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Development of Horse Mango (*Mangifera foetida*) Jam and Consumer Acceptance

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Abstract

The purposes of this research were to develop horse mango (*Mangifera foetida* Lour.) jam, to investigate the quality of the developed jam and consumer acceptance of horse mango jam. The methodology of research was conducted by studying three concentration levels (35%,45% and 55%) of ripe horse mango flesh suitable to be processed into horse mango jam and evaluating the jam properties: physical, chemical and microbiological quality and consumer acceptance of the jam. The experimental results indicated that ripe horse mango flesh could be suitably processed as jam, and that horse mango also had a unique smell. Furthermore, the quality of horse mango jam was investigated by measuring the quality of jam according to the Thai Community Product Standard (TCPS) criteria for coloring (L*a* b*) and spreadability used to deform the jam, it was found that 3 horse mango jams are concentrated in terms of color, odor and flavor, according to TCPS criteria: L*, a* decreased and b* increased when the concentration of horse mango jam increased. The texture of the jam decreased when the concentration of horse mango increased. Horse mango jam selection by sensory evaluation from 50 panelists found that horse mango jam 55% received the most favorable rating in terms of color, odor, flavor and overall liking and there was a significant difference with 35%, 45% jam ($p < 0.05$). When using 55% horse mango jam for chemical and microbiological quality, it was found that jam contains the amount of β-carotene at 1.04 g, moisture at 28.5 g, ash 0.56 g protein 0.45 g, carbohydrate and fat 0.73 g per 100 grams of horse mango jam. The amount of microbes detected was not up to the standard of TCPS. For the acceptance of 100 consumers, consumers accepted 97% of jam and decided to buy horse mango jam at 76%.

Introduction

Horse mango (*Mangifera foetida*) is in genus *Mangifera* that belongs to Anacardiaceae family, which is in the same genus as mango. It is an oval shaped and shell is green when ripe and also is orange-yellow with a sweet, sour taste, has a strong specific smell and a very rough texture (Wong & Ong,1993). Horse mango is a native plant in Indonesia, Malaysia, Myanmar, Singapore, Vietnam and Thailand. Horse mango is a native fruit of

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southern Thailand it can be found in many provinces of the southern region for instance, Phang Nga, Phuket, Trang, Krabi, Phatthalung Nakhon Si Thammarat, etc. (Kostermans & Bompard, 1993). It has names for other dialects such as mamud, som mut, malmut, muangmod, limus, bachang, machang etc., horse mango is cultivated widely and often mixed with other plants and will produce a lot during January to April.

Horse mango is a fruit that has high nutritional value, such as carbohydrates, dietary fiber, beta-carotene, vitamin C including other vitamins, including B vitamins and niacin (Lim, 2012), which have an antioxidant capacity 31.53 - 97.30% (Ikram & Khairul, 2009). The edible portion of horse mango represents 56% of fruit weight. For every 100 g edible portion of flesh, it contains 78.5 g water, 0.8 g protein, 17.9 g carbohydrates, 16 mg calcium, 19 mg phosphorus, 0.09 mg thiamine, 255 µg carotenes, and 47.4 mg vitamin C. There are the antioxidant capacity and antioxidant components in fresh, powder and fiber products prepared from horse mango (*Mangifera foetida*) fruit for example, reducing, flavonoid, carotenoid, and ascorbic acid contents were in the fresh, fiber and powder, whereas based on β-carotene bleaching method, order of antioxidant activity was fiber, powder, fresh in order. (Tyug et al., 2010).

Due to the unique characteristics of horse mango, when ripe has a strong smell and a coarse texture, the ripe horse mango is eaten or used relatively little, resulting in relatively low prices for fresh fruit. Farmers therefore prefer to use horse mango for cooking. However, there are still a lot of horse mangoes that cannot be sold. Mostly, horse mango is consumed as of soft fruit, and is popularly consumed as a savory dish like yellow curry. The researchers found that, there are only few products apply horse mango as an ingredient. There are studies have concentrated on the antioxidant properties of commercial mango (*Mangifera indica*), no research has been published on horse mango (*Mangifera foetida*). Thus, there is a need to explore the health promoting properties of this underutilized fruit. Horse mango can be produced into different food ingredients and products for example powder and fiber. Therefore, processing horse mango into a product adds value to the product.

