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Quality and Consumer Acceptance of Ready to Drink Horse Mango (*Mangifera foetida* Lour.) Juice

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Abstract

Horse mango (*Mangifera foetida* Lour.) fruit is rich in nutrition and is characterized by soft pulp-like mango that is suitable to prepare for ready-to-drink juice. The purpose of this study was to examine the physical properties, chemical properties, microbiological test, sensory evaluation and consumer acceptance test of the horse mangoes' pulp and juice. Ready-to-drink Horse mango juice with 3 concentrations of pulp (20, 40 and 60%) was pasteurized and poured into glass bottles. The results showed that the physical properties of Horse mango pulp were observed at L*(68.78), a*(-13.24), b*(50.26), pH (3.37) and Total Soluble Solids (15.17 ^{o}Brix). The content of chemical quality of Horse mango pulp reported carbohydrate, protein, fat, ash, vitamin C per 100 g of pulp as 12.67 g, 0.74 g, 0.48 g, 0.95 g, 29.98 mg, respectively and beta-carotene as 0.86 mg/kg. In reference to the Horse mango juice, the result of the coloring content was shown as b* values (yellowness) increased with a higher amount of Horse mango pulp related to beta-carotene (the yellow pigment). The microbiological content of the 3 concentrations of Horse mango juice aligned to the Thai Community Product Standard (TCPS) 701/2557 because of pasteurization (90 °C 10 min) during the juice productions. The ready-to-drink at 40% of Horse mango juice received the highest score on all attributes (color, odor, flavor, taste and overall liking) and was analyzed for chemical content; carbohydrate, protein, fat, ash, vitamin C per 100 g of juice as 21.50 g, 2.27 g, 0.04 g, 0.33 g, 10.29 mg, respectively and beta-carotene content as 0.61 mg/kg. For the acceptance of 100 consumers, consumer accepted 70% of juice products and decided to buy ready-to-drink Horse mango juice products at 66%. However, many consumers are still unfamiliar with Horse mango therefore adding another juice for example, pineapple and orange juices could obtain more acceptance.

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Introduction

Thailand is a Southeast Asian country located in the tropics which has a great diversity of fruits (Baimai, 2010). Horse mango (*Mangifera foetida* Lour.) is a plant belonging to the Anacardiaceae family and is in the genus *Mangifera,* the same as mango (*Mangifera indica* L.). Horse mango is a native plant native to Southeast-Asian countries which is found in several countries such as Thailand, Malaysia and Indonesia. For Thailand, it is known as mamujt or malamut or maa-chang or ma chae and in Malaysia and Indonesia as bacang or limus or macang (Orwa et al., 2009). Horse mango fruit is oval-shaped and the peel is green in color and changes to yellow when ripe while the flesh is orange-yellow with a sour and sweet flavor. Horse mango has a strong unique smell and a rough texture (Wong & Ong, 1993). Horse mango fruit is indicated to have rich nutrients and phytochemicals such as carbohydrate (17.9 %), protein (0.8%), vitamin C content (47.4 mg/100 g), calcium (16 mg/100 g), phosphorus (19 mg/100 g), thiamine (0.09 mg/100 g), carotenes (0.255 mg/100 g) and antioxidant capacity (31.53 – 97.30%) (Tyug et al., 2010; Ikram & Khairul, 2009). Mostly, Horse mango is grown in southern Thailand and immature fruit is used as an ingredient for traditional food like yellow curry and salads "Yum Ma-Mut". The ripe fruit can be eaten fresh and to a lesser extent to process for other products. However, previous studies revealed the products from horse mango fruit as horse mango powder product, horse mango fiber products, horse mango jam and horse mango sherbet ice cream (Tyug et al., 2010; Palasuwan & Sapbua, 2020; Nuwongsri et al., 2021). A prior report showed that 55% of horse mango jam received the best on color, odor, flavor and overall liking and 97% of consumers accepted the jam while 76% of consumers decided to buy horse mango jam (Palasuwan & Sapbua, 2020). The consumer acceptance is important to note that the method of the study allows for evaluating from the consumer point of view about new products that a high level of acceptance leads to rationalization, causing consumers to be more likely to approve of new products (Bos et al., 2013).

