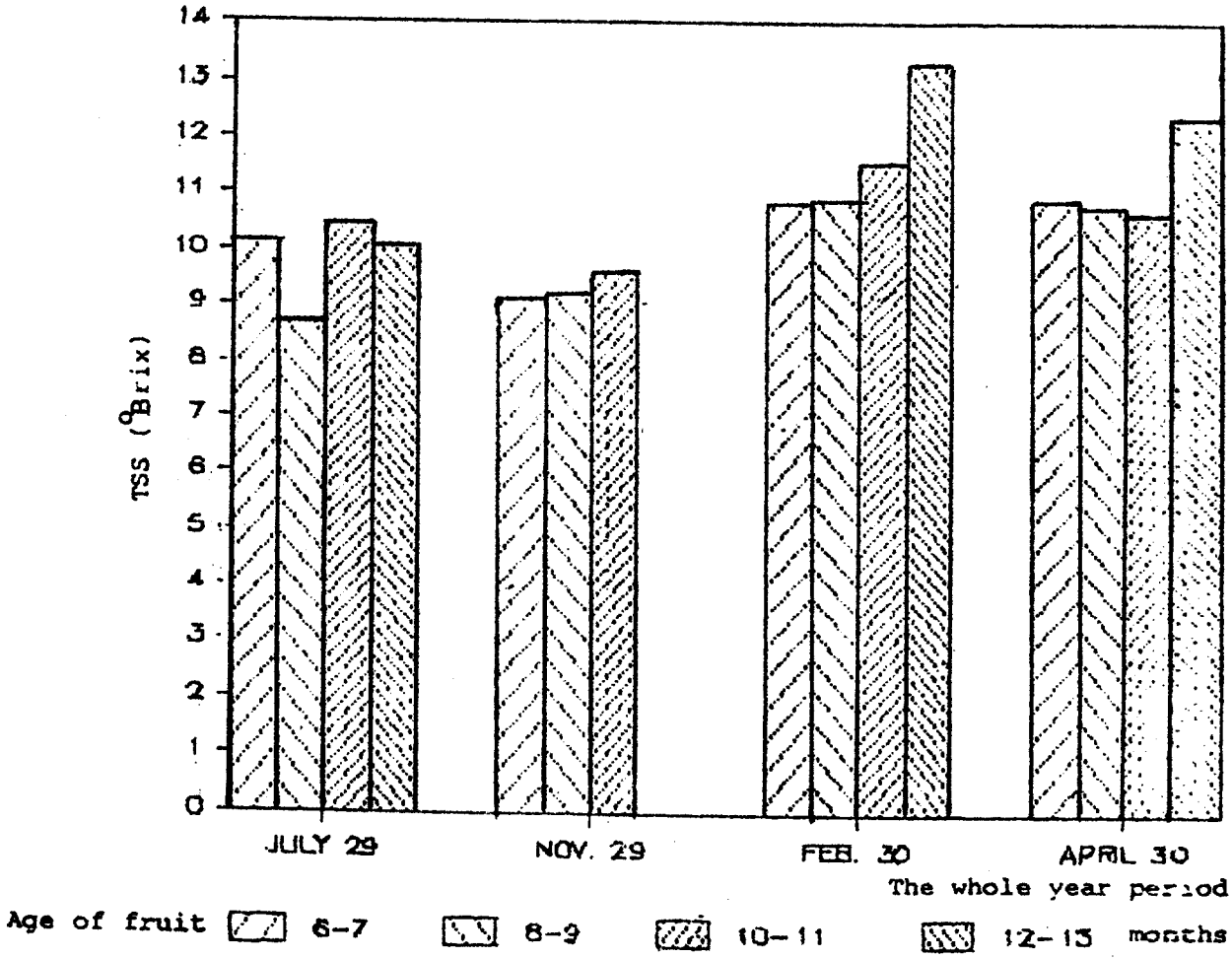

Figure 1. Total soluble solids (TSS) content of tangerine juice in Pathum Thani province for the whole year survey.