Horse mango creates diversity for consumers and helps to conserve local plants in the southern region because if the products are not used in the future, farmers may turn to grow economic crops such as natural rubber, palm oil, which may cause local plants to disappear. Therefore, there is an idea to bring the ripe horse mango to develop into horse mango jam products. Because jam is one of the preservation methods that can be stored for a long time and has a simple method, while also helping to increase the value of raw materials from horse mango. In addition, there has never been a report about processing horse mango into jam products.

The best suitable technique to preserve perishable fruits is jam preparation which is an ancient way for preservation in several parts of the world. Jam is made of the pulp or the puree of a single or a mixed fruit by boiling fruits with sugar (sucrose), pectin, acid and other ingredients (preservative, coloring, limited amount of fruit peals and flavoring materials). Normally, jam should contain at least 40% of fruit component and the expected total soluble solid content should not less than 68%. Thus, jam should be in relatively stiff, solidity and set enough to carry the fruit tissues in position. Jams are full of sugar, energy, fiber, life-sustaining vitamins, minerals and amino acids. However, it does not contain any fat or cholesterol. In relation with the above reason, jam consumption is able to reduce the risk of cardiovascular disease (Bekele et al., 2020). In accordance with the announcement of the Ministry of Public Health in Thailand, jam is a product made from fruit ingredients. It can be whole fruit, piece of fruit, pulp or smoothie mixed with sugar, or mixed with fruit juice or concentrated fruit juice, after that make it suitable for consistency. It also includes vegetables suitable for jam, which is fresh, rotten, unhealthy or moldy by washing off dust, pesticides and other contaminated substances. The Ministry of Public Health has set the quality of the jam such as it must have the characteristic flavor of the jam, total soluble solid not less than 65%, pH between 2.8 to 3.5, no pathogenic microbes and there are no sweeteners other than sugar. It's consistent with the Codex Alimentarius specify that finished jam should contain more than 65% TSS (Codex Standard 79, 1981).

This research aims to increase the value of horse mango by developing into horse mango jam products along with studies in terms of physical quality and studies of consumer acceptance of horse mango jam products. Thai Community Product Standard is the quality specifications that are appropriate for community products to be trusted, accepted and guarantee for consumers of products by focusing on sustainable development for developing the quality of community products.

Materials and methods

1. Preparation of horse mango pulp

Horse mangoes were purchased from fresh markets and farm located at Nakhon Si Thammarat, Phatthalung and Trang provinces. Horse mango was used 8-10 cm. in size, with 20% yellow skin and above. Horse mangoes were washed, peeled and washed again because horse mango has quite a lot of rubber. The skins were carefully peeled with a kitchen knife and removed the seed from the flesh that yield of fruit is 60%. The yellow flesh is shown in Fig. 1 and 2. Then sliced horse mango into small pieces and blended with a blender, then filtered by a 60-mesh sieve to become pulp horse mango for making horse mango jam.

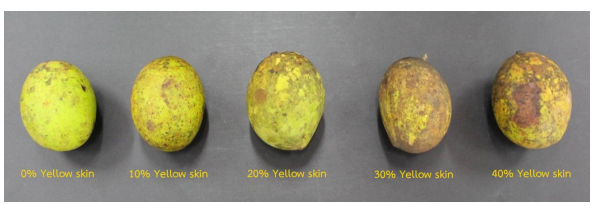

Fig. 1 The characteristics of horse mango

Fig. 2 The characteristics of horse mango's yellow skin with 20% yellowness

2. Preparation of horse mango jam

Horse mango jam products were developed by studying the suitable quantity of horse mango pulp at 3 different levels of concentration 35%, 45% and 55%, as shown in Table 1. Then, horse mango pulp mixture was heated at a temperature of about 80ºC, after that added sugar, pectin and stirred the mixture to be dissolved and added citric acid while measuring the amount of total soluble solid content should not less than 65% according to the standards was announced by the Ministry of Public Health, Thailand. Jam was filled in to sterilized container while was heat and was analyzed for physical, chemical and microbiological quality characteristic and sensory evaluation.