Fruit juice is the liquid contained in fruit which is prepared by squeezing fruit flesh. The fresh fruit juice is safe for drinking within a day but when the juice is heated or pasteurized, it can prolong product shelf-life by inhibiting microbial and enzyme activity (Deak, 2014). In addition, fruit juices are an important source of vitamins and minerals (Islam et al., 2015). After the COVID-19 Pandemic, the trends in fruit juice consumption reported that fruit juice consumption increased to support health and immunity. During the 10-year period (2012 – 2021), fruit juice products were produced in Thailand and sold second in the world after China (Trade Policy and Strategy Office, Ministry of Commerce, 2022). The report revealed carotenoids boost immunity facing COVID-19 and related symptoms (Khalil et al., 2021) According to research the advantage of vitamin C as a primary prevention of COVID-19 due to vitamin C being essential for the proper functioning of the immune system (Colunga Biancatelli, et al., 2020). Therefore, the consumption of fruits or fruits juice which have carotenoids and vitamin C has positive affects for health. Ready-to-drink horse mango juice is another alternative for consumers who are concerned about health. The development of ready-to-drink horse mango juice adds value to local fruits which are highly nutritious as well as helping to conserve local plants. Thus, the objective of this study was to examine the physical properties, chemical properties, microbiological test, sensory evaluation of the horse mango pulp and Horse mango juice and consumer acceptance test for commercial usage in the future.

Materials and methods

1. Plant materials preparation

Horse mango used in this study were sampled from local markets and farms located in Trang, Phatthalung, and Nakhon Si Thammarat provinces in Southern Thailand. Fruits were collected in size (8-10 cm.) and at physiological maturity (20% yellow peel) shown in Fig. 1. The whole fruit was washed under running tap water to remove dirt and insects, peeled and washed again to clean Horse mango pulp from rubber. The Horse mango pulp was cut into small pieces by a knife and

Fig. 1 The characteristics of horse mango's 20 % yellow peel and pulp

blended with a blender (HR2195, PHILIPS, China) until smooth and filtered by 60-mesh sieve to become pulp for drinking.

2. Preparation of Horse mango juice

Ready-to-drink Horse mango juice was subjected to different levels of concentration 20%, 40% and 60% and the ingredients are presented in Table 1. The process of juice from Horse mango pulp are shown in Fig. 2.

Table 1 The ingredients of horse mango juice

Ingredient (g)	Horse mango juice		
	20 %	40%	60%
Horse mango pulp	20.0	40.0	60.0
Water	65.4	45.4	25.4
Sugar	14.4	14.4	14.4
Citric acid	0.2	0.2	0.2

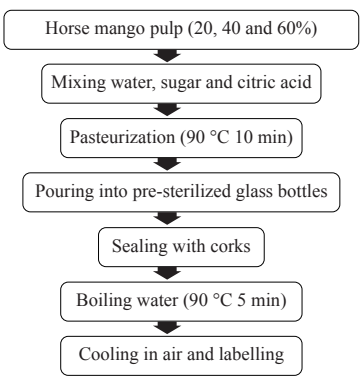

Fig. 2 The process of horse mango juice

3. Quality of Horse mango pulp and Horse mango juice

3.1 Physical properties

3.1.1 Determination of color

Reflected color measurement of pulp was measured using Colorimeter (Minalta CR-410 Series, Konica Minolta, lnc., Japan). For all 3 levels of Horse mango juice was performed using Colorimeter (Minalta CR-410 Series, Konica Minolta, lnc., Japan) in combination with the sample holder CR-A505 and specimen holder CM-A96 and a glass cell 10 mm CM-A98.This method followed by Guzel-Seydim et al. (2021) by The CIELAB L* a* b* system. Results were reported as an average of individual values as L* (lightness), a* (+a =red, -a = green) and b*(+b = yellow, -b = blue).

3.1.2 Determination of TSS

Total soluble solid (TSS) of Horse mango used a hand refractometer (ATAGO MASTER-M, China) (AOAC., 2000).