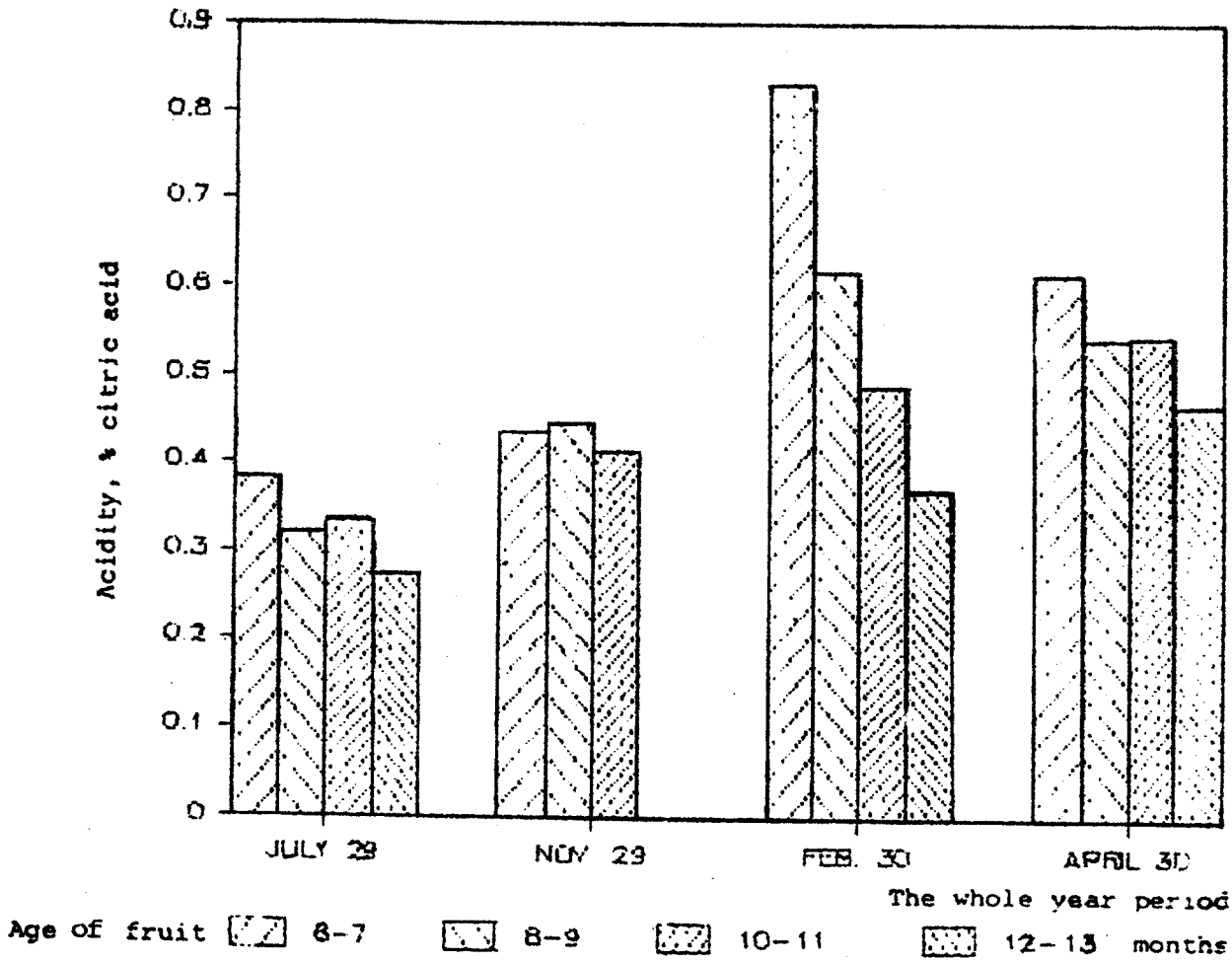

Figure 2. Titratable acidity of tangerine juice in Pathum Thani province for the whole year.