Table 1 Formula of horse mango pulp at different levels of concentration

Ingredients (%)	Horse mango pulp (% w/w)		
	35	**45**	**55**
Horse mango pulp	35.0	45.0	55.0
Water	21.0	11.0	1.0
Sugar	43.4	43.4	43.4
Pectin	0.2	0.2	0.2
Citric acid	0.4	0.4	0.4
Total	**100**	**100**	**100**

3. Quality of horse mango jam and selection of horse mango jam formula

3.1 Physical quality

3.1.1 Quality inspection in terms of appearance, color and flavor of all 3 levels of horse mango jam was conducted by 5 experts from the Culinary Technology and Service Program to inspect horse jam. From the analysis, sniffing and tasting according to the criteria of the Thai Community Product Standard No.342 in the topic of jam, which has set the criteria as follows: 3 points means good, 2 points means moderate and 1 point means abnormal.

3.1.2 Determination of color values of all 3 levels of horse mango jam, measure the color values with a color meter (Minolta colorimeter CR–410, Japan) and report the results as L* or brightness (0 = black, 100 = white), a* (+a = red, -a = green) and b* (+b = yellow, -b = blue)

3.1.3 Texture characteristics determination by applying all 3 horse mango jam levels to measure the spreadability with a texture analyzer (Stable Micro System TA.XT Plus). It uses a 45° conical probe Perspex (P/45C), pre-test speed 1 mm/s, distance 20 mm and trigger force 5 g to read the area under the graph as the spreadability of g.sec. (Sompongse et al., 2016)

3.2 Selection of horse mango jam formula

Horse mango jam formula was selected by sensory evaluation of all 3 levels of horse mango jam by liking the 9 point hedonic scaling test (9 = extreme like, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = extreme dislike) (Lawless & Heyman, 2010). The 50 untrained panelists was selected randomly from the students, the staffs and the lecturers of Suan Dusit University, Trang Center considered the different parameters like color, odor, flavor, texture, spreadability and overall acceptability, then analyzed for statistical results, then horse mango jam formula that received the most

acceptance scores and will be tested for microbiological quality and consumer acceptance testing.

3.3 Chemical quality

Horse mango jam with the most acceptable scores from sensory evaluation were investigated for chemical quality by measuring

3.3.1 Total soluble solid (TSS) by Hand Refractometer (ATAGO MASTER-M, China) (AOAC, 2000).

3.3.2 Beta-carotene (Britton et al., 2004)

2 g of finely ground horse mango samples were weighed. After that, saponification was done with ethanolic. KOH, soaked in ice and added hexanes to be used as extractors, rinse the Hexanes with the water for 2-3 more times to remove all the hexanes solution, then dried by rotary evaporator in the bath and analyzed by high-performance chromatography-diode array detection (HPLC-DAD). In the analysis, the solution must be prepared according to the standard concentration at 0, 0.5, 1.0, 2.0 3.0 and 4.0 g, then measured the absorbance of beta-carotene, calculate beta-carotene content from the area under the peak which is compared with the standard solution.

3.3.3 The content of the main compound in food is moisture, ash, protein, carbohydrate and fat (AOAC, 2016)

3.3.4 The pH value of horse mango jam was determined by using digital pH meter (SevenCompact, Mettler Toledo, Switzerland)

3.4 Microbiological quality

The analysis of microbiological quality in horse mango jam with the most accepted scores was conducted by total plate count, *Samonella* spp., *Staphylococcus aureus,* coliform by MPN, yeast and mold by FDA, BAM (Maturin & Peeler 2001) according to Thai Community Product Standard; TCPS (ICS 67.080.01)

4. Consumer acceptance test

The most highly-rated horse mango jam products from the sensory evaluation were tested for consumer acceptance using the 9 point hedonic scaling test (Lawless & Heyman, 2010). The test site is the Central Location Test (CLT) and 100 consumers (50 males and 50 females, 15-50 years old) at Huai Yot district, Trang province in terms of appearance, color, odor, flavor and overall acceptance.

5. Statistical Analysis

The physical quality and chemical analysis are done by planning a Complete Randomized Design (CRD). The selection of horse mango jam formula and consumer testing was done by planning a Randomized Complete Block Design (RCBD), then analyzing the variance and comparing the mean value with DMRT at 95% confidence level and interpret statistical results by using SPSS software.

Results and discussion

1. Physical quality

The results of the quality analysis of all 3 levels of horse mango jam showed that horse mango jam was yellow in color according to horse mango's characteristics. All 3 levels of jams were rated in terms of appearance, color and flavor (complies with the TCPS standard) and there was no significant difference $p > 0.05$ (Table 2).