3.1.3 Determination of pH

The pH value of Horse mango was measured using the digital pH meter (Seven Compact, Mettler Toledo, Switzerland).

3.2 Chemical quality

3.2.1 Determination of carbohydrate, protein, fat and ash content

The major compound content of Horse mango pulp as protein, fat and ash were determined by AOAC (2016), official method 920.152, 954.02 and 923.03, respectively and carbohydrate was determined by method of Sullivan & Carpenter (1993).

3.2.2 Determination of vitamin C content

Determination of ascorbic acid or vitamin C content was modified from Furusawa & Kishida (2001) and Mazurek & Jamroz (2015). Each standard ascorbic acid solution was prepared using 10 mg, mixed in 100 mL of distilled water and using the HPLC mobile phase for dilution of the desired solution. HPLC system was equipped with a photo-diode array detector (Shimadzu, Kyoto, Japan), Josco PU-980 HPLC pump (Jasco, Tokyo, Japan) and a column thermostat. Separations were made using a column (250 x 4.6 mm^2 i.D.). The mobile phase was set as flow rate of 1.0 mL/min at room temperature. The injection volume was 20 µL using 1 mL of a sample and the samples are expressed as vitamin C.

3.2.3 Determination of Beta-carotene content

Beta-carotene content was analyzed by high-performance liquid chromatography (HPLC) with a diode-array detector (DAD) (HPLC-DAD) (Britton et al., 2004). Two grams of horse mango samples were homogenized and ethanolic KOH was added for saponification. After that, the samples were extracted with hexanes, hexanes were washed with water for 2-3 times until neutralize, then dried with a vacuum on the water bath and reconstituted with buffer solution. The samples solution was measured for beta-carotene by HPLC-DAD. The beta-carotene content was calculated from the area under the peak of the absorbance and compared with the standard solution.

3.3 Microbiological test

Microbiological test of Horse mango juice was determined according to Thai Community Product Standard; TCPS (ICS 67.160.20) by total plate count, *Salmonella* spp., *Staphylococcus aureus, Bacillus cereus, Clostridium perfringens* and yeast and mold by FAD

BAM, *Escherichia coli* and coliform by MPN (Maturin & Peeler, 2001).

3.4 Sensory evaluation

The sensory evaluation of horse mango juice was performed using the 9-point hedonic scale. Fifty untrained panelists evaluated their preference of quality attributes including color, odor, flavor, taste and overall liking. The 9-point hedonic scale was used as 9 like extremely, 8 like very much, 7 like moderately, 6 like slightly, 5 neither dislike nor like, 4 dislike, 3 dislike moderately, 2 dislike very much and 1 dislike extremely (Resurreccion, 1998).

4. Consumer acceptance test

The best score of the horse mango juice from the sensory test was evaluated for consumer acceptance test using the 5-point hedonic scale in terms of color, odor, taste and overall liking (Lawless & Heyman, 2010). The 100 consumers were chosen randomly at Huay Yod District, Trang Province.

5. Statistical analysis

Completely randomized design (CRD) was performed to study the quality of Horse mango pulp and Horse mango juice on the physical and chemical properties. The experiments were done in triplicate. The randomized completely block design (RCBD) was performed to study the quality of Horse mango juice on sensory properties. The results were presented as mean values ± standard deviations (S.D.). The statistical analysis used SPSS software (SPSS Version 17; SPSS Inc., Chicago, USA). Analysis of variance (ANOVA) with Duncan's New Multiple's Range Test (DMRT). The differences were determined to be statistically significant at $p < 0.05$.

Results and discussion

1. Quality of Horse mango pulp and Horse mango juice

1.1 Quality of Horse mango pulp

The appearance of Horse mango pulp appeared a yellow color when it was ripening, the texture of Horse mango pulp was similar to the mango pulp as illustrated in Fig. 3 and the physical properties of Horse mango pulp are shown in Table 2. The pH value and the TSS content of Horse mango pulp were 3.37 and 15.17 °Brix, respectively. According to previous studies, the pH value and the TSS content of pulp of six mango varieties were in the range of 3.33-4.75 and 11.90 – 17.06 °Brix (Bekele et al., 2020). The color expressed L*(lightness), a*(redness) and b*(yellowness) value as 68.78, -13.24 and 50.26, respectively. The Horse mango pulp appeared yellow because of the ripening process of the fruit. The chlorophyll (green) was degraded while the carotenoids (yellow) exposed more vivid (Sriwimon & Boonsupthip, 2011).