TABLE 2. COLOUR IDENTIFICATION OF TANGERINE JUICE IN PATHUM THANI PROVINCE FOR THE WHOLE YEAR

Period	Colour identification[1] (hue/value/chroma)			
Fruit age (month)	July, 86	November, 86	February, 87	April, 87
6-7	6.7 YR 7.1/12.3	5.5 YR 6.8/14.1	7.5 YR 7.3/13.0	6.8 YR 6.9/13.4
8-9	6.6 YR 7.1/12.1	6.1 YR 6.8/13.8	6.9 YR 7.0/13.4	7.2 YR 6.9/13.3
10-11	6.4 YR 6.9/12.7	6.0 YR 6.8/13.8	6.5 YR 7.1/13.6	7.1 YR 7.0/13.5
12-13	6.6 YR 7.0/12.3	N/A	5.7 YR 6.8/13.6	6.0 YR 6.9/13.7

[1] Munsell colour notation equipment

TABLE 3. GRADING OF TANGERINE FROM PATHUM THANI PROVINCE BY A SIZING MACHINE

No.	Distribution in various sizes[1] (%)							Ratio of fruit size[2] small medium large		
	Size no (diameter in mm)									
	#3 (45)	#2 (45)	#1 (50)	#0 (55)	#00 (60)	#000 (65)	#0000 (65)			
1	6.8	17.4	28.7	20.2	15.6	0.6	10	24	60	16
2	4	20	30	30	10	5	10	24	60	16
3	13.7	17.1	31.5	16.1	1.2	21	5	30	40	26
4	10	10	30	25	25	-	-	20	55	25
5	7.5	10	25	30	27.5	-	-	18	55	27
6	5.7	11.8	22.6	27.8	22.4	1.5	7.6	20	50	30
7	4.5	10	25	25	25	10	5	15	50	35
8	-	12.5	15	30	30	3.8	8.7	25	40	35
9	5	10	10	25	25	25	-	15	35	50
10	1.7	8.3	16.7	16.7	33.3	16.7	6.6	10	35	50
Average, %	5.9	12.7	23.4	25.5	21.6	8.3	3.5	19.4	49.6	31.0

[1] From middle man in the wholesale market, average production 9-17 tonnes per person

[2] Ratio of fruit size calculated from percentage by weight.

The price of mix sized fruits from the cultivated area is between three to eight baht per kilogram. During April to May, the price will be lowest because it is the peak season for many kinds of fruits in Thailand.

The properties of the most acceptable juice were shown in Table 4. After that TISTR cooperated with the private company to conduct the organoleptic test of the natural tangerine juice. The results showed that the products were well accepted by the consumers.

TISTR has set up a pilot scale for tangerine production at the capacity of 1 tonne tangerine fruits for 8 working hours. The fixed cost of this pilot scale, when the FMC citrus juice extractor is used, is 3,213,000.- baht while the fixed cost of this pilot scale is 1,559,000.- baht, when the Game automatic citrus press extractor is used. From the experiments, it can be concluded that FMC citrus juice extractor has higher extraction rate than that of Game automatic citrus press extractor. The disadvantage points of FMC citrus juice extractor is that suitable tangerine size for FMC extractor is ranging from 65-70 mm in diameter which has only 10.9 percent of the tangerine fruits production (as shown in Table 3). The oil content and the bitter taste in raw juice extracted from different sizes of tangerine by FMC citrus juice extractor were also studied, the results were shown in Table 5. The minimum amount of tangerine (60-65 mm) to be extracted by FMC citrus juice extractor must be 300 kg per lot in order to obtain the maximum yield of juice extract which is equal to 56.14 percent (as shown in Table 6). The average yield of tangerine juice extracted by Game automatic citrus press extractor is 42 percent.

TABLE 4. PROPERTIES OF SINGLE-STRENGTH NATURAL TANGERINE JUICE AND 50% TANGERINE DRINK FINISHED PRODUCTS

Items	Single-strength natural tangerine juice	50% tangerine drink
Total soluble solids content	(1) 12.5° ± 0.5° Brix (2) 15° ± 1° Brix	15° ± 1° Brix
Total titratable acidity (as citric acid)	0.5 ± 0.05	0.5 ± 0.05
pH	4.3-4.4	4.0-4.1
Vitamin C	26 mg/100 g	4-19 mg/100 g
Colour[1]	9.2 YR-7.3/12.9	8.4 YR-7.2/13.1
Oil content	0.011% 0.027%	-
Shelf life	Keep in glass bottles about 30°C 3 months, still acceptable	Keep in glass bottles Temperature about 30°C 3 months, still acceptable

[1] Munsell colour notation equipment

TABLE 5. COMPARING THE QUALITY AND QUANTITY OF RAW TANGERINE JUICE EXTRACTED FROM DIFFERENT SIZES OF TANGERINE BY FMC CITRUS JUICE EXTRACTOR