Table 2 The acceptance's score of color, odor and flavor according TCPS standard

Characteristics	Horse mango puree (% w/w)		
	35	45	55
Appearance^{ns}	2.2 ± 0.45	2.2 ± 0.45	2.4 ± 0.55
Color^{ns}	2.6 ± 0.55	2.6 ± 0.55	2.6 ± 0.55
Flavor^{ns}	2.2 ± 0.45	2.2 ± 0.45	2.4 ± 0.54

Remark: ns means non significant differences ($p \geq 0.05$)

The results of color measurement of all 3 levels of horse mango jam showed that, when the concentration of horse mango jam increased; L* and b* values decreased, increased a* and were significantly different at $p < 0.05$. This is due to the characteristic of flesh horse mango says, when the ripeness level increases, the flesh becomes dark yellow until it becomes darker. Therefore, when the quantity of horse mango pulp increases, it results in less brightness (Table 3). In the past study, changing of color values as the results of thermal degradation during heat treatment, enzymatic browning, millard reaction and ascorbic acid degradation. (Ma et al., 2008)

The results showed that the texture characteristics of all 3 levels of horse mango jam by measuring the spreadability that indicates the force used to deform the jam, it was found that the spreadability tends to decrease as the concentration of horse mango increases. Horse mango at 45% and 55% concentration will have no significant difference on spreadability ($p > 0.05$) (Table 3). It therefore showed that when the amount of horse mango puree increases, the force used to deform the jam or decrease the force of the bread slice. Therefore, it

could be said that the viscosity of the jam decreases. This was due to an increase in the volume of horse mango puree while the sugar content remains the same, resulting in reduced gel set. Thus, the force used to deform the jam is reduced.

Table 3 Quality of coloring, texture of difference level for horse mango

Horse mango jam	Quality of coloring			Quality of texture
	L*	a*	b*	spreadability (g.sec)
Horse mango 35%	39.25 ± 0.18^{a}	4.46 ± 0.16^{b}	19.74 ± 0.38^{a}	557.62 ± 69.48^{a}
Horse mango 45%	36.47 ± 0.14^{b}	5.03 ± 0.19^{b}	15.01 ± 1.34^{b}	335.36 ± 18.14^{b}
Horse mango 55%	30.09 ± 0.22^{c}	5.96 ± 0.39^{a}	6.54 ± 0.21^{c}	337.15 ± 19.29^{b}

Remark: Each value is presented as mean ± standard deviation (n=3), different superscripts in the same column indicate significant differences ($p < 0.05$)

2. Selection of horse mango jam formula

The results of the selection of horse mango jam formula by testing the preference of all 3 levels of horse mango jam tester showed that, the testers rated the highest liking in terms of color, odor, flavor, spreadability and overall liking to horse mango jam at 55% concentration and were significantly different from horse mango jam at 35 and 45% but the texture did not different significantly from other concentrations ($p \geq 0.05$) (Table 4).

Table 4 Acceptance scoring of horse mango puree

Characteristics	Horse mango puree (% w/w)		
	35	45	55
Color	6.84 ± 0.99^{b}	6.64 ± 1.37^{b}	7.42 ± 1.26^{a}
Odor	6.38 ± 1.46^{b}	6.32 ± 1.15^{b}	7.24 ± 1.31^{a}
Flavor	6.40 ± 1.64^{b}	6.48 ± 1.50^{b}	7.80 ± 1.26^{a}
Texture^{ns}	6.88 ± 1.57	6.74 ± 1.41	6.94 ± 1.15
Spreadability	5.90 ± 1.54^{b}	7.38 ± 1.37^{a}	7.60 ± 1.05^{a}
Total acceptance	6.80 ± 0.93^{b}	6.88 ± 1.32^{b}	7.74 ± 1.03^{a}

Remark: Each value is presented as mean ± standard deviation (n=3), different superscripts in the same column indicate significant differences ($p < 0.05$), ns shown that there was no statistically significant difference ($p > 0.05$)

3. Chemical quality

The most favorite 55% horse mango jam products were analyzed for chemical quality by measuring total soluble solids, beta-carotene, moisture, ash, protein, carbohydrate and fat content. The pH value of horse mango jam found in 3.0 in according to Ministry of Public Health in Thailand and Codex. Moreover, there was the reported that pH value of the fruit is an important factor in jam processing because it is related with gel formation. The pH value of jam production should be between 3 and 3.5 (Bekele et al., 2020). However, the optimal pH for pectin gelatin is between pH 2.8 and 3.5. There were few other factors involved in reaching the perfect set and getting pectin to gel properly, but pH is absolutely key factor.