The chemical properties of horse mango pulp reported as carbohydrate, protein, fat, ash, vitamin C and beta-carotene content as 12.67 g/100 g, 0.74 g/100 g, 0.48 g/100 g, 0.95 g/100 g, 29.98 mg/100 g and 0.86 mg/kg, respectively (Table 2). In a prior study, bacang or Horse mango (*Mangifera foetida*) grown in Malaysia was analyzed with 100 g of edible portion, it contained carbohydrate, protein, fat, ash, vitamin C and carotene content as 17.9, 0.8, 0.21, 0.66, 0.047 and 0.0003 g, respectively (Tyug et al., 2010; Salma et al., 2008). In this study, vitamin C and beta-carotene content of Horse mango pulp reported lower than the prior study due to the variation of growing condition of each country such as climate, soil, water and light exposure that influence the antioxidant component (vitamin C and beta-carotene) (Ikram & Khairul, 2009). Thepyotin et al. (1999) reported vitamin C and beta-carotene content of *Mangifera indica* L. cv. 'Mahachanok' mango pulp as 0.469 g/100 g and 7.830 µg/g which is more than this study's vitamin C and beta-carotene content of horse mango pulp because it is a different species of fruit although it is a same genus of planet.

Fig. 3 Characteristics of Horse mango pulp

Table 2 Physical and chemical properties of horse mango pulp

Quality	Quantity
Physical	
Total soluble solid (°Brix)	15.17 ± 0.29
pH	3.37 ± 0.12
L*	68.78 ± 0.21
a*	-13.24 ± 0.99
b*	50.26 ± 0.97
Chemical	
Carbohydrate (g /100g)	12.67 ± 0.06
Protein (g /100g)	0.74 ± 0.03
Fat (g /100g)	0.48 ± 0.04
Ash (g /100g)	0.95 ± 0.02
Vitamin C (mg /100g)	29.98 ± 0.34
Beta-carotene (mg /kg)	86.00 ± 0.0

Table 3 Physical and chemical properties of Horse mango juice

Horse mango juice	Physical properties			Chemical properties	
	L*	a*	b*	Vitamin C (mg /100g)	Beta-carotene (mg/kg)
Horse mango 20%	70.80 ± 0.68[a]	-1.95 ± 0.05[a]	15.3 ± 0.46[c]	3.13 ± 0.13[c]	0.48 ± 0.01[c]
Horse mango 40%	61.97 ± 0.53[b]	-2.10 ± 0.08[ab]	27.43 ± 0.26[b]	10.29 ± 0.04[b]	0.61 ± 0.01[b]
Horse mango 60%	56.21 ± 0.31[c]	-2.31 ± 0.22[b]	35.93 ± 0.08[a]	17.35 ± 0.05[a]	1.08 ± 0.01[a]

Remark: The results were expressed as average ± standard deviation. The difference letters represented significant difference at $p < 0.05$