Diameter of tangerine (mm)	Yield of raw tangerine juice (%)	Oil content (ppm)	Bitter taste in raw juice
>45-50	-	350-418	Strong
55-60	57.08	202-280	Can be detected
65-70	59.20	148-158	Can not be detected

TABLE 6. COMPARING THE YIELD OF TANGERINE JUICE FROM DIFFERENT AMOUNT OF RAW MATERIALS BY FMC CITRUS JUICE EXTRACTOR

Amount of tangerine for each lot manufacturing (kg)	Waste (kg)		Yield of pure juice	
	Peels	Pulp & core	Litre	%
150 (60-65 mm)	57.94	16.77	1/ 54.87	36.59
300 (60-65 mm)	107.80	17.68	2/ 168.40	56.14

1/ This data averages from 8 lots of production.

2/ This data averages from 5 lots of production.

The production cost of single-strength natural tangerine juice and 50 percent tangerine drink packed in different sizes of packaging were calculated from pilot scale production data of more than 30 test runs. The results shown in Table 7 can be concluded that the production cost of natural tangerine juice is higher than that of 50 percent tangerine drink about 20 percent in every type of packaging.

TISTR conducted several premarket tests by directly selling both natural tangerine juice and 50 percent tangerine drink to consumers in various fairs. The selling price is 10 baht for one 250 ml glass bottle of natural tangerine juice and 4 baht for one take away cup filled with 100 ml tangerine juice with a half cup of crushed ice. The juice is well accepted in both types of packaging. Five companies bought the products from TISTR and conducted their own premarket tests of which one was run in Hongkong and Tokyo and the other four were run in Bangkok. The feed back information from those private companies indicated that the natural tangerine juice packed in glass bottle was well accepted by consumers at the price of 10 baht. Premarket test as a take away drink was also well accepted. There is a demand of natural tangerine juice from hotels in the city, approximately 80 litres per day per hotel. The TISTR's tangerine juice quality is much better than that of hotel in terms of flavour, colour, and sedimentation. However, the hotel manager complained about the high price when TISTR proposed for 30 baht per litre. The acceptable price for hotels is between 25-26 baht per litre.

TABLE 7. PRODUCTION COST FOR SINGLE-STRENGTH NATURAL TANGERINE JUICE AND 50% TANGERINE DRINK IN DIFFERENT KINDS OF PACKAGING

Condition / Items	Tangerine at high limited price 6.5 baht/kg						Tangerine at lowest price 3 baht/kg					
	Single-strength natural tangerine juice			50% tangerine drink			Single-strength natural tangerine juice			50% tangerine drink		
Style of packaging	20 l (unit)	11.5 l (unit)	250 cc (bottle)	20 l (unit)	11.5 l (unit)	250 cc (bottle)	20 l (unit)	11.5 l (unit)	250 cc (bottle)	20 l (unit)	11.5 l (unit)	250 cc (bottle)
Direct & indirect materials cost 1/ (baht/l)	344.80	199.99	6.82	216.60	218.60	5.22	204.8	119.12	5.08	114.80	84.56	4.33
Total manufacturing cost (baht/l)	134.20	77.30	1.68	134.20	77.30	1.68	134.2	77.30	1.68	134.2	77.30	1.68
Total production cost (baht/unit)	479.00	277.29	8.50	350.8	295.90	6.9	339.0	196.42	6.76	279.0	161.86	6.01
Total production cost (baht/l)	23.95	24.07	34.0	17.54	17.64	27.6	16.95	17.05	27.09	13.95	14.05	24.04

1/ Data from the year of 1986 to 1988

4. CONCLUSIONS AND RECOMMENDATIONS

In order to produce good quality of natural tangerine juice, the quality of raw material must be controlled. The maturity of fruit must be at least 10 months before harvesting. There is also the seasonal effect on the tangerine juice quality. The price of tangerine in the wholesale market varies according to the demand and supply. Therefore, the factory which has its own orchards can easily control the price, supply, and quality of raw materials to be more consistent all the year round. While the factory which relies on the wholesale market needs to have a long term purchase in order to ensure constant price, supply and quality of raw materials, however, there is a period of two months between August and September when the quality of tangerine juice is worst due to the early harvesting. During this period there is large demand of tangerine so the price is very high but the tangerine is still immature. Therefore, stocking the products in cold room or in concentrated form is needed.

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