Table 5 Content of chemical quality of 55% horse mango jam

Chemical quality	Quantity (% w/w)
Beta-carotene	1.04
Moisture	28.5
Ash	0.56
Protein	0.45
Carbohydrate	70.4
Fat	0.73

4. Microbiological quality

Microbiological quality inspection for horse mango jam at a concentration of 55% in accordance with the Thai Community Product Standard (TCPS) 342/2018 found that horse mango jam has a standardized microbial value (Table 6). The production of horse mango jam was packed with the sterilized process, for the reason that the resulting in the amount of microbes is not exceeding the standard.

Table 6 Microbiological value

Microbiological	Microbiological value	
	TCPS standard 342/2561	Mamud jam 55%
Total plate count	Less than $1x10^{4}$ cfu/g	Less than 10 cfu/g
Salmonella spp.	Not detected	Not detected
Staphylococcus aureus	Less than 10 cfu/g	Less than 3 cfu/g
Coliform	Less than 3 MPN/g	Less than 3 MPN/g
Yeast and mold	Less than $1x10^{2}$ cfu/g	Less than 10 cfu/g

5. Consumer acceptance test

The consumer test results for 55% horse mango jam products selected for 100 consumers were as follows:

5.1 General information of consumers

General information of 100 consumers who tested acceptance of horse mango jam products, there were respondents consisting of equal numbers of males and females (50% of each gender), between the ages of 20-30 years (33%), most of them had education levels below bachelor degree (46%), most of them are students (43%) and an average monthly income of less than or equal to 10,000 baht (53%).

5.2 Jam consumption behavior

Consumer behavior data revealed that, most consumers choose to buy jam products by using flavor criteria (87%), frequency of eating jam 1-2 times a week (48%), the places to buy jam products are department stores (53%).

5.3 Consumer acceptance of horse mango jam products

Consumer test results on horse mango jam products by allowing the testers to taste horse mango jams and give scores on color odor, taste, texture, spreadability and overall liking on bread and overall liking. The results of their liking for the various features of horse mango jam products are as follows: the preference for color was at the level of 4.26, which was high; the odor was at the level of 3.87, which was moderate; the taste was 3.89, which was moderate; the texture is at a rating of 3.99, which was high; the spreadability on the bread was at the level of 4.03, which was high and overall liking was at the 4.00, which was high. Consumers acceptance 97% of horse mango jam products and decided to buy horse mango jam products, 76%. From the consumer acceptance test scores, horse mango can be used to make horse mango jam products. Although horse mango had a strong smell, when used as jam, the smell of horse mango had no effect on consumer acceptance.

Conclusion

The development of jam from horse mango fruits indicated that ripe horse mango flesh could be suitably processed as jam and applied on bread, Horse mango also had a unique smell. Furthermore, the quality of horse mango jam was investigated by measuring the quality of jam according to the Thai Community Product Standard (TCPS) criteria for coloring measurement (L* a* b*) and spreadability measurement used to deform the jam, it was found that all 3 horse mango jams are concentrated in terms of color, smell and flavor, according to TCPS criteria: L*, a* decreased and b* increased when the concentration of horse mango jam increased. The texture of the jam decreased when the concentration of horse mango increased. Horse mango jam selection by sensory evaluation from 50 panelists found that horse mango jam 55% received the most favorite rating in terms of color, odor, flavor and overall liking and there was a significant difference with 35% and 45% horse mango jam ($p < 0.05$). When using 55% horse mango jam for chemical and microbiological quality, it was found that Jam contains beta carotene at 1.04 g and moisture at 28.5g per 100 grams of horse mango jam. The amount of microbes detected was not up to the standard criteria of TCPS. For the acceptance of 100 consumers per horse mango jam product, consumers accepted 97% of horse mango jam products and decided to buy horse mango jam products at 76%.

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