1.2 Quality of horse mango juice

1.2.1 Physical and chemical properties

The physical and chemical properties of horse mango juice are shown in Table 3, lightness (L* values) decreased and yellowness (b*) increased which were significantly different at $p < 0.05$ with a higher concentration of Horse mango pulp. Beta-carotene content of all Horse mango juice increased with a higher amount of Horse mango pulp and was significantly different at $p < 0.05$. This result was similar to the result of Thepyotin et al. (1999) study on consumer acceptance and quality of ready-to-drink Mahajanaka mango juice. In that study the result showed mango juice had beta-carotene content and it increased with a higher amount of mango pulp. The content of beta-carotene related to b* values (yellowness) since the yellow pigment in fruit pulp was carotenoid (Sriwimon & Boonsupthip, 2011). The vitamin C content of juice with Horse mango pulp at 20% 40% 60% were 3.13, 10.29 and 17.35 mg /100g, respectively. This result infers that as added Horse mango pulp increased in the juice then the vitamin C content also increased. However, the vitamin C content of all Horse mango juice is lower than the fresh Horse mango fruits (29.98 mg /100g). Ascorbic acid or vitamin C is known to be sensitive to heat treatment. This was found when the fresh Chokanan mango juice showed ascorbic acid as 8.91 mg/mL and when heat was transferred to the juice the ascorbic acid was 3.10 mg/ml (Santhirasegaram et al., 2013). In this study, the Horse mango juice was treated with heat (90°C 10 min) to increase the ascorbic acid losses. In addition, vitamin C is beneficial to human health because it is an antioxidant that prevents humans from oxidative stress (Stevens et al., 2007).

1.2.1 Microbiological examination

Microbiological examination of Horse mango juice was inspected according to Thai Community Product Standard (TCPS) 701/2557. The result showed that the amount of micro-organism in all 3 concentrations of the pasteurized horse mango juices products were not exceeding the standard (Table 4).

Table 4 Microbiological quality of Horse mango juice

Microbiological	TCPS standard 701/2557	Horse mango juice		
		20%	40%	60%
Total plate count (CFU/mL)	Less than 1	Less than 1	Less than 1	Less than 1
Salmonella (CFU/mL)	Not detected	Not detected	Not detected	Not detected
Staphylococcus aureus (CFU/mL)	Less than 1	Less than 1	Less than 1	Less than 1
Bacillus cereus (CFU/mL)	Less than 1	Less than 1	Less than 1	Less than 1
Clostridium perfringens (CFU/mL)	Less than 1	Less than 1	Less than 1	Less than 1
Escherichia coli (Per 100 mL)	Not detected	Not detected	Not detected	Not detected
Coliform (Per 100 mL)	Less than 1	Less than 1	Less than 1	Less than 1
Yeast and mold (CFU/mL)	Less than 1	Less than 1	Less than 1	Less than 1

1.2.2 Sensory test

Sensory evaluation of Horse mango juice on color, odor, flavor, taste and overall liking and the final score of 50 panelists are illustrated in Table 5. The Horse mango juice that received the highest score for all attributes of juice was the juice at 40%. However, there was no significant difference among all concentrations. As observed from the sensory score, the flavor attribute received the lowest score for all attributes due to the unique smell of Horse mango that affected the flavor liking.

Table 5 Sensory test of Horse mango juice

Sensory attribute	Horse mango juice		
	20 %	40%	60%
Color[ns]	6.9 ± 1.4	6.9 ± 1.6	6.8 ± 1.6
Odor[ns]	6.9 ± 1.6	7.2 ± 1.6	6.9 ± 1.6
Flavor[ns]	6.7 ± 1.6	6.9 ± 1.8	6.8 ± 1.6
Taste[ns]	7.2 ± 1.8	7.2 ± 1.5	7.1 ± 1.5
Overall liking[ns]	7.2 ± 1.9	7.3 ± 1.6	7.2 ± 1.1

Remark: The results were expressed as average ± standard deviation. ns represented non-significant difference at $p < 0.05$

2. Consumer acceptance test

2.1 Information of Horse mango juice with 40%

The best concentration of Horse mango juice from the sensory test was 40% (Fig. 4). So, this concentration of juice was used in the next step for the consumer acceptance test. The 40% Horse mango juice products were analyzed for chemical content; moisture, carbohydrate, protein, fat, ash, vitamin C and beta-carotene content as 77.90 g/100g, 21.50 g/100g, 2.27 g/100g, 0.04 g/100g, 0.33 g/100g, 10.29 mg/100g and 0.61 mg/kg, respectively (Table 6). The beta-carotene content of juice (0.61 mg/kg) slight decreased compared to the beta-carotene content of fresh Horse mango (0.86 mg/kg) due to the pigment stability of beta-carotene that decreased with high temperature (Thakur, 2018). According to research regarding fresh Chokanan mango juice which showed carotenoid content as 82.03 µg/100 mL but when heat was transferred to the juice then the carotenoid content became 48.92 µg/100 mL (Santhirasegaram et al., 2013). Beta-carotene is a natural antioxidant related to reduce risk of cancer and is a precursors of vitamin A (Grune et al., 2010).

Fig. 4 Characteristics of 40% drink Horse mango juice

Table 6 Chemical properties of 40% Horse mango juice

Chemical quality	Quantity
Moisture (g /100g)	77.90 ± 0.0
Carbohydrate (g /100g)	21.50 ± 0.01
Protein (g /100g)	2.27 ± 0.01
Fat (g /100g)	0.04 ± 0.01
Ash (g /100g)	0.33 ± 0.01
Vitamin C (mg /100g)	10.29 ± 0.04
Beta-carotene (mg/kg)	0.61 ± 0.01

2.2 Consumer acceptance test

The 40% Horse mango juice was tasted for acceptance by 100 consumers (47 men and 53 women) who accepted the unique smell of Horse mango juice. Most of the consumers were aged under 20 years old (25%) and between the ages of 20-30 years (25%), most had education levels below a bachelor's degree (45%). While 34% were students that had an average monthly income less than or equal to 10,000 baht (41%). Most consumers decided to buy juice products with taste attributes (66%), frequency of drinking juice 1-2 times a week (36%) and bought juice products at department stores (32%) and convenience stores (32%).

The results of consumer acceptance scores on color, odor, taste and overall liking were equal to 4.1, 4.0, 4.0 and 4.0 as shown in Table 7 and which all attributes had a high level of liking. Consumer acceptance at 70% of Horse mango juice products and 66% of consumers decided to buy Horse mango juice products. However, the consumers acceptance of Horse mango juice were lower than 80% that might be due to the strong and unique smell of Horse mango. Therefore, mixing another fruit juice such as pineapple and orange juices might improve the consumers acceptance. According to research the mixed fruit juice by 35% mango juice, 40% orange juice and 25% pineapple was the best consumer acceptance and showed the highest score on sensory evaluation (Begam et al., 2018). Currently, most consumers are still unfamiliar with fresh local mango fruits so adding well known fruit juice such as pineapple and orange juices that have rich nutrients is a positive method to promote the local fruit.

Table 7 Acceptance score of 40% of Horse mango juice

Sensory attribute	Score
Color	4.1 ± 0.7
Oder	4.0 ± 0.8
Taste	4.0 ± 0.7
Overall liking	4.0 ± 0.6

Remark: The results were expressed as average ± standard deviation

Conclusion

The Horse mango (*Mangifera foetida* Lour.) flesh revealed L*(68.78), a*(-13.24) and b*(50.26), pH (3.37), and Total Soluble Solids (15.17 ^{o}Brix) Carbohydrate, protein, fat, ash, vitamin C and beta-carotene content were 12.67 g/100 g, 0.74 g/100 g, 0.48 g/100 g, 0.95 g/100 g, 29.98 mg/100 g, and 0.86 mg/kg, respectively. Horse mango are underutilized fruits. Therefore, ready-to-drink Horse mango juice products are an alternative juice that has benefits for health. Beta-carotene of all concentrations of horse mango juice increased with a higher

amount of Horse mango pulp, the same as b* value (yellowness) of juice. The 40% Horse mango juice received the highest score on all attributes (color, odor, flavor, taste and overall liking) and this concentration of juice was analyzed for chemical properties: moisture, carbohydrate, protein, fat, ash and beta-carotene content as 77.90 g/100 g, 21.50 g/100 g, 2.27 g/100 g, 0.04 g/100 g, 0.33 g/100 g 10.29 mg/100 g and 0.61 mg/kg, respectively. Microbiological tests of the products passed the Thai Community Product Standard (TCPS) 701/2557 and 70% of consumer accepted the ready-to-drink Horse mango juice products. Most consumers are still unfamiliar with fresh local mango fruits so adding well known fruit juice such as pineapple and orange juices can aid in promoting the local fruits which have rich nutrients.